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IDENTIFIERS	*Third International MAthematics and Science Study

ABSTRACT

This kit is designed to assist citizens and educators in using the findings from the Third International Mathematics and Science Study (TIMSS) to help improve related educational programs in the United States. The kit helps state and local policymakers, educators, and citizens compare their local community's education system for mathematics and science to those of other countries. The kit is divided into four modules: (1) Education; (2) Student Achievement; (3) Teaching; and (4) Curricula. Each module can be used independently. The modules contain multimedia resources, including reports on TIMSS findings, videotapes of classroom teaching, discussion guides, presentation overheads, checklists, leaflets, and flyers. The "Education" module, designed for individual and small-group use, contains an overview of TIMSS and a discussion of how science and mathematics education in the United States compares with that in 40 other countries. It includes a 13-minute videotape summarizing key TIMMS findings. The "Achievement" module discusses how U.S. students' performance in mathematics and science ranks internationally. The "Teaching" module evaluates how U.S. teaching compares internationally and how educators can use TIMSS as a resource to improve classroom instruction. This module also includes an 80-minute videotape of eighth-grade mathematics lessons from the U.S., Japan, and Germany. The "Curricula" module features a guidebook to help with curriculum selection and analysis. (AIM)

TIMSS AS A STARTING POINT TO EXAMINE:

U.S. EDUCATION

STUDENT ACHIEVEMENT

TEACHING

CURRICULA

U.S. DEPARTMENT OF EDUCATION
OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT
ORAD 97-1010

ATTAINING EXCELLENCE

Guide to the TIMSS Resource Kit

CONTENTS:

ORAD 97-1038

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ATTAINING
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GUIDE TO THE TIMSS RESOURCE KIT

U.S. DEPARTMENT OF EDUCATION
OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT

Improving U.S. Education Through International Comparisons

Attaining Excellence: A TIMSS Resource Kit is designed to help educators and citizens use the findings of the Third International Mathematics and Science Study (TIMSS) to improve the education we provide our nation's children. Based on the world's largest, most comprehensive, and rigorous international comparison of mathematics and science education, the kit will help state and local policymakers, educators, and citizens compare their community's education system to those of other countries. Its wealth of information about international student achievement, teaching, and curricula is designed to facilitate local discussions.

How to Use the TIMSS Resource Kit

The Resource Kit is a *catalyst* for careful analysis, open discussion, and considered action. Individuals—or groups among the education community, public decision makers, community leaders, and the general public—can use the kit to enlighten, explain, and stimulate. It *does not* tell schools and districts what they should or should not do. It does help schools, districts, parents, and the business community think about improving mathematics and science education.

The kit contains four modules: *TIMSS as a Starting Point to Examine U.S. Education, TIMSS as a Starting Point to Examine Student Achievement, TIMSS as a Starting Point to Examine Teaching,* and *TIMSS as a Starting Point to Examine Curricula*. These modules can also be obtained separately. While many may find all four modules useful, some may find it helpful to work with particular modules for specific groups. Individual modules can serve as the basis for faculty seminars and workshops, school board deliberations, student assemblies, town meetings, or PTA discussion groups. Special committees or task forces may use the modules to investigate various aspects of state or local education programs in light of the TIMSS findings.

The kit consists of multimedia resources including clear, understandable reports on TIMSS findings; videotapes of classroom teaching; guides for using this information in discussions; presentation overheads with talking points for speakers, checklists, leaflets, and flyers.

All contents of *Attaining Excellence: A TIMSS Resource Kit* are in the public domain. Authors of copyrighted work included in the kit have given permission for their work to be reproduced. Therefore, users may reproduce or adapt all materials contained in this kit in any form they desire. Those interested in reprinting the kit or any of the materials that appear in this kit may obtain a camera-ready, zip-file version of the kit suitable for professional printers by contacting the National Center for Education Statistics' TIMSS Customer Service Line at (202) 219-1333.

Where to Get More Information on TIMSS and the Resource Kit

The National Center for Education Statistics (NCES) will make *Attaining Excellence: A TIMSS Resource Kit* available for downloading on its World Wide Web site at http://www.ed.gov/NCES/timss. For additional information, call the TIMSS Customer Service Line at (202) 219-1333. Or, write to Lois Peak, TIMSS Project Officer, National Center for Education Statistics, U.S. Department of Education, 555 New Jersey Avenue, NW, Washington, DC 20208-5574.

Contents of Attaining Excellence: A TIMSS Resource Kit

GUIDE TO THE TIMSS RESOURCE KIT

This brief guide to the kit includes a list of the contents, an introduction to the kit and its varied uses, an overview of the different modules in the Resource Kit, and a summary of the Third International Mathematics and Science Study (TIMSS) reports on grades eight and four.

OVERVIEW MODULE

Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education

What is TIMSS? Why is it important? How does U.S. mathematics and science education compare with that of 40 other nations? This module, designed for individual and small-group use, sheds new light on education in the United States through the prism of other countries. It features the following publications and videotape:

6

Introduction to TIMSS: The Third International Mathematics and Science Study—A comprehensive overview of TIMSS' purpose, scope, and findings. The booklet also includes overhead transparencies and other materials to facilitate community discussions about TIMSS.

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context—The NCES eighth-grade TIMSS report released November 20, 1996.

Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context—The NCES fourth-grade TIMSS report released June 10, 1997.

A Video Presentation of Pursuing Excellence: U.S. Eighth-Grade Findings from TIMSS—A 13-minute VHS tape summarizing key findings in the report.

Discussion Guide for "A Video Presentation of Pursuing Excellence"—A viewer workbook and suggestions for moderators leading community meetings or small-group discussions.

ACHIEVEMENT MODULE

ATTAINING EXCELLENCE: TIMSS AS A STARTING POINT TO EXAMINE STUDENT ACHIEVEMENT

How does our young people's performance in mathematics and science rank internationally? This module, designed for individual or small-group use, features the following publications and makes the TIMSS findings about eighth-grade student achievement relevant to local decision makers, educators, and parents:

Benchmarking to International Achievement—A guide to the international eighth-grade TIMSS reports that facilitates reflection about U.S. student achievement in comparison to the achievement of students in other TIMSS countries.

Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)—A TIMSS International Study Center report that presents findings on eighth-grade mathematics achievement and schooling in 41 countries.

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)—A TIMSS International Study Center report that presents findings on eighth-grade science achievement and schooling in 41 countries.

TEACHING MODULE

Attaining Excellence: TIMSS as a Starting Point to Examine Teaching

How does U.S. teaching stack up internationally? How can educators draw upon TIMSS to continue to improve classroom instruction? Using videotapes of actual eighth-grade mathematics lessons from the United States, Japan, and Germany, this module vividly demonstrates differences and similarities in teaching styles and the purposes underlying instructors' techniques. This module is designed for teachers and those who work with them and includes the following publications and videotape:

Eighth-Grade Mathematics Lessons: United States, Japan, and Germany—An 80-minute VHS tape with abbreviated versions of six eighth-grade mathematics lessons: one algebra and one geometry lesson each from the United States, Japan, and Germany.

Moderator's Guide to Eighth-Grade Mathematics Lessons: United States, Japan, and Germany—A discussion guide to the video structured for those leading half-day or full-day seminars. Appendices include transcripts of the lessons, notes on the lessons, and contextual information about mathematics teaching in the three countries.

Fostering Algebraic and Geometric Thinking: Selected Standards from the NCTM Standards Documents—Selected excerpts from the *Curriculum and Evaluation Standards for School Mathematics* and *Professional Standards for Teaching Mathematics* by the U.S. National Council of Teachers of Mathematics (NCTM).

Mathematics Program in Japan (Kindergarten to Upper Secondary School)—The official English translation of the Japanese Ministry of Education National Course of Study for Mathematics.

CURRICULA MODULE

Attaining Excellence: TIMSS as a Starting Point to Examine Curricula

What is taught in mathematics and science? What is included in instructional materials? This module features a guidebook to help all of those involved in curriculum selection evaluate their own offerings and use the information to develop new curricula. It includes curriculum-analysis models anchored to frameworks and standards. The guide is designed for all of those involved in curriculum selection and may require outside assistance to actually undertake curriculum analyses.

Guidebook to Examine School Curricula—A guidebook for use by school and district educators to evaluate and analyze curricula. It includes an overview of curriculum reform, a guide to using the module, the TIMSS curriculum-analysis methodology, and other models for analyzing curricula from several sources: the National Science Foundation, the American Association for the Advancement of Science Project 2061, the state of California, and the Council of Chief State School Officers. It also includes an executive summary of the TIMSS report on mathematics and science curricula, *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, and an annotated bibliography.

TIMSS Overview and Key Findings from *Pursuing Excellence*

With information on a half-million students worldwide, including more than 33,000 U.S. youth in more than 500 U.S. public and private schools, the Third International Mathematics and Science Study (TIMSS) conducted in 1995 is the largest, most comprehensive, and most rigorous international study of schools and students ever conducted. Students from 41 nations, including our country's major trading partners, were tested at three different grade levels (fourth, eighth, and upon completion of secondary school) to compare their mathematics and science achievement.

TIMSS researchers conducted intensive studies of students, teachers, schools, curricula, instruction, lessons, textbooks, and policy issues to understand the educational context in which mathematics and science learning take place. By combining multiple methodologies and scientific sampling procedures that go beyond simple student test score comparisons and questionnaires, TIMSS created a complete and accurate portrait of how U.S. mathematics and science education differs from that of other nations.

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context was the first TIMSS report released by the Office of Educational Research and Improvement, U.S. Department of Education, in November 1996. Key findings include the following:

- U.S. eighth graders score below average in mathematics achievement and above average in science achievement, compared to the overall average of the 41 nations in the TIMSS assessment.
- In mathematics, our eighth-grade students' international standing is stronger in Algebra and Fractions than in Geometry and Measurement.
- In science, our eighth graders' international standing is stronger in Earth Science, Life Science, and Environmental Science and the Nature of Science than in Chemistry and Physics.
- The United States is one of 11 TIMSS nations in which there is no significant gender gap in eighth-grade mathematics and science achievement.
- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.
- Most U.S. mathematics teachers report familiarity with reform recommendations, although only a few apply the key points in their classrooms.
- Evidence suggests that U.S. teachers do not receive as much practical training and daily support as their Japanese and German colleagues.

No single factor can be considered to influence student performance in isolation from other factors. There are no simple answers to complex questions.

(continued on reverse)

The fourth-grade report, *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context,* was released by the Office of Educational Research and Improvement, U.S. Department of Education, in June 1997. Key findings include the following:

- U.S. fourth graders score above average in both mathematics and science, compared to the 26 nations in the assessment. In science, only Korea outperforms the United States.
- U.S. students' international standing is stronger at the fourth-grade level than it is at the eighth-grade level in both mathematics and science.
- U.S. students' international standing is stronger in science than it is in mathematics at both the fourth- and eighth-grade levels.
- In mathematics, 9 percent of U.S. fourth graders would rank among the world's top 10 percent. In science, 16 percent of U.S. fourth graders would rank among the world's top 10 percent.
- In mathematics content areas, our fourth graders' performance exceeds the international average in Whole Numbers, Fractions, Data Representation, Geometry, and Patterns. Our students are below the international average in Measurement.
- In science content areas, our fourth graders' performance exceeds the international average in all four of the areas assessed: Earth Science, Life Science, Physical Science, and Environmental Issues and the Nature of Science.
- There is no significant gender gap in fourth-grade mathematics achievement. However, in some content areas of fourth-grade science, U.S. boys outperform U.S. girls.
- Differences between the U.S. average and the international average for most factors which might influence achievement are relatively small. Many factors in which the U.S. average exceeds the international average at the fourth-grade level are not shared by the countries that outperform us.
- Many factors in the United States are similar at both fourth- and eighth-grade levels. Because many of the differences between the grades in the United States also characterize many other TIMSS countries, they cannot account for differences in our students' relative performance at these grade levels.

TIMSS provides a lens through which we can see our nation's education in comparative perspective and identify aspects of education that deserve our attention.

TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and by the National Science Foundation.

For more information on TIMSS, or to download TIMSS reports, visit the World Wide Web site at http://www.ed.gov/NCES/timss. Or, call the TIMSS Customer Service Line at (202) 219-1333. Or, write to Lois Peak, TIMSS Project Officer, National Center for Education Statistics, U.S. Department of Education, 555 New Jersey Avenue, NW, Washington, DC 20208-5574.

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ATTAINING EXCELLENCE

A TIMSS RESOURCE KIT

Learning From TIMSS: How Does U.S. Education Compare Internationally?

Curious about how math and science education in the United States compares with that of 40 other countries?

The Third International Mathematics and Science Study (TIMSS)—the largest, most comprehensive international comparison of mathematics and science education—provides a lens through which educators can see themselves in international perspective.

Attaining Excellence: A TIMSS Resource Kit uses the information learned from TIMSS to help educators, practitioners, policymakers, and concerned citizens reflect deeply upon their own local practices. The TIMSS Resource Kit will help you find out:

- How U.S. math and science education compares with that of other countries,
- How U.S. curricula and expectations for student learning compare with those of other countries, and
- How teaching practices in the United States compare with those in Japan and Germany.

Attaining Excellence: A TIMSS Resource Kit

($94; stock #065-000-01013-5)
The multimedia Resource Kit includes four modules containing the following items:

- Clear, easy-to-understand reports on the TIMSS findings;
- Videotapes of classroom teaching in the United States, Japan, and Germany;
- Guides for discussion leaders;
- Presentation overheads with talking points for speakers; and
- Checklists, leaflets, and flyers.

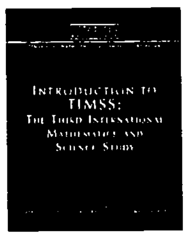
The Resource Kit contains a guide to the kit and four modules: U.S. Education, Student Achievement, Teaching, and Curricula. The contents of each module are described to the right. Please note that the modules and most individual items may also be purchased separately.

U.S. Education Module

Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education
($37; stock #065-000-01014-3)

This module presents an overview of the TIMSS findings. It is designed for individual and small-group use. It features the following publications and video:

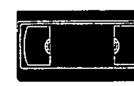
Introduction to TIMSS: The Third International Mathematics and Science Study—A comprehensive overview of TIMSS' purpose, scope, and findings. The booklet also includes overhead transparencies, talking points for speakers, and other materials to facilitate community discussions about TIMSS. *Introduction to TIMSS: The Third International Mathematics and Science Study* is included in the *U.S. Education Module* when purchased separately or as part of the *TIMSS Resource Kit*. This book is also included in the other modules when those modules are purchased separately.



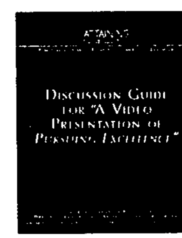
Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context—The official report by the National Center for Education Statistics describing U.S. eighth-grade student achievement and schooling in comparative perspective. ($9.50; stock #065-000-00959-5)

Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context—The official report by the National Center for Education Statistics describing U.S. fourth-grade student achievement and schooling in comparative perspective. ($4.75; stock #065-000-01018-6)

A ***Video Presentation of Pursuing Excellence: U.S. Eighth-Grade Findings from TIMSS***—A 13-minute VHS tape summarizing key findings in the report with commentary by various education and business leaders. ($20; stock #065-000-01003-8)



Discussion Guide for "A Video Presentation of Pursuing Excellence"—A viewer workbook and ideas for moderators leading community meetings or small-group discussions. ($5.50; stock #065-000-01021-6)



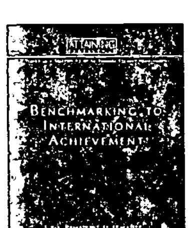
Student Achievement Module

Attaining Excellence: TIMSS as a Starting Point to Examine Student Achievement
($51; stock #065-000-01015-1)

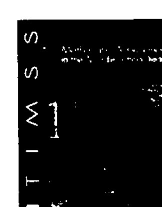
This module, designed for individual or small-group use, features the following publications and makes the TIMSS findings relevant to local decision makers, educators, and parents:

Introduction to TIMSS: The Third International Mathematics and Science Study—See *U.S. Education Module*. (Not sold separately.)

Benchmarking to International Achievement—A guide to the international eighth-grade TIMSS reports that uses actual test items to facilitate comparisons of U.S. student achievement with achievement of students in other TIMSS countries. ($3.75; stock #065-000-01022-4)



Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)—A TIMSS International Study Center report that presents findings on eighth-grade mathematics achievement and schooling in 41 countries. (S18; stock #065-000-01023-2)



Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)—A TIMSS International Study Center report that presents findings on eighth-grade science achievement and schooling in 41 countries. ($19; stock #065-000-01024-1)

Teaching Module

Attaining Excellence: TIMSS as a Starting Point to Examine Teaching

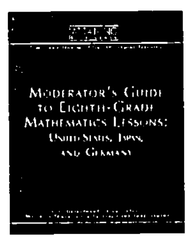
($31; stock #065-000-01016-0)

Using videotapes of actual eighth-grade mathematics lessons from the United States, Japan, and Germany, this module vividly demonstrates differences and similarities in teaching styles and techniques of educators in these countries. This module is designed for teachers, and those who work with them, and includes the following publications and videotape:

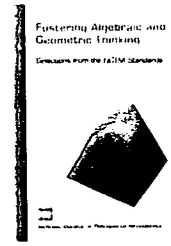
Introduction to TIMSS: The Third International Mathematics and Science Study*—See *U.S. Education Module. (Not sold separately.)

***Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*—**An 80-minute VHS tape with abbreviated versions of six eighth-grade mathematics lessons: one algebra and one geometry lesson each from the United States, Japan, and Germany. ($20; stock #065-000-01025-9)

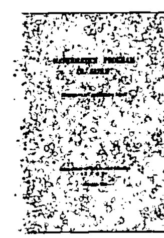
***Moderator's Guide to Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*—**A discussion guide to the video designed for those leading half-day or full-day seminars. Appendices include transcripts of the lessons, notes on the lessons, and contextual information about mathematics teaching in the three countries. ($12; stock #065-000-01026-7)



***Fostering Algebraic and Geometric Thinking: Selections from the NCTM Standards*—**Excerpts from the *Curriculum and Evaluation Standards for School Mathematics* and *Professional Standards for Teaching Mathematics* by the National Council of Teachers of Mathematics (NCTM). ($4.75;-stock #065-000-01027-5)



***Mathematics Program in Japan (Kindergarten to Upper Secondary School)*—**The official English translation of the Japanese Ministry of Education National Course of Study for Mathematics. ($4.75; stock #065-000-01028-3)



Curricula Module

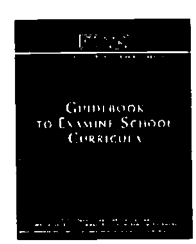
Attaining Excellence: TIMSS as a Starting Point to Examine Curricula

($33; stock #065-000-01017-8)

This module features a guidebook to help those involved in curriculum selection evaluate their own offerings. It includes curriculum analysis models, frameworks, and standards.

Introduction to TIMSS: The Third International Mathematics and Science Study*—See *U.S. Education Module. (Not sold separately.)

***Guidebook to Examine School Curricula*—**A guidebook for use by school and district educators to evaluate and analyze curricula. It includes an overview of curriculum reform, a guide to using the module, the TIMSS curriculum analysis methodology, and other models for analyzing curricula from several sources: the National Science Foundation, the American Association for the Advancement of Science's Project 2061, the State of California, and the Council of Chief State School Officers. The executive summary of the TIMSS report on mathematics and science curricula, *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, and an annotated bibliography are included. (Not sold separately.)



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Attaining Excellence: A TIMSS Resource Kit is designed to help educators and citizens use the findings of the Third International Mathematics and Science Study (TIMSS) to improve the education we provide our nation's children.

The kit—based on the world's largest, most comprehensive, and most rigorous international comparison of mathematics and science education—will help state and local policymakers, educators, and citizens compare their education systems with those of other countries. This represents the most comprehensive effort to date by the U.S. Department of Education to assemble significant research findings and present them in a format that can be used by educators for discussion.

TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and the National Science Foundation. The study tested the mathematics and science knowledge of students in 41 countries during the 1995 school year.

To order ***Attaining Excellence: A TIMSS Resource Kit***, contact the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250-7954; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: orders@gpo.gov; World Wide Web: http://www.access.gpo.gov/su_docs. Also may be downloaded from: http://www.ed.gov/NCES/timss

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TIMSS as a Starting Point to Examine U.S. Education

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Introduction to TIMSS: The Third International Mathematics and Science Study

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TIMSS AS A STARTING POINT TO EXAMINE U.S. EDUCATION

INTRODUCTION TO TIMSS: THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

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Contents

TIMSS AS A STARTING POINT TO EXAMINE U.S. EDUCATION

In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that the United States will be "first in the world in mathematics and science achievement by the year 2000." The Third International Mathematics and Science Study (TIMSS) shows that our nation has not yet reached this mark.

Attaining Excellence: A TIMSS Resource Kit is designed to provide educators, parents, business leaders, government officials, and community leaders with information and tools they can use to help students, teachers, and school officials examine their own performance in an international perspective. It brings the main findings of the TIMSS study directly to the states, districts, schools, and classrooms. Through this information, local teaching, achievement, and curricula can be compared to those of other countries. Such a review can help schools find ways to help all students—including children with disabilities, limited English proficiency, and traditionally disadvantaged backgrounds—reach higher levels and achieve greater success.

The first step in any journey is to determine the starting point. TIMSS is such a beginning. It helps us scrutinize the quality and effectiveness of U.S. education by holding up a mirror to how well our students perform, comparing our results with those of other countries, and thereby providing us with a solid basis for judging our performance.

But TIMSS goes further. It also provides deep insights into our own methods of teaching and learning. It affords an unprecedented opportunity to view our education system through the prism of other countries' techniques and achievements.

Such a comparison helps us understand our own practices better and also suggests possible alternatives. The goal of this Resource Kit is not to prescribe practices to be adopted, but rather to provide insights from TIMSS to make our own unique processes of education more effective.

This overview, *Introduction to TIMSS: The Third International Mathematics and Science Study*, helps educators and others in states, communities, and schools to use TIMSS as a starting point. It provides a succinct overview of the TIMSS study, key findings and conclusions from the eighth- and fourth-grade reports, and supporting materials to help communities and states use TIMSS to examine their own practices from an international perspective. This booklet includes the following major sections:

- Overview of TIMSS—A basic summary of what TIMSS is and how it was conducted.
- Key TIMSS Results: Eighth Grade—What TIMSS tells us about U.S. eighth-grade achievement in international perspective.
- Key TIMSS Results: Fourth Grade—What TIMSS tells us about U.S. fourth-grade achievement in international perspective.
- TIMSS Presentation Overheads—A set of black-line masters that can be duplicated onto overhead transparencies for introducing TIMSS to various audiences. These overheads highlight key facts that audiences should learn about the study and its findings.
- Presentation Talking Points—Accompanying remarks for the presentation overheads to help the presenter highlight or elaborate upon major points.
- Sample Meeting Announcement—A black-line prototype meeting announcement to aid in developing flyers and posters for TIMSS community meetings.
- Information on the CD-ROM version of *Attaining Excellence: A TIMSS Resource Kit*—A version of these documents on disc for use by schools and school districts.
- Sources of Other TIMSS Reports—A list of sources for ordering a variety of TIMSS-related analyses and reports.
- TIMSS Resource Kit Questionnaire—We believe that customers are the best judges of what works in making TIMSS products useful to a variety of audiences, and we urge you to fill out the questionnaire and send it to the U.S. Department of Education, Office of Educational Research and Improvement (OERI).

Attaining Excellence: A TIMSS Resource Kit is only one of the many ways to learn about TIMSS. In the coming years, new reports and resources will be published by the Office of Educational Research and Improvement, including modules on assessment and twelfth-grade TIMSS results. TIMSS material also can be found at the National Center for Education Statistics' TIMSS site on the World Wide Web at http://www.ed.gov/NCES/timss.

Overview of TIMSS—An Unprecedented International Study

With data from a half-million students, the 1995-1996 Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study ever conducted. Students from 41 nations were tested in 30 different languages at three different education levels to compare their mathematics and science achievement. Intensive studies of students, teachers, schools, curricula, instruction, and policy issues were also carried out to understand the educational context in which teaching and learning take place. In the United States, over 33,000 students and more than 500 schools were included.

Policymakers recognize that a nation's mathematical and scientific literacy affect economic productivity. World-class competence in mathematics and science is essential to compete successfully in today's interdependent global marketplace. TIMSS provides a comparative international assessment of educational achievement in these two subjects and the factors that contribute to it.

TIMSS Countries

Australia	**France**	**Korea**	**Singapore**
Austria	**Germany**	**Kuwait**	**Slovak Republic**
Belgium (Flemish)	**Greece**	**Latvia**	**Slovenia**
Belgium (French)	**Hong Kong**	**Lithuania**	**South Africa**
Bulgaria	**Hungary**	**Netherlands**	**Spain**
Canada	**Iceland**	**New Zealand**	**Sweden**
Colombia	**Iran, Islamic Republic**	**Norway**	**Switzerland**
Cyprus	**Ireland**	**Portugal**	**Thailand**
Czech Republic	**Israel**	**Romania**	**United States of America**
Denmark	**Japan**	**Russian Federation**	
England		**Scotland**	

TIMSS—More Than a Report Card

TIMSS is an important study for those interested in U.S. education. In 1983, the National Commission on Excellence in Education pointed to our nation's low performance in international studies as evidence that we were *A Nation at Risk.* In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the United States will be the first in the world in mathematics and science achievement."

Mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989, and *Professional Standards for Teaching Mathematics* in 1991.

In 1993 the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy,* and in 1996, the National Academy of Sciences published *National Science Education Standards.*

TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science. But TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. It was designed to look beyond the scorecard to illuminate how our education policies and practices compare to those of the world community.

TIMSS helps us answer several critical questions about our nation's mathematics and science learning:

- **Achievement**—Do U.S. students know as much mathematics and science as students in other countries?
- **Curriculum**—Are U.S. curricula and expectations for student learning as demanding as those of other nations?
- **Teaching**—How does U.S. classroom instruction compare with that of other countries?
- **Teachers' Lives**—Do U.S. teachers receive as much support in their efforts to teach students as do their colleagues in other nations?
- **Students' Lives**—Are U.S. students as focused on their studies as their international counterparts?

The National Center for Education Statistics of the U.S. Department of Education already has and will continue to publish numerous reports that summarize findings of the study. Publications include the *Pursuing Excellence* series, which comprises three separate reports on mathematics and science achievement at the fourth, eighth, and twelfth grades. Over the next several years, additional reports on selected topics will be published.

Rigorous Quality Control

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is not a comparison of "all our students with other nations' best"—a charge that some critics have leveled at previous international comparisons. The students who participated in TIMSS were selected randomly to represent all students in their respective nations.

The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities in the assessment process arose, such as differences in ages of students, are clearly noted in the reports. At each step of its development, TIMSS researchers followed careful quality-control procedures. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the tests reflected the mathematics and science curricula of the variety of TIMSS countries and did not overemphasize what is taught in only a few.

International monitors carefully checked the test translations and visited many classrooms while the tests were being administered in each of the 41 countries to make sure that the instructions were properly followed. The raw data from each country were scrutinized to be sure that no anomalies existed, and all analyses were double-checked. Finally, the TIMSS reports and related materials published by the National Center for Education Statistics were written and carefully reviewed to avoid overgeneralization and inaccuracy.

Focus on Fourth, Eighth, and Twelfth Grades

TIMSS was designed to focus on students at three stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Because various countries set different ages at which children should begin school, decisions about which students to test needed to consider both age and grade level.

Who was Tested

Population 1	**Students in the pair of adjacent grades containing the most nine-year-olds**	**Grades three - four in the United States**
Population 2	**Students in the pair of adjacent grades containing the most 13-year-olds**	**Grades seven - eight in the United States**
Population 3	**Students in their final year of secondary school, regardless of age**	**Grade 12 in the United States**

In all countries, students in both public and private schools received the TIMSS test. In all but a few of the 41 TIMSS countries, virtually all children in Populations 1 and 2 are enrolled in school and are therefore eligible to take the test. Testing occurred two to three months before the end of the 1995-1996 school year. Students with special needs and disabilities that would make it difficult for them to take the test were excused from the assessment. In each country, the test was translated into the primary language or languages of instruction. All testing in the United States was done in the English language.

Data Collection Methods

TIMSS brought a variety of different and complementary research methods to bear on the important education questions posed in the study by the International Association for the Evaluation of Educational Achievement (IEA). Five different approaches were used: assessments, questionnaires, curriculum analyses, videotapes of classroom instruction, and case studies of policy topics. Each of these five approaches used in TIMSS represents an important advancement in its field. Taken together, they create an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

All TIMSS countries participated in the following three IEA-sponsored parts of the study:

- **Mathematics and science assessments**—One and one-half hours in length, the assessments included both multiple-choice and free-response items. A smaller number of students also completed "hands-on" performance assessments.
- **School, teacher, and student questionnaires**—Students answered questions about their mathematics and science studies and beliefs. Teachers answered questions on their beliefs about mathematics and science and on teaching practices. School administrators answered questions about school policies and practices.
- **Curriculum analysis**—This exploratory study compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance.

In-Depth Studies of the United States, Japan, and Germany

In conjunction with the three activities above, the National Center for Education Statistics sponsored two additional TIMSS-related studies, which were carried out in the United States, Japan, and Germany. These three countries are all economic superpowers with close economic and political ties. They also are nations whose educators have learned a great deal from each other in the past and whose school systems are both similar to and different from each other in important ways. TIMSS researchers in the United States, Japan, and Germany collaborated in sharing their assessment and questionnaire data and in carrying out the following two parts of the study:

- **Videotapes of mathematics instruction**—In the United States and Germany, half of the eighth-grade mathematics classrooms that participated in the main TIMSS study were randomly chosen to be videotaped. In Japan, eighth-grade classrooms in a random sample of 50 of the TIMSS schools were chosen. In all three countries teachers were filmed teaching a typical lesson, and these tapes were analyzed to compare teaching techniques and the quality of instruction.
- **Ethnographic case studies of key policy topics**—Teams of bilingual researchers spent three months in the United States, Japan, and Germany, observing classrooms and interviewing education authorities, principals, teachers, students, and parents. Topics of study were education standards, methods of dealing with individual differences, the lives and working conditions of teachers, and the role of school in adolescents' lives.

The TIMSS Research Team

TIMSS was conducted by the IEA, a Netherlands-based organization of ministries of education and research institutions in its member countries. The IEA delegated responsibility for overall coordination and management of the study to Professor Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the 41 IEA member-nations that made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The costs of the international coordination were paid for by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government.

In the United States, TIMSS was funded by NCES and NSF. Professor William Schmidt of Michigan State University was the U.S. National Research Coordinator. Lois Peak of NCES monitored the international and U.S. data collections.

The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. Professor James Stigler at the University of California at Los Angeles managed the TIMSS videotape study of mathematics instruction, and Professor Harold Stevenson at the University of Michigan managed the TIMSS ethnographic case studies. Experts from many fields served as advisors to the study. The U.S. TIMSS team also included the students, teachers, and principals who participated in the data collection. Their cooperation made the TIMSS project possible.

Key TIMSS Results: Eighth Grade

Student Achievement

One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. Although at the eighth-grade level we are far from this mark, we are on par with other major industrialized nations, such as Canada, England, and Germany.

In mathematics, our eighth graders score...

- Below the international average of 41 TIMSS countries. Our students' scores are not significantly different from those of England and Germany.
- At about the international average in Algebra; Fractions; and Data Representation, Analysis, and Probability. We do less well in Geometry, Measurement, and Proportionality.

In science, our eighth graders score...

- Above the international average of 41 TIMSS countries. Our students' scores are not significantly different from those of Canada, England, and Germany.
- Above the international average in Earth Science, Life Science, and Environmental Issues and the Nature of Science. Our students score about average in Chemistry and Physics.

If an international talent scout selected the top 10 percent of all eighth graders in the 41 TIMSS countries...

- In mathematics, 5 percent of U.S. students would be included.
- In science, 13 percent would be included.

Curriculum

U.S. policymakers are concerned about whether expectations for our students are high enough and, in particular, whether they are as challenging as those of our foreign economic partners. In all countries, the relationships among standards, teaching, and learning are complex. This is even more true in the United States, which is atypical among TIMSS countries in that curriculum is defined at the local, rather than national, level.

- The mathematics content of U.S. eighth-grade classes is at a seventh-grade level in comparison to other countries.
- The U.S. eighth-grade mathematics curricula include more topics than those of other countries.
- The number of topics in the U.S. eighth-grade science curricula may be similar to that of other countries.
- U.S. eighth graders spend more hours per year in mathematics and science classes than German and Japanese students.

Teaching

In recent years, concern about the quality of instruction in U.S. classrooms has led professional organizations to issue calls for reform. TIMSS data cannot tell us about the success of these reform efforts for several reasons. This assessment occurred too soon after the beginning of the movement for states and districts to have designed their own programs, retrained teachers, and nurtured a generation of students according to the new approach. Also, we do not have comparable earlier baseline information against which to compare findings from TIMSS.

However, TIMSS includes the first large-scale observational study of U.S. mathematics teaching ever undertaken. Therefore, it forms a historical baseline against which future progress may be measured.

- The content of U.S. mathematics classes requires less high-level mathematical thought than classes in Germany and Japan.
- U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help them understand mathematical concepts.
- Japanese teachers widely practice what the U.S. mathematics reform recommends, while U.S. teachers do so less frequently.
- Although most U.S. mathematics teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.

Lives of Teachers

The training that teachers receive before they enter the profession, and the regular opportunities that they have for on-the-job learning and improvement, affect the quality of classroom teaching. The collegial support that teachers receive and the characteristics of their daily lives also affect the type of teaching they provide.

- Unlike new U.S. teachers, new Japanese and German teachers undergo long-term structured apprenticeships in their profession.
- U.S. teachers have more college education than their colleagues in all but a few TIMSS countries.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for German teachers as well.

Lives of Students

The manner in which societies structure the schooling process gives rise to different opportunities and expectations for young people. The motivators, supports, and obstacles to study in each country are outgrowths of the choices provided by society and schools.

- Eighth-grade students of different abilities are typically divided into different classrooms in the United States and into different schools in Germany. In Japan, no ability grouping is practiced until entrance to high school at the tenth grade.
- In mathematics, U.S. students in classes of higher ability levels study different material than students in lower level classes. In Germany and Japan, all students study basically the same material, although in Germany the depth and rigor of study depends on whether the school is for students of higher or lower ability levels.
- Japanese eighth graders are preparing for a high-stakes examination to enter high school at the end of ninth grade.
- Teachers assign more homework and spend more class time discussing it than teachers in Germany and Japan. U.S. students report about the same amount of out-of-school mathematics and science study as their Japanese and German counterparts.
- Heavy TV watching is as common among U.S. eighth graders as it is among their Japanese counterparts.

Conclusions from Eighth-Grade TIMSS

The report, *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context,* presents initial findings from TIMSS for eighth-grade mathematics and science. A fuller understanding of the health of education in our nation must await the integration of these and the fourth-grade data with information gathered at the twelfth-grade level.

The search for factors associated with student performance is complicated, because student achievement after eight years of schooling is the product of many different factors. Furthermore, the U.S. education system is large and decentralized with many interrelated parts. With these cautions in mind, the eighth-grade report in the *Pursuing Excellence* series offers the following insights into factors that may be associated with our students' performance.

- No single factor in isolation from others should be regarded as the solution to improving the performance of U.S. eighth-grade students.
- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.
- Although most U.S. mathematics teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.
- Evidence suggests that U.S. teachers do not receive as much support when they enter the teaching profession as their German and Japanese colleagues do.

Key TIMSS Results: Fourth Grade

Student Achievement

President Clinton praised U.S. fourth graders for their performance on the TIMSS test, saying that the results showed that "we can be the best in the world if we simply believe it and then organize ourselves to achieve it." Education Secretary Richard W. Riley said that TIMSS shows that U.S. children "can compete with those anywhere in the world."

In mathematics, U.S. fourth graders score...

- Above the international average of the 26 TIMSS countries. Our students' scores are not significantly different from those of Canada and exceed those of England.
- Above the international average in Whole Numbers; Fractions and Proportionality; Data Representation, Analysis, and Probability; Geometry; and Patterns, Relations, and Functions. We perform below the international average in Measurement, Estimation, and Number Sense.

In science, U.S. fourth graders score...

- Above the international average of the 26 TIMSS countries. Our students are outperformed by students in only one country, Korea, and our scores are not significantly different from those of Japanese students. We outperform England and Canada.
- Above the international average in Earth Science, Life Science, Physical Science, and Environmental Issues and the Nature of Science.

If an international talent scout selected the top 10 percent of all fourth graders in the 26 countries...

- In mathematics, 9 percent of U.S. students would be included.
- In science, 16 percent would be included.

Compared to their international peers...

- Our fourth graders' international standing is stronger than that of our eighth graders.
- Our students perform better in science than in mathematics at both grade levels.

Conclusions from Fourth-Grade TIMSS

- It is too early in the process of data analysis to provide strong evidence for factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as overwhelmingly important.
- Differences between the U.S. and international averages for most factors that might influence achievement are relatively small. Many factors in which the U.S. average exceeds the international average at the fourth grade are not shared by the countries that outperform us.
- Many factors in the United States are similar at both fourth- and eighth-grade levels. Because many of the differences between the grades in the United States also characterize many other TIMSS countries, they cannot account for differences in our students' relative performance at these grade levels. Further analyses are needed to provide more information on these subjects.

Resources

TIMSS offers an objective picture of how our students compare to their international counterparts. We are not yet where we aim to be in terms of our national goal for excellence among nations in mathematics and science, particularly at the eighth-grade level.

Improving local schools is the responsibility of every citizen. *Attaining Excellence: A TIMSS Resource Kit* is a tool that can help communities to reflect on their own schools and determine the best ways to improve them.

TIMSS is not an answer book. It is a mirror with which we can see ourselves in comparison to other countries. The purpose of this Resource Kit is to help U.S. citizens view with new eyes everyday practices in our schools and classrooms. It helps those concerned about education in their communities to compare their achievement, teaching, and curricula to what TIMSS has learned about the world. This can help us to reexamine assumptions we have taken for granted and to suggest new alternatives. The following pages present additional materials to improve access to, and use of, TIMSS data and resources in this kit.

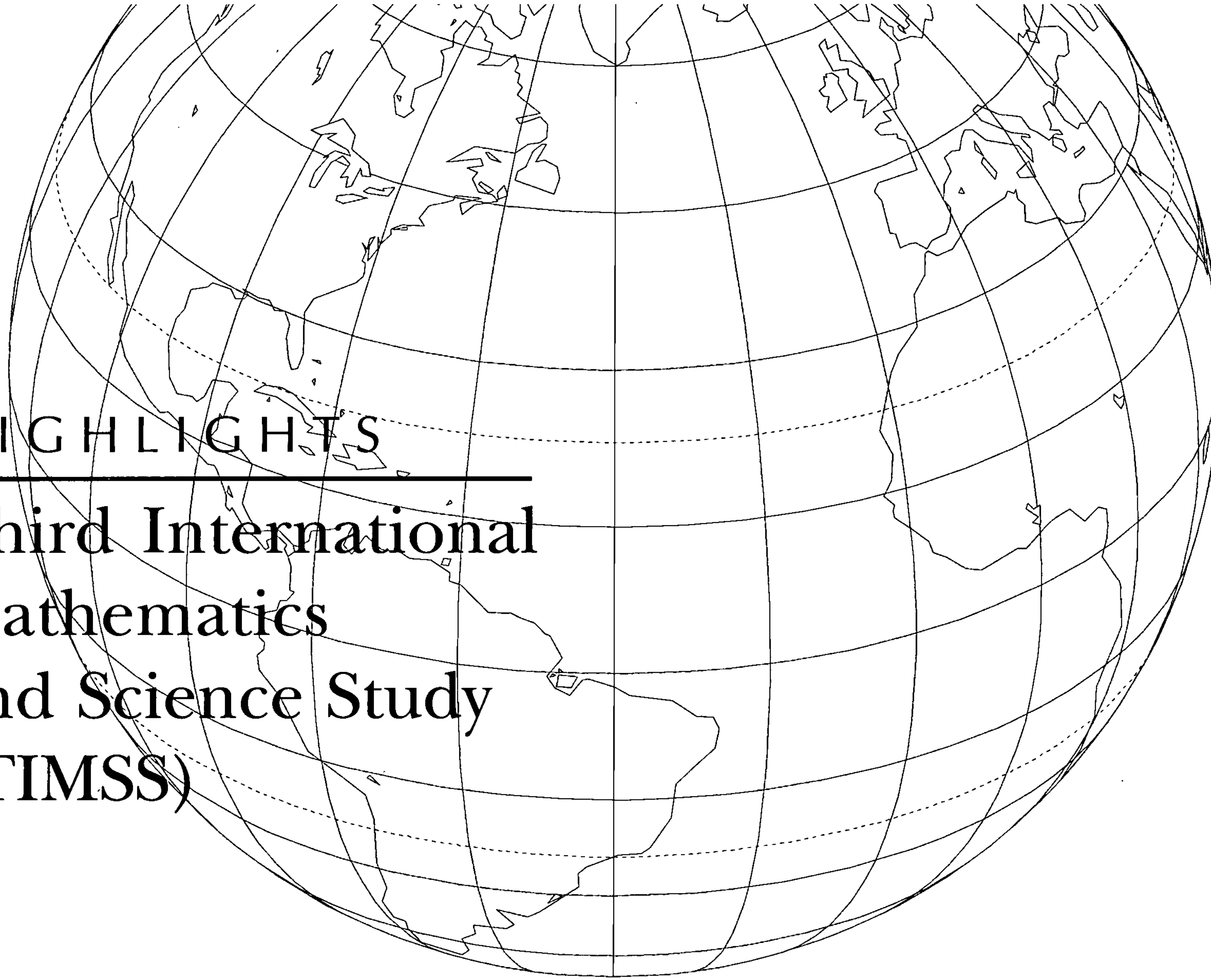
Overheads for TIMSS Presentations

The following black-line masters were designed to assist you in introducing TIMSS to various audiences and in speaking at community meetings, faculty seminars, and assemblies.

They contain the key findings and implications of TIMSS in an easy-to-digest format and sequence and can be adapted or augmented as necessary for your particular audience. Talking points are contained in the section that follows. There are no copyright restrictions on these overheads or on any of the materials in this Resource Kit. If desired, these black-line masters may be reproduced onto transparencies for use with an overhead projector.

HIGHLIGHTS

Third International Mathematics and Science Study (TIMSS)



- TIMSS is the world's largest, most comprehensive, and most rigorous international comparison.
- TIMSS tested more than a half-million students in three age groups in 41 countries.
- TIMSS focuses on mathematics and science in the fourth, eighth, and twelfth grades.
- TIMSS compares achievement, teaching, curricula, and the lives of students and teachers.
- TIMSS includes a videotape study of mathematics teaching in the United States, Japan, and Germany.

FIVE RESEARCH STRATEGIES OF TIMSS

- Assessments
- Questionnaires
- Curriculum analyses
- Videotapes of eighth-grade mathematics teaching
- Case studies of policy topics

These provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

TIMSS: A Treasure Trove of Data

- Provides a variety of data to create an accurate, complete picture of the United States in comparison to other countries.
- Helps define world-class performance.
- Supplies useful findings to help teachers and schools become more successful.

TIMSS Answers These Questions:

- Are U.S. curricula and expectations as demanding as those of other nations?
- How does U.S. classroom instruction compare with that of other countries?
- Do U.S. teachers receive as much support in their efforts to teach students as their colleagues in other nations?
- Are U.S. students as focused on their studies as their international counterparts?

EIGHTH-GRADE STUDENT ACHIEVEMENT

- U.S. eighth graders score above the international average in science.
- U.S. eighth graders score below the international average in mathematics.
- U.S. eighth graders are outperformed in ***both*** subjects by Austria, Bulgaria, Czech Republic, Hungary, Japan, Korea, Netherlands, Singapore, and Slovenia.

U.S. Eighth Graders Compared to Other G-7 Nations' Students

- In mathematics, U.S. eighth graders are behind Japan, France, and Canada. They are on par with England and Germany.

- In science, U.S. eighth graders are behind Japan; on par with England, Canada, and Germany; and above France.

Fourth-Grade Student Achievement

- U.S. fourth graders score above the international average in science and are outperformed only by students in Korea.

- U.S. fourth graders score above the international average in mathematics.

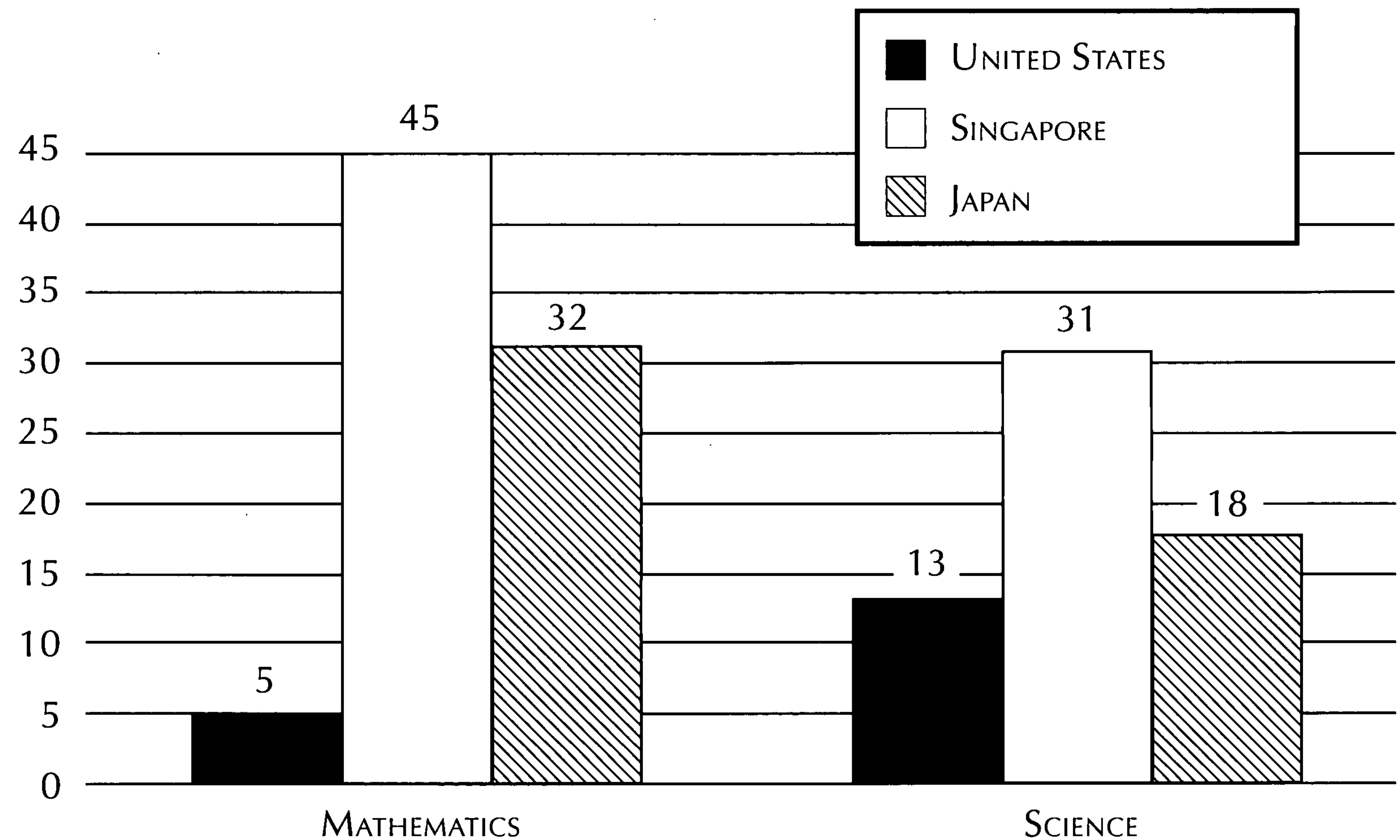
U.S. Fourth Graders Compared to Other G-7 Nations' Students

- In mathematics, U.S. fourth graders are behind Japan, on par with Canada, and ahead of England.

- In science, U.S. fourth graders are on par with Japan and ahead of Canada and England.

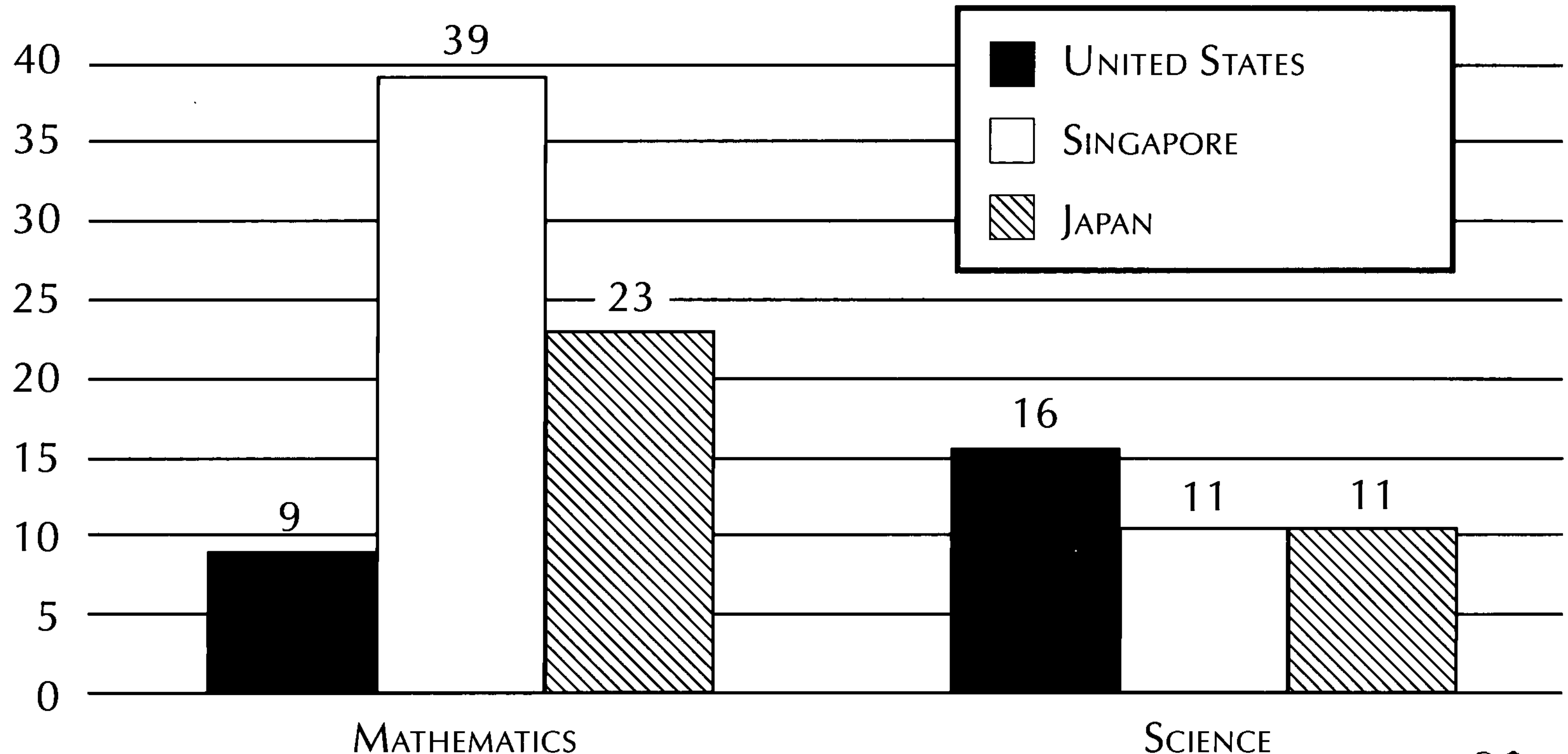
How Do Our *Best* Eighth Graders Stack Up?

Percentage of eighth graders in the world's top 10%



How Do Our *Best* Fourth Graders Stack Up?

Percentage of fourth graders in the world's top 10%



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U.S. Strengths and Weaknesses (Eighth Grade)

Strengths:

- Earth Science
- Life Science
- Environmental Issues & the Nature of Science
- Algebra
- Fractions & Number Sense
- Data Representation, Analysis, & Probability

Weaknesses:

- Chemistry
- Physics
- Geometry
- Measurement
- Proportionality

U.S. Strengths and Weaknesses (Fourth Grade)

Strengths:

- Earth Science
- Life Science
- Physical Science
- Environmental Issues & the Nature of Science
- Whole Numbers
- Fractions & Proportionality
- Data Representation, Analysis, & Probability
- Geometry
- Patterns, Relations, & Functions

Weaknesses:

- Measurement, Estimation, & Number Sense

EIGHTH-GRADE MATHEMATICS TEACHING

- What we teach in eighth-grade mathematics, most other countries teach in the seventh.
- The content of U.S. eighth-grade mathematics lessons requires less high-level thought than classes in Germany and Japan.
- The typical goal of a U.S. eighth-grade mathematics teacher is to teach students how to do something. The typical goal of a Japanese teacher is to help students understand mathematical concepts.

Eighth-Grade Curricula

- The eighth-grade mathematics curricula in Japan and Germany focus on algebra and geometry, while U.S. curricula still include considerable arithmetic.
- Topic coverage in U.S. eighth-grade mathematics classes is not as focused as in Germany and Japan (although in science, topic coverage may be similar to other countries in degree of focus).
- U.S. curricula are defined locally, whereas the curricula of most other nations are established nationally.

TEACHERS' LIVES

- Unlike U.S. teachers, new Japanese and German teachers receive long-term structured apprenticeships in their profession.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- U.S. teachers have more college education than those in all but a few TIMSS countries.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for their German colleagues as well.

STUDENTS' LIVES

- Eighth-grade students of different abilities are typically divided into different classrooms in the United States and different schools in Germany. In Japan, no ability grouping is practiced.
- In the United States, students in higher level mathematics classes study different material than do students in lower level classes. In Germany and Japan, all students study the same material, although in Germany, lower level classes study it with less depth and rigor.
- Japanese eighth graders are preparing for a high-stakes examination to enter high school.

Rethinking Common Beliefs— We Know the Problem Is NOT:

- **TIME**—U.S. eighth graders have ***more*** hours of instruction in mathematics and science than students in Japan or Germany.
- **HOMEWORK**—U.S. students ***do as much or more.***
- **TV**—Japanese students watch ***as much TV, yet do better*** in school.

INVESTMENT IN TIMSS

- Provides objective assessment of where we stand in comparison to other countries.
- Shows aspects of U.S. education that deserve attention.
- Helps states and localities reflect on "world-class" education.

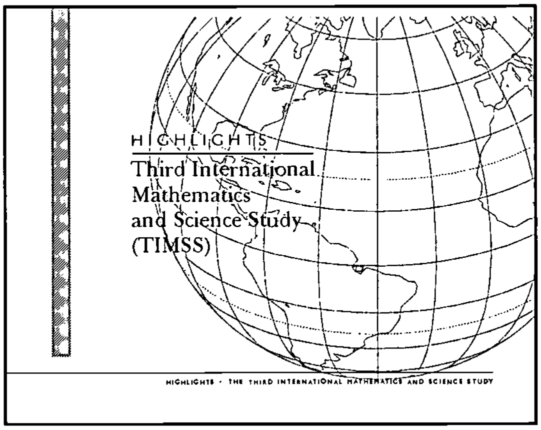
Using TIMSS to Improve Achievement

- TIMSS begins a national conversation about what we want our schools to accomplish.
- TIMSS provides a lens through which we can view ourselves in an international perspective.
- TIMSS can help expand discussions on what we expect from our students.
- TIMSS can help improve U.S. education.

Presentation Talking Points

These speaker's notes are designed to accompany the overheads for TIMSS presentations contained in the previous section.

Further information and the findings from the study are contained in the reports in the *Pursuing Excellence* series, which are available in the section of this Resource Kit titled *Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education.* They can also be obtained directly from the Government Printing Office (see the publications section at the end of this document), or downloaded from the TIMSS Web site at the National Center for Education Statistics' site on the World Wide Web at http://www.ed.gov/NCES/timss.



OVERHEAD 1

TIMSS is an important study for those interested in U.S. education. Through it, we can examine our students' achievement, our schools, and our education practices in comparison to those of other countries.

- TIMSS is the world's largest, most comprehensive, and most rigorous international comparison.
- TIMSS tested more than a half-million students in three age groups in 41 countries.
- TIMSS focuses on mathematics and science in the fourth, eighth, and twelfth grades.
- TIMSS compares achievement, teaching, curricula, and the lives of students and teachers.
- TIMSS includes a videotape study of mathematics teaching in the United States, Japan, and Germany.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 2

TIMSS' rich information not only allows us to compare achievement, but also provides insights into how life in U.S. schools differs from that in other nations.

This presentation is based on a series of reports, known as *Pursuing Excellence,* from the National Center for Education Statistics, that describe findings about our fourth- and eighth-grade student achievement and schooling.

OVERHEAD 3

> **FIVE RESEARCH STRATEGIES OF TIMSS**
>
> - Assessments
> - Questionnaires
> - Curriculum analyses
> - Videotapes of eighth-grade mathematics teaching
> - Case studies of policy topics
>
> These provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.
>
> HIGHLIGHTS · THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

The study brought a variety of different and complementary research methods to bear on important policy questions. This makes the findings of the study more reliable and provides broader and deeper information.

- Mathematics and science assessments were 90 minutes long. The assessments included both multiple-choice and free-response items. A smaller number of students completed "hands-on" performance assessments in science.
- On questionnaires, students answered questions about their mathematics and science studies and beliefs; teachers answered questions on their beliefs about mathematics, science, and teaching practices; school administrators answered questions about school policies and practices.
- The exploratory curriculum analysis compared eighth-grade mathematics and science curriculum guides and textbooks, subject-matter content, and sequencing of topics.
- Videotapes of mathematics instruction were conducted in half of the U.S. and German participating eighth-grade classrooms. In Japan, eighth-grade classrooms in a random sample of 50 of the TIMSS schools were chosen to be videotaped. In all three countries, teachers were filmed teaching a typical lesson. These tapes were then analyzed to compare teaching techniques and quality of instruction.
- Ethnographic case studies of key policy topics were conducted by a team of 12 bilingual researchers who each spent three months in the United States, Japan, or Germany observing classrooms and interviewing education authorities, principals, teachers, students, and parents. Topics of study were education standards, methods of dealing with individual differences, the lives and working conditions of teachers, and the role of school in adolescents' lives.

Each of the five strategies represents an important advance in its field. Taken together, they provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

TIMSS: A Treasure Trove of Data

- Provides a variety of data to create an accurate, complete picture of the United States in comparison to other countries.
- Helps define world-class performance.
- Supplies useful findings to help teachers and schools become more successful.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 4

In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the United States will be first in the world in mathematics and science achievement."

TIMSS helps us think about our own education in comparison to other countries.

TIMSS is a fair and accurate comparison of mathematics and science achievement. It is not a comparison of "all of our students with other nations' best."

The students who participated in TIMSS were randomly selected to represent all students in each participating nation. Rigorous quality control was followed, and international monitoring was carried out at every step of the study.

TIMSS Answers These Questions:

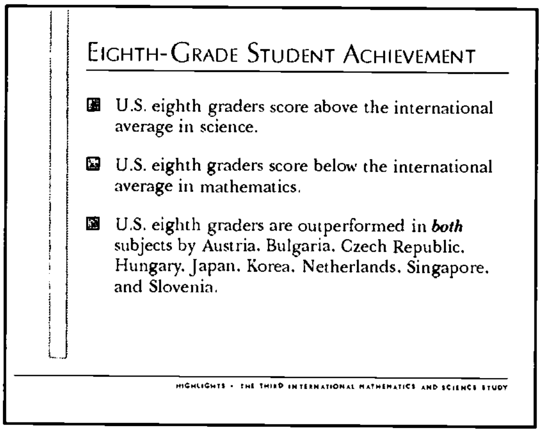
- Are U.S. curricula and expectations as demanding as those of other nations?
- How does U.S. classroom instruction compare with that of other countries?
- Do U.S. teachers receive as much support in their efforts to teach students as their colleagues in other nations?
- Are U.S. students as focused on their studies as their international counterparts?

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 5

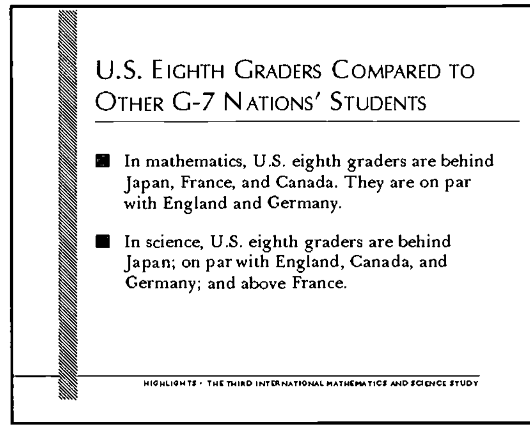
TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science.

But, TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. TIMSS was designed to look beyond the scorecard to illuminate how our education policies and practices compare with those of the world community.



OVERHEAD 6

The United States outperforms seven countries in ***both*** mathematics and science: Colombia, Cyprus, Iran, Kuwait, Lithuania, Portugal, and South Africa.



OVERHEAD 7

The Group of Seven includes the nations that are major trading partners with the United States: Canada, England, France, Germany, Italy, and Japan. Italy did not participate in eighth-grade TIMSS.

FOURTH-GRADE STUDENT ACHIEVEMENT

- U.S. fourth graders score above the international average in science and are outperformed only by students in Korea.
- U.S. fourth graders score above the international average in mathematics.

OVERHEAD 8

U.S. fourth-graders performed above the international average in both subjects, and their scores in science were particularly strong.

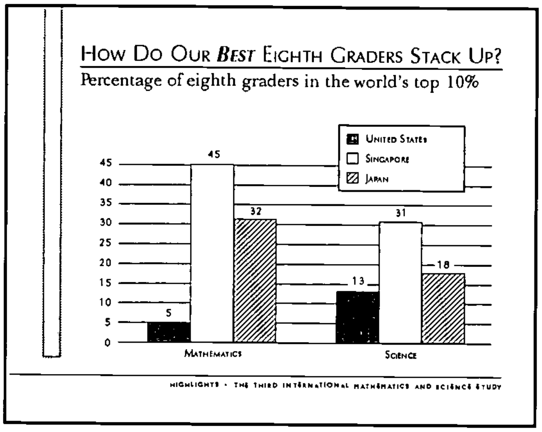
U.S. Fourth Graders Compared to Other G-7 Nations' Students

- In mathematics, U.S. fourth graders are behind Japan, on par with Canada, and ahead of England.
- In science, U.S. fourth graders are on par with Japan and ahead of Canada and England.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 9

Italy, Germany, and France did not participate in fourth-grade TIMSS due to resource constraints in their own countries.



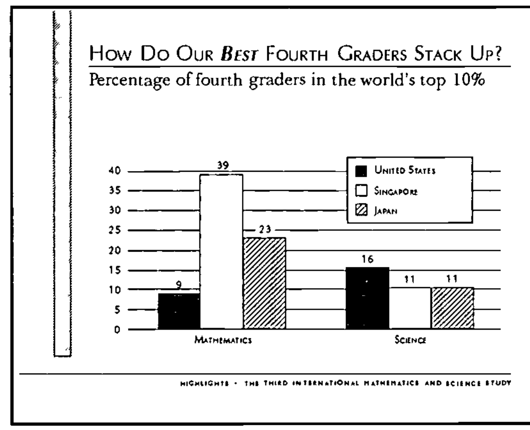
Overhead 10

If an international talent search were to select the top 10 percent of all eighth-grade students in the 41 TIMSS countries combined, then, for mathematics, 5 percent of U.S. eighth graders, 45 percent of Singaporean eighth graders, and 32 percent of Japanese eighth graders would be chosen.

In science, 13 percent of U.S. eighth-grade students would be selected compared to 31 percent of Singaporean eighth-grade students and 18 percent of Japanese eighth-grade students.

If the talent search were to lower its standards to the top half of all students, then, in mathematics, 94 percent of eighth graders in Singapore and 83 percent of eighth graders in Japan would be selected, but only 45 percent of U.S. eighth graders would be selected for the top half.

In science, 82 percent of the eighth-grade students in Singapore and 71 percent of the eighth-grade students in Japan would be selected for the top half, compared to 55 percent of the eighth-grade students in the United States.



Overhead 11

If an international talent search were to select the top 10 percent of all fourth-grade students in the 26 TIMSS countries combined, 9 percent of U.S. fourth graders would be in the world's top 10 percent. This is well below the 39 percent of Singaporean fourth graders, and 23 percent of Japanese fourth graders who would be chosen in the international mathematics talent search.

In science, 16 percent of U.S. fourth graders would rank among the world's top 10 percent. No country has significantly more of their fourth-grade students in the top 10 percent (Korea has one point more), and 21 nations have a smaller percentage. Only 11 percent of the fourth-grade students in Singapore and Japan would be selected.

If the international talent search were to lower its standards to the top half of all fourth-grade students in the 26 TIMSS countries, in mathematics 56 percent of U.S. fourth graders would be included. This compares with 82 percent of fourth graders in Singapore and 79 percent in Japan. In science, 63 percent of U.S. fourth graders would be in the top half of all fourth-grade students in the TIMSS countries, compared to 68 percent in Japan.

U.S. STRENGTHS AND WEAKNESSES
(EIGHTH GRADE)

Strengths:
- Earth Science
- Life Science
- Environmental Issues & the Nature of Science
- Algebra
- Fractions & Number Sense
- Data Representation, Analysis, & Probability

Weaknesses:
- Chemistry
- Physics
- Geometry
- Measurement
- Proportionality

HIGHLIGHTS · THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

OVERHEAD 12

Representing student achievement in mathematics and science as a total score is a useful way to summarize achievement. However, mathematics and science contain different content areas, which are emphasized and sequenced differently in curricula around the world. Based on these national priorities, in each country, some content areas have been studied more than others at a particular grade level.

The United States is among the top countries in the world in Environmental Issues and the Nature of Science, and we are also above the international average in Earth Science and Life Science. In Chemistry and Physics, our performance is not significantly different from the international average. Our better-than-average scores in Environmental Issues, Earth Science, and Life Science may pull our overall science score up to above average.

U.S. students' performance is at about the international average in Algebra; Data Representation, Analysis, and Probability; and Fractions and Number Sense. Compared to other countries, we do less well in Geometry, Measurement, and Proportionality. Our weaker performance in the latter topics may pull the overall U.S. score down to below average.

U.S. Strengths and Weaknesses (Fourth Grade)

Strengths:

- Earth Science
- Life Science
- Physical Science
- Environmental Issues & the Nature of Science
- Whole Numbers
- Fractions & Proportionality
- Data Representation, Analysis, & Probability
- Geometry
- Patterns, Relations, & Functions

Weaknesses:

- Measurement, Estimation, & Number Sense

HIGHLIGHTS - THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 13

Mathematics and science contain very different content areas, which are emphasized and sequenced differently in curricula around the world. Based on these national priorities, some content areas are emphasized more than others at a particular grade level.

U.S. fourth graders score above the international average in all four science content areas. In three of these content areas—Earth Science, Life Science, and Environmental Issues and the Nature of Science—U.S. fourth graders are outperformed by only one or two other nations. In Physical Science, U.S. students are outperformed by five other nations.

In five out of six TIMSS mathematics content areas, the scores of U.S. fourth graders are above the international averages for those content areas. U.S. fourth graders' performance is above the international average in Whole Numbers; Fractions and Proportionality; Data Representation, Analysis, and Probability; Geometry; and Patterns, Relations, and Functions. In only one content area is the U.S. average below the international average—Measurement, Estimation, and Number Sense.

Eighth-Grade Mathematics Teaching

- What we teach in eighth-grade mathematics, most other countries teach in the seventh.
- The content of U.S. eighth-grade mathematics lessons requires less high-level thought than classes in Germany and Japan.
- The typical goal of a U.S. eighth-grade mathematics teacher is to teach students how to do something. The typical goal of a Japanese teacher is to help students understand mathematical concepts.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 14

The topics taught in U.S. mathematics classrooms were at a seventh-grade level in comparison to other countries, while the topics observed in the German and Japanese classrooms were at a high eighth-grade or even ninth-grade level.

In contrast to expert recommendations that well-taught lessons focus on having students think about and come to understand mathematical concepts, U.S. and German eighth-grade mathematics teachers usually explain that the goal of their lesson is to have students acquire particular skills.

EIGHTH-GRADE CURRICULA

- The eighth-grade mathematics curricula in Japan and Germany focus on algebra and geometry, while U.S. curricula still include considerable arithmetic.
- Topic coverage in U.S. eighth-grade mathematics classes is not as focused as in Germany and Japan (although in science, topic coverage may be similar to other countries in degree of focus).
- U.S. curricula are defined locally, whereas the curricula of most other nations are established nationally.

HIGHLIGHTS · THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

OVERHEAD 15

The curricula in the United States are less advanced than those of Germany and Japan. In the videotapes studied, 40 percent of U.S. eighth-grade mathematics lessons included arithmetic topics such as whole number operations, fractions, and decimals, whereas these topics were much less common in Germany and Japan. In contrast, German and Japanese eighth-grade lessons were more likely to cover algebra and geometry.

Evidence from a variety of sources in TIMSS shows us that U.S. mathematics curricula are less focused than those of other countries. The U.S. science curricula more closely resemble international practices.

In 29 TIMSS countries, including Japan, the curricula are determined by national authorities. In three countries, including Germany, they are determined at the state level. In nine countries, including the United States, curricula are determined at the local level.

Teachers' Lives

- Unlike U.S. teachers, new Japanese and German teachers receive long-term structured apprenticeships in their profession.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- U.S. teachers have more college education than those in all but a few TIMSS countries.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for their German colleagues as well.

HIGHLIGHTS · THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 16

U.S. teachers lack the long and carefully mentored introduction to teaching that Japanese and German teachers receive. In Germany, after passing a state examination at the end of college, prospective teachers spend two weeks in a student teaching apprenticeship. During this time, they progress from classroom observation, to assisted teaching, to unassisted teaching under a mentor. At the end of the second year, candidates take another state examination and apply for jobs. In Japan, new teachers undergo intensive mentoring and training during their first year on the job, including at least 60 days of closely monitored teaching and 30 days of further training at resource centers.

Prospective U.S. teachers typically spend 12 weeks or less in student teaching near the end of their undergraduate training. After teachers meet the state licensing requirements, the nature of their induction program varies by district.

Nearly half of the U.S. teachers have a master's degree, a proportion exceeded by only four other TIMSS countries.

Teachers in all three countries frequently describe student diversity as a challenge. Uninterested students and a wide range of academic abilities challenge teachers in all three countries. Severe discipline problems and threats to student and teacher safety are neither widespread nor unique to the United States.

Students' Lives

- Eighth-grade students of different abilities are typically divided into different classrooms in the United States and different schools in Germany. In Japan, no ability grouping is practiced.
- In the United States, students in higher level mathematics classes study different material than do students in lower level classes. In Germany and Japan, all students study the same material, although in Germany, lower level classes study it with less depth and rigor.
- Japanese eighth graders are preparing for a high-stakes examination to enter high school.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overhead 17

Japanese public schools offer a single curriculum for all students through the end of ninth grade, regardless of individual differences in motivation or ability. In mathematics, all eighth-grade Japanese students study a curriculum heavily focused on algebra and geometry. At the end of ninth grade, virtually all Japanese students continue on to high school. The high school entrance exam serves as a gateway, dividing students into high-, medium-, and low-level schools. The slowest students are accepted only by the lesser ranked commercial or vocational high schools. The German school system basically sorts students into one of three types of schools at the end of fourth grade. Within most schools, eighth graders all follow the same course of study in mathematics and science, regardless of their ability level.

In the United States, students are frequently grouped by ability into different mathematics classes. In the eighth grade, lower level classes typically focus on a review of arithmetic and other basic skills, with a small amount of algebra. Higher level classes focus more heavily on algebra, with a small amount of geometry. In contrast, Germany and Japan teach algebra and geometry to all of their eighth-grade students, although the rigor may differ by track.

RETHINKING COMMON BELIEFS—
WE KNOW THE PROBLEM IS NOT:

- TIME—U.S. eighth graders have *more* hours of instruction in mathematics and science than students in Japan or Germany.
- HOMEWORK—U.S. students *do as much or more*.
- TV—Japanese students watch *as much TV, yet do better* in school.

HIGHLIGHTS • THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

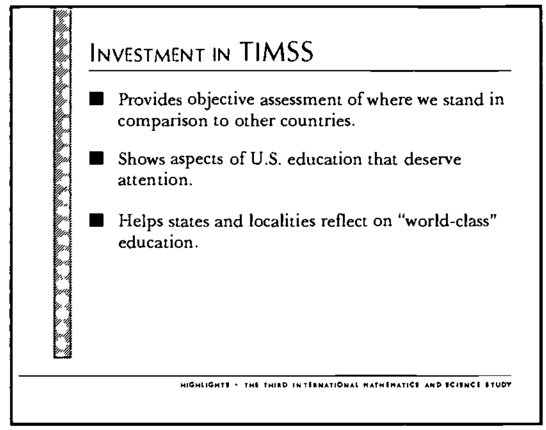
OVERHEAD 18

The report shows that there are no "magic solutions."

The data do not identify any single factor that we can say is present in all countries that succeed and absent in those with lower performance. But, we can say that TIMSS testifies against many simplistic proposals based on myths.

The facts show that:

- **U.S. eighth graders have more hours of instruction**—U.S. students in the eighth grade average 143 hours of mathematics instruction a year, compared to 114 hours in Germany and 117 hours in Japan. U.S. students average 140 hours of science instruction, compared with 136 hours in Germany and only 90 in Japan.
- **U.S. eighth graders do as much homework**—86 percent of U.S. mathematics teachers, 75 percent of German teachers, and only 21 percent of Japanese teachers assign homework 3 to 5 times a week. In science, 48 percent of U.S. teachers, 12 percent of German teachers, and only 4 percent of Japanese teachers assign homework 3 to 5 times per week. U.S. and German teachers also spend more class time working on homework. Only U.S. teachers let students start their homework in school. However, students in all three countries report spending the same amount of time each day studying outside of school.
- **Japanese students do as much TV watching**—Eighth-grade students in Germany, Japan, and the United States all do more TV watching, socializing, and playing sports than studying or reading.
- **Our performance is not due to how much time we spend, but rather how we spend it**—U.S. students spend as much time studying mathematics and science as other students who outperform them. We also cover more topics than most other countries.



OVERHEAD 19

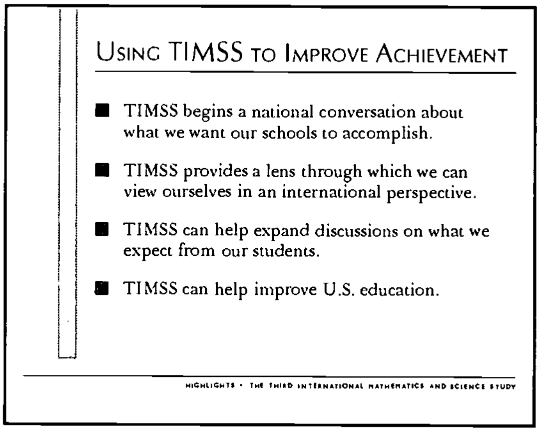
TIMSS is not a set of answers but a new way to see ourselves compared to other countries.

Through TIMSS we can see what students in other countries study, what materials they use, what their teachers do in the classrooms, and what students ultimately achieve.

If we want the United States to improve the mathematics and science education of its students, we must carefully examine not just how other countries rank, but also how their polices and practices help students achieve.

Not only does TIMSS show us where U.S. education stands in terms of test scores, but it also shows us what is included in textbooks, taught in schools, and learned by students.

Examining these data provides a unique opportunity to shed new light on education in the United States through the prism of other countries. At the same time, we should avoid the temptation to zero in on any one finding or leap to a conclusion without carefully considering the data.



OVERHEAD 20

TIMSS is not an answer book, but a mirror in which we can see our own education system at all stages of renewal and with an international perspective.

We can view with new eyes aspects of our education system and progress toward excellence that we may have taken for granted.

We can think more deeply about the assumptions that form the basis for our approaches to schooling and about the reform directions we are taking.

Through TIMSS, we can come to understand our own system better at all stages of education.

Sample Meeting Announcement

The prototype announcement for a meeting about TIMSS provided on the next page can be used as is or adapted as you see fit.

Flyers need to attract the reader's attention immediately and get the point across simply. Here are a few tips:

- Be brief.
- Select an eye-catching headline and drop in a graphic illustration from "clip art" books or software packages.
- Use big, bold print and standard-sized paper for easy reproduction.

Urgent Community Meeting!

Do You Know...

- How Our Students Rate Internationally?
- How We Can Improve Students' Mathematics and Science Achievement?

Findings from the Third International Mathematics and Science Study

For Teachers, Administrators, Parents, and Everyone Concerned with Our Children's Education

WHERE:

WHEN:

ORDER FORM FOR CD-ROM VERSION OF *ATTAINING EXCELLENCE: A TIMSS RESOURCE KIT*

The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC), located at Ohio State University, is producing a CD-ROM that will contain most of the resources in this kit, previously published TIMSS reports, related papers, and other auxiliary materials. In addition to the TIMSS materials, the disc will include ENC's Resource Finder, an electronic catalog of K-12 mathematics and science curriculum resources.

Schools can receive the ENC CD-ROM free of charge by filling out this form, accompanied by a letter on school letterhead signed by the principal. Call toll free, (800) 621-5785, or send E-mail to cd_request@enc.org

Send To: ____________________

Name ____________________

Title ____________________

School ____________________

Street ____________________

City ____________________ State ________ ZIP ____________

❑ I work at a school and would like to request a free CD-ROM. I am sending a letter on school letterhead signed by the principal.

Send to:
Eisenhower National Clearinghouse
The Ohio State University
1929 Kenny Road
Columbus, OH 43210
Telephone: (800) 621-5785
Fax: (614) 292-2066

If you do not work at a school and are still interested in the CD-ROM, contact the Eisenhower National Clearinghouse.

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Third International Mathematics and Science Study Publications

WHERE CAN I FIND A GOOD SUMMARY OF TIMSS FINDINGS THAT PUTS U.S. EDUCATION IN COMPARATIVE PERSPECTIVE?

***Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, November 1996—This report draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in the eighth grade. Paperback, 80 pp. $9.50.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; GPO #065-000-00959-5. It may also be downloaded from: http://www.ed.gov/NCES/timss

***Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, June 1997—This report summarizes the most important findings concerning U.S. achievement and schooling in the fourth grade. Paperback, 68 pp. $4.75**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; NCES 97-255; GPO #065-000-01018-6. It also may be downloaded from: http://www.ed.gov/NCES/timss

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***A Video Presentation of Pursuing Excellence: U.S. Eighth-Grade Findings from TIMSS*, July 1997—This video summarizes the TIMSS' key findings concerning U.S. eighth-grade education and includes the views of business leaders, policymakers, educators, and researchers on the study's implications for schools in the United States. 13° minutes. $20.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; GPO #065-000-01003-8.

Web Sites—There are several Web sites devoted to TIMSS. For general information about the study as well as direct access to many TIMSS publications, please see:

http://www.ed.gov/NCES/timss
http://wwwcsteep.bc.edu/timss
http://uttou2.to.utwente.nl/
http://ustimss.msu.edu/

***Highlights of Results from TIMSS*, November 1996—Glossy brochure, 8 pp.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF EIGHTH-GRADE STUDENTS?

***Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996—This report focuses on mathematics achievement in 41 countries at the two grades with the largest proportion of 13-year-olds, the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 176 pp. + 60 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. The report may also be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

***Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996—This report focuses on science achievement in 41 countries at the two grades with the largest proportion of 13-year-olds, the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 168 pp. + 62 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. The report may also be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF FOURTH-GRADE STUDENTS?

Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS), **June 1997—This report focuses on mathematics achievement in 26 countries at the two grades with the largest proportion of nine-year-olds, the third and fourth grades in most countries. The report includes selected background information about students and teachers. Paperback. $20 (+ $7 shipping & handling, if international).**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. The report also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

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HOW CAN I GET A FIRSTHAND GLIMPSE OF ACTUAL CLASSROOM LESSONS IN THE UNITED STATES, JAPAN, AND GERMANY?

***VHS Video Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*—Actual footage of eighth-grade mathematics classes in the United States, Japan, and Germany lets viewers see firsthand an abbreviated geometry and algebra lesson from each of three countries: the United States, Japan, and Germany. 80 minutes. $20.00**

To order, contact: U.S. Government Bookstore, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; GPO #065-000-01025-9.

***CD-ROM Video Examples from the TIMSS Videotape Classroom Study: Eighth-Grade Mathematics in United States, Japan, and Germany*—Actual footage of eighth-grade mathematics classes lets viewers see firsthand an abbreviated geometry and algebra lesson from each of three countries. Inquire about pricing by telephoning the National Education Data Resource Center.**

Minimum System Requirements:

IBM PC or 100% compatible, MS Windows® (Windows 95® recommended), Pentium® 90, 16 mb of RAM, 256-color SVGA or better, Double-speed or faster CD-ROM drive, sound card; or

Macintosh® PowerPC 100® or 100% compatible System 7.5.3, 16 mb of RAM, 256-color or better, Netscape Navigator® 3.0 with MPG plug-in, double-speed or faster CD-ROM drive

To order, contact: National Education Data Resource Center, c/o Pinkerton Computer Consultants, Inc., 1900 N. Beauregard St., Suite 200, Alexandria, VA 22311-1722; Telephone: (703) 845-3151; Fax: (703) 820-7465; E-mail: ndrc@inet.ed.gov; World Wide Web: http://www.ed.gov/pubs/ncesprograms/elementary/others/ndrc.html

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WHERE CAN I FIND OUT WHAT TIMSS HAS LEARNED ABOUT CURRICULA?

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***Characterizing Pedagogical Flow: An Investigation of Mathematics and Science Teaching in Six Countries*, 1996—Describes the results of the Study of Mathematics and Science Opportunity (SMSO) survey, which investigated curriculum content and instructional methods in France, Japan, Norway, Spain, Switzerland, and the United States, using case studies in each participating country. 229 pp. Hardback ISBN: 07923-42720, $110; Paperback ISBN: 07923-42739, $49.**

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Pursuing Excellence

A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context

Initial Findings from the
Third International Mathematics and Science Study

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Office of Educational Research and Improvement
U.S. Department of Education

PURSUING EXCELLENCE

A STUDY OF U.S. EIGHTH-GRADE MATHEMATICS AND SCIENCE TEACHING, LEARNING, CURRICULUM, AND ACHIEVEMENT IN INTERNATIONAL CONTEXT

LOIS PEAK

With contributions by:

Nancy Caldwell
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INITIAL FINDINGS FROM THE
THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

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November 1996

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COMMISSIONER'S STATEMENT

With data on half a million students from 41 countries, the Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and students ever. This report, *Pursuing Excellence*, is a synthesis of initial findings from TIMSS on U.S. eighth-grade mathematics and science education, providing a comparative picture of education in the United States and the world that can be used to examine our education system, scrutinize improvement plans, and evaluate proposed standards and curricula. Subsequent TIMSS reports will examine U.S. mathematics and science education for fourth and twelfth-grade students in an international context.

TIMSS is significant not only because of its scope and magnitude, but also because of innovations in its design. In this international study, the National Center for Education Statistics (NCES) combined multiple methodologies to create an information base that goes beyond simple student test score comparisons and questionnaires to examine the fundamental elements of schooling. Innovative research techniques include analyses of textbooks and curricula, videotapes, and ethnographic case studies. The result is a more complete and accurate portrait of how U.S. mathematics and science education differs from that of other nations, with extended comparisons to Germany and Japan.

The information in these reports can serve as a starting point for our efforts to define a "world-class" education. If the U.S. is to improve the mathematics and science education of its students, we must carefully examine not just how other countries rank, but also how their polices and practices help student achieve. TIMSS shows us where U.S. education stands — not just in terms of test scores, but also what is included in textbooks, taught in schools, and learned by students. Examining these data provides a unique opportunity to shed new light on education in the United States through the prism of other countries. As the same time, we should avoid the temptation to zero in on any one finding or leap to a conclusion without carefully considering the broader context.

This report is only the first of many NCES investigations into TIMSS data. Additional reports will be released throughout the coming year, including linkages of student achievement in U.S. states to achievement in the TIMSS countries, as well as findings on fourth and twelfth grade students. Moreover, NCES plans to make TIMSS the most accessible international education study ever by releasing the data to scholars and the research community, and actively disseminating the findings to policymakers, educators, parents, and others concerned with quality education. Beginning with this report, NCES is releasing the information in a variety of new forms, including CD-ROM, videotape, and the World-Wide Web. Visit the NCES TIMSS website at "http://www.ed.gov/NCES/timss" for further information.

In all these efforts, our purpose is not just to take a snapshot of the present, but to develop a valuable resource for school improvement efforts. TIMSS clearly and accurately provides a wealth of useful data and information on curriculum, instruction, teacher and student lives, and student achievement. The investment in TIMSS can enhance the quality of our nation's mathematics and science education, and improve the performance of our students to a more internationally competitive level.

Pascal D. Forgione Jr.
Commissioner of Education Statistics

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EXECUTIVE SUMMARY

PREFACE

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international comparison of education ever undertaken. During the 1995 school year, the study tested the math and science knowledge of a half-million students from 41 nations at five different grade levels. In addition to tests and questionnaires, it included a curriculum analysis, videotaped observations of mathematics classrooms, and case studies of policy issues.

- TIMSS' rich information allows us not only to compare achievement, but also provides insights into how life in U.S. schools differs from that in other nations.

- This report on eighth-grade students is one of a series of reports that will also present findings on student achievement at fourth grade, and at the end of high school, as well as on various other topics.

ACHIEVEMENT

One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. Although we are far from this mark, we are on a par with other major industrialized nations like Canada, England, and Germany.

- In mathematics, U.S. eighth graders score below the international average of the 41 TIMSS countries. Our students' scores are not significantly different from those of England and Germany.

- In science, U.S. eighth graders score above the international average of 41 TIMSS countries. Our students' scores are not significantly different from those of Canada, England, and Germany.

- In mathematics, our eighth-grade students' standing is at about the international average in Algebra; Fractions; and Data Representation, Analysis, and Probability. We do less well in Geometry; Measurement; and Proportionality.

- In science, our eighth graders' standing is above the international average in Earth Science, Life Science, and Environmental Issues. Our students score about average in Chemistry and Physics.

- If an international talent search were to select the top 10 percent of all students in the 41 TIMSS countries, in mathematics 5 percent of U.S. students would be included. In science 13 percent would be included.

CURRICULUM

U.S. policy makers are concerned about whether expectations for our students are high enough, and in particular whether they are as challenging as those of our foreign economic partners. In all countries, the relationship between standards, teaching, and learning is complex. This is even more true in the U.S., which is atypical among TIMSS countries in its lack of a nationally defined curriculum.

- The content taught in U.S. eighth-grade mathematics classrooms is at a seventh-grade level in comparison to other countries.
- Topic coverage in U.S. eighth-grade mathematics classes is not as focused as in Germany and Japan.
- In science, the degree of topic focus in the U.S. eighth-grade curriculum may be similar to that of other countries.
- U.S. eighth graders spend more hours per year in math and science classes than German and Japanese students.

TEACHING

In recent years, concern about the quality of instruction in U.S. classrooms has led mathematics professional organizations to issue calls for reform. However, TIMSS data cannot tell us about the success of these reform efforts for several reasons, including the fact that this assessment occurred too soon after the beginning of the reform for states and districts to have designed their own programs, retrained teachers, and nurtured a generation of students according to the new approach. Also, we do not have comparable earlier baseline information against which to compare the findings from TIMSS. However, TIMSS includes the first large-scale observational study of U.S. teaching ever undertaken, and this can form a baseline against which future progress may be judged.

- U.S. mathematics classes require students to engage in less high-level mathematical thought than classes in Germany and Japan.
- U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help them understand mathematical concepts.
- Japanese teachers widely practice what the U.S. mathematics reform recommends, while U.S. teachers do so infrequently.
- Although most U.S. math teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.

TEACHERS' LIVES

The training that teachers receive before they enter the profession and the regular opportunities that they have for on-the-job learning and improvement of their teaching affect the quality of the teaching force. The collegial support that teachers receive and the characteristics of their daily lives also affect the type of teaching they provide.

- Unlike new U.S. teachers, new Japanese and German teachers undergo long-term structured apprenticeships in their profession.
- U.S. teachers have more college education than their colleagues in all but a few TIMSS countries.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for German teachers as well.

STUDENTS' LIVES

The manner in which societies structure the schooling process gives rise to different opportunities and expectations for young people. The motivators, supports, and obstacles to study in each country are outgrowths of the choices provided by society and schools.

- Eighth-grade students of different abilities are typically divided into different classrooms in the U.S., and into different schools in Germany. In Japan, no ability grouping is practiced at this grade level.
- In mathematics, U.S. students in higher ability-level classes study different material than students in lower-level classes. In Germany and Japan, all students study basically the same material, although in Germany the depth and rigor of study depends on whether the school is for students of higher or lower ability levels.
- Japanese eighth-graders are preparing for a high-stakes examination to enter high school at the end of ninth grade.
- U.S. teachers assign more homework and spend more class time discussing it than teachers in Germany and Japan. U.S. students report about the same amount of out-of-school math and science study as their Japanese and German counterparts.
- Heavy TV watching is as common among U.S. eighth graders as it is among their Japanese counterparts.

CONCLUSIONS

This report presents initial findings from TIMSS for eighth-grade mathematics and science. A fuller understanding of our nation's educational health must await data from the fourth and twelfth-grade levels. The search for factors associated with student performance is complicated because student achievement after eight years of schooling is the product of many different factors. Furthermore, the U.S. education system is large and decentralized with many interrelated parts. No single factor in isolation from others should be regarded as the answer to improving the performance of U.S. eighth-grade students. With these cautions in mind, this report offers the following insights into factors that may be associated with our students' performance:

- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.
- Most U.S. mathematics teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.
- Evidence suggests that U.S. teachers do not receive as much practical training and daily support as their German and Japanese colleagues.

TIMSS is not an answer book, but a mirror through which we can see our own education system in international perspective. Careful study of our nation's reflection in the mirror of international comparisons will assist educators, business leaders, teachers, and parents as they guide our nation in the pursuit of excellence.

PREFACE

KEY POINTS:

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international comparison of education ever undertaken.

TIMSS' rich information allows us not only to compare achievement, but also to understand how life in U.S. schools differs from that in other nations.

This report on eighth-grade students is the first of a series of reports that will present findings on student achievement at the fourth grade, at the end of high school, as well as on various other topics.

OVERVIEW

The Third International Mathematics and Science Study is the largest and most comprehensive comparative international study of education that has ever been undertaken. A half-million students from 41 countries were tested in 30 different languages at five different grade levels to compare their mathematics and science achievement. Intensive studies of students, teachers, schools, curriculum, instruction, and policy issues were also carried out to understand the educational context in which learning takes place.

TIMSS COUNTRIES

AUSTRALIA	KOREA
AUSTRIA	KUWAIT
BELGIUM (FLEMISH)	LATVIA
BELGIUM (FRENCH)	LITHUANIA
BULGARIA	NETHERLANDS
CANADA	NEW ZEALAND
COLOMBIA	NORWAY
CYPRUS	PORTUGAL
CZECH REPUBLIC	ROMANIA
DENMARK	RUSSIAN FEDERATION
ENGLAND	SCOTLAND
FRANCE	SINGAPORE
GERMANY	SLOVAK REPUBLIC
GREECE	SLOVENIA
HONG KONG	SOUTH AFRICA
HUNGARY	SPAIN
ICELAND	SWEDEN
IRAN, ISLAMIC REPUBLIC	SWITZERLAND
IRELAND	THAILAND
ISRAEL	UNITED STATES
JAPAN	

TIMSS is an important study for those interested in U.S. education. In 1983, the National Commission on Excellence in Education pointed to our nation's low performance in international studies as evidence that we were *A Nation at Risk*. In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the U.S. will be first in the world in mathematics and science achievement." Mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989, and *Professional Standards for Teaching Mathematics* in 1991. In 1993 the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy*, and in 1996, the National Academy of Sciences published *National Science Education Standards*.

TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science. But TIMSS is much more than a scorecard for the math and science events in the "educational Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. It was designed to look behind the scorecard to illuminate how our education policies and practices compare to those of the world community.

TIMSS helps us answer the following questions about our nation's mathematics and science learning:

- Are U.S. curricula and expectations for student learning as demanding as those of other nations?
- Is the level of classroom instruction in the U.S. as high as that in other countries?
- Do U.S. teachers receive as much support in their efforts to teach students as their colleagues in other nations?
- Are U.S. students as focused on their studies as their international counterparts?

This report draws from the many reports and parts of the TIMSS study to summarize the initial findings concerning achievement and schooling in the eighth grade. It is part of the first of three waves of TIMSS reports. It will be followed in the next year by a series of reports focusing on the fourth grade, then by a series focusing on the last year of high school. Additional reports on selected topics will be published over the next several years. Much more will be learned as further analysis of the eighth grade data is carried out and findings from grades four and twelve are added.

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is not a comparison of "all of our students, with other nations' best," a charge which some critics have leveled at previous international comparisons. The students who participated in TIMSS were randomly selected to represent all students in their respective nations. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose are clearly noted in this and other TIMSS reports.

At each step of its development, TIMSS used careful quality control procedures. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the tests reflect the math and science curricula of the variety of TIMSS countries and do not over-emphasize what is taught in only a few. International monitors carefully checked the test translations and visited many classrooms while the tests were being administered in each of the 41 countries to make sure that the instructions were properly followed. The raw data from each country were scrutinized to be sure that no anomalies existed, and all analyses were double checked. Finally, this report has been written and carefully reviewed to avoid over-generalization and inaccuracy.

STUDY DESIGN

TIMSS is the third comparison of mathematics and science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). Previous IEA studies of mathematics and science were conducted for each subject separately at various times during the 1960s, 1970s, and 1980s. This is the first time that IEA has assessed both mathematics and science in the same study. Comparative studies of other subjects, including reading literacy (1992)[1], and computers in education (1993)[2] have also been published by the IEA.

TIMSS was designed to focus on students at three different stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Because countries around the world set different ages at which children should begin school, decisions about which students should be tested needed to take both age and grade level into account. The populations tested are listed below. Participation in Population 2 was required of all TIMSS nations, but participation in Populations 1 and 3 was optional.

- Population 1 - those students enrolled in the pair of adjacent grades that contained the most nine-year-olds. (Grades 3 and 4 in the U.S. and most of the world. Grades 2 and 3 in a few nations.)
- Population 2 - those students in the pair of adjacent grades that contained the most thirteen-year-olds at the time of testing. (Grades 7 and 8 in the U.S. and most of the world. Grades 6 and 7 in a few nations.)
- Population 3 - students in their final year of secondary school, whatever their age. (Grade 12 in the U.S. and most nations. Grades 9-13 in some nations.)

In all countries, students in both public and private schools received the TIMSS test. In all but a few of the 41 TIMSS countries, virtually all population 1 and 2 children are enrolled in school and were therefore eligible to take the test. Testing occurred 2 to 3 months before the end of the 1995-96 school year. Students with special needs and disabilities which would make it difficult for them to take the test were excused from the assessment. In each country, the test was translated into the primary language or languages of instruction. All testing in the U.S. was done in the English language.

TIMSS includes five different parts: assessments, questionnaires, curriculum analyses, videotapes of classroom instruction, and case studies of policy topics. The study was designed to bring a variety of different and complementary research methods to bear on important policy questions. The use of multiple methodologies has three major benefits. First, it strengthens the conclusions of the study because researchers are able to cross-check key findings by comparing results based on different research methods. Second, it provides broader information because more different types data are gathered than can be acquired through a single method or instrument. Third, the use of multiple methodologies enriches understanding of the contextual meaning of key findings. Each of the five parts on its own represents an important advance in its field. Taken together, they provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

At population 2, all 41 TIMSS countries participated in the following three IEA-sponsored parts of the study:

- Math and science assessments - One and a half hours in length, the assessments included both multiple-choice and free-response items. A smaller number of students also completed "hands-on" performance assessments, to be reported later.

- School, teacher, and student questionnaires - Students answered questions about their mathematics and science studies and beliefs. Teachers answered questions on their beliefs about math and science and on teaching practices. School administrators answered questions about school policies and practices.

- Curriculum analysis - This exploratory study compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance.

In conjunction with these three activities, the United States sponsored two additional parts of TIMSS, which were carried out in Germany, Japan, and the U.S. These three countries are all economic superpowers with close economic and political ties. They also are nations whose educators have learned a great deal from each other in the past, and whose school systems are both similar to and different from each other in important ways. The TIMSS researchers in Germany, Japan, and U.S. collaborated in sharing their assessment and questionnaire data, and in carrying out the following two parts of the study:

- Videotapes of mathematics instruction - In the U.S. and Germany, half of the eighth-grade mathematics classrooms that participated in the main TIMSS study were randomly chosen to be filmed. In Japan, an eighth-grade classroom in a random sample of 50 of the TIMSS schools was chosen to be videotaped. In all three countries teachers were filmed teaching a typical lesson, and these tapes were analyzed to compare teaching techniques and the quality of instruction.

- Ethnographic case studies of key policy topics - A team of 12 bilingual researchers each spent three months in Germany, Japan, or the U.S. observing classrooms and interviewing education authorities, principals, teachers, students, and parents. Topics of study were education standards, methods of dealing with individual differences, the lives and working conditions of teachers, and the role of school in adolescents' lives.

More detail on the findings and methodology of each of these parts of TIMSS can be found in the additional reports listed in Appendix 1.

THE TIMSS RESEARCH TEAM

TIMSS was conducted by the IEA, which is a Netherlands-based organization of ministries of education and research institutions in its member countries. The IEA delegated responsibility for overall coordination and management of the TIMSS study to Professor Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the 41 IEA member-nations that made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The costs of the international coordination were paid by the National Center for Education Statistics of the U.S. Department of Education (NCES), the National Science Foundation (NSF), and the Canadian Government.

TIMSS in the United States was also funded by NCES and NSF. Professor William Schmidt of Michigan State University was the U.S. National Research Coordinator. Policy decisions on the study were made by the U.S. National Coordinating Committee, composed of William Schmidt, Larry Suter of NSF, and Jeanne Griffith, Eugene Owen, and Lois Peak of NCES. Lois Peak monitored the international and U.S. TIMSS data collections. The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. Professor James Stigler at UCLA managed the TIMSS videotape study of mathematics instruction, and Professor Harold Stevenson at the University of Michigan managed the TIMSS ethnographic case studies. The many advisors to the study are listed in Appendix 2.

The U.S. TIMSS team also includes the nearly 4,000 seventh and 7,000 eighth graders who took the assessment, and their principals and teachers in more than 180 schools nationwide. Their cooperation has made this report possible. Third, fourth, and twelfth graders also took different TIMSS tests, and findings from these parts of the study will be reported during the next year.

ORGANIZATION OF THIS REPORT

This report summarizes early findings from the eighth-grade data based on results from all five parts of the TIMSS study. Both seventh and eighth grade students took the TIMSS test, but this initial report focuses on findings for the eighth grade. Future reports based on a more complete and extensive analysis of the data will provide deeper understanding and investigate relationships between the findings from the different parts of the study. Science teacher questionnaire data used in this report are based on preliminary weights which will be further refined in subsequent reports. Extensive documentation of the data collection methodologies and statistical analyses used in this report are available from NCES, and will be published separately.

This report combines the major findings from each of the five parts of the study into a single story about U.S. eighth-grade mathematics and science achievement in comparative perspective. In some respects, results for mathematics and science are similar. The report focuses more on mathematics for two reasons. First, the way in which the subject is taught makes it easier to compare across countries. Second, TIMSS contains more data about mathematics because the videotapes of classroom instruction were conducted only in this subject. Discussion of findings notes where the results in science differ from those in math. This report describes the U.S. against the backdrop of the 41 TIMSS countries, with a special attention to comparisons with Germany and Japan, because we have more information on these countries.

Chapter 1 draws from the results of the student assessments to describe how U.S. students perform in mathematics and science. Succeeding chapters focus on factors which may have an important influence on achievement, and describe how our nation's schools, teachers, and students compare to those in other countries. Chapter 2 examines educational standards and the curriculum, based on data from the curriculum analysis, case studies, videotape study, and questionnaires. Chapter 3 focuses on how teachers actually teach that curriculum, drawing from results of the videotape study and questionnaires. Chapter 4 examines the working life of teachers, based upon findings from the case studies and questionnaires. Chapter 5 describes the lives of students, both in and out of school, based upon case study and questionnaire data. The Conclusions at the end of the report looks across all of the findings for insights about factors associated with student performance and indicates questions for further study.

CHAPTER 1: ACHIEVEMENT

KEY POINTS:

U.S. eighth graders score below average in mathematics achievement and above average in science achievement, compared to the 41 nations in the TIMSS assessment.

In mathematics, our eighth-grade students' international standing is stronger in Algebra and Fractions than in Geometry and Measurement.

In science, our eighth graders' international standing is stronger in Earth Science, Life Science, and Environmental Issues than in Chemistry and Physics.

The U.S. is one of 11 TIMSS nations in which there is no significant gender gap in eighth-grade math and science achievement.

In the past, the mathematics and science achievement of U.S. students has caused nation-wide cries for improvement. Various international studies of these subjects conducted over the past thirty years have shown that our eighth graders have not performed as well as we expect, in comparison to their peers in other nations. U.S. students are not weak in all subjects, however. In a recent IEA study of reading literacy[3], U.S. eighth graders were among the best in the world. Indeed, TIMSS shows that U.S. eighth grade students also scored better than the average of the 41 participating countries in science. The results in mathematics, however, put our nation below average compared to the other nations.

HOW WELL DO U.S. STUDENTS DO?

Compared to their international counterparts, U.S. students are somewhat below the international average of 41 TIMSS countries in mathematics. In science, our students are somewhat above the international average. Figures 1 and 2 on pages 20 and 21 show how U.S. students perform in these subjects.

Tempting as it may be, it is not correct to report U.S. scores by rank alone, as would be the case if one were to say the U.S. is "number x in mathematics out of the 41 TIMSS countries." This is because the process of estimating each country's score from the sample of students who took the test produces only an estimate of the range within which the country's real score lies. This margin of error is expressed as a "plus or minus" interval around the estimated score. In TIMSS, we can say with 95 percent confidence that comparisons of other countries to the U.S. are accurate plus or minus about 20 points, depending on the size and design of the sample in the other countries. Comparisons of the U.S. to the international average are accurate plus or minus about 10 points. (Appendix 3 contains a list of standard errors). Because the precise score cannot be determined with perfect accuracy, to fairly compare the U.S. to other countries, nations have been grouped into broad bands according to whether their performance is higher than, not significantly different from, or lower than the U.S.

In mathematics, students in 20 countries outperform our eighth graders. Students in 13 countries are not significantly different than ours, and U.S. students outperform their counterparts in 7 nations. In science, students in 9 nations outperform U.S. eighth graders, performance in 16 other nations is not statistically different than ours, and we outperform another 15 nations.

SOME SPECIAL NOTES ON THE TEST SCORES

TIMSS required participating nations to adhere to extremely high technical standards at all stages of participation in the project. Many nations experienced some difficulty in this respect. In two nations, difficulties in meeting the standards were so severe that international monitors decided that their data should not be included in the report, and so findings are reported only for the remaining 41 nations. Of the 41 nations, 25 met or came close to meeting all technical standards for the study. However, 16 nations experienced difficulties of various types. In some countries, these

FIGURE 1:
NATIONS' AVERAGE MATHEMATICS PERFORMANCE COMPARED TO THE U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
SINGAPORE	643
KOREA	607
JAPAN	605
HONG KONG	588
BELGIUM-FLEMISH°	565
CZECH REPUBLIC	564
SLOVAK REPUBLIC	547
SWITZERLAND°	545
(NETHERLANDS)	541
(SLOVENIA)	541
(BULGARIA)	540
(AUSTRIA)	539
FRANCE	538
HUNGARY	537
RUSSIAN FEDERATION	535
(AUSTRALIA)	530
IRELAND	527
CANADA	527
(BELGIUM-FRENCH)	526
SWEDEN	519

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(THAILAND)	522
(ISRAEL)*	522
(GERMANY)*°	509
NEW ZEALAND	508
ENGLAND*°	506
NORWAY	503
(DENMARK)	502
UNITED STATES°	500
(SCOTLAND)	498
LATVIA (LSS)°	493
SPAIN	487
ICELAND	487
(GREECE)	484
(ROMANIA)	482

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
LITHUANIA*	477
CYPRUS	474
PORTUGAL	454
IRAN, ISLAMIC REPUBLIC	428
(KUWAIT)	392
(COLOMBIA)	385
(SOUTH AFRICA)	354

INTERNATIONAL AVERAGE= 513

SOURCE: Beaton et al. (1996) *Mathematics achievement in the middle school years.* Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
4. The international average is the average of the national averages of the 41 nations.
5. The country average for Sweden may appear to be out of place; however, statistically, its placement is correct.

difficulties arose because a large proportion of schools, teachers, or students declined to take the test. In others, the selection of schools or classrooms was not carried out according to international plan. In still others, students were slightly older than the international target age. The names of those nations in which major difficulties arose are shown in parentheses in the figures in this report, and Appendix 4 describes any deviations from international specifica-

(continued on page 23)

FIGURE 2:
NATIONS' AVERAGE SCIENCE PERFORMANCE COMPARED TO THE U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
SINGAPORE	607
CZECH REPUBLIC	574
JAPAN	571
KOREA	565
(BULGARIA)	565
(NETHERLANDS)	560
(SLOVENIA)	560
(AUSTRIA)	558
HUNGARY	554

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
ENGLAND *°	552
BELGIUM-FLEMISH °	550
(AUSTRALIA)	545
SLOVAK REPUBLIC	544
RUSSIAN FEDERATION	538
IRELAND	538
SWEDEN	535
UNITED STATES °	534
(GERMANY) *°	531
CANADA	531
NORWAY	527
NEW ZEALAND	525
(THAILAND)	525
(ISRAEL) *	524
HONG KONG	522
SWITZERLAND °	522
(SCOTLAND)	517

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
SPAIN	517
FRANCE	498
(GREECE)	497
ICELAND	494
(ROMANIA)	486
LATVIA (LSS) °	485
PORTUGAL	480
(DENMARK)	478
LITHUANIA *	476
(BELGIUM-FRENCH)	471
IRAN, ISLAMIC REPUBLIC	470
CYPRUS	463
(KUWAIT)	430
(COLOMBIA)	411
(SOUTH AFRICA)	326

INTERNATIONAL AVERAGE= 516

SOURCE: Beaton et al. (1996) *Science achievement in the middle school years*. Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
4. The international average is the average of the national averages of the 41 nations.
5. The country average for Scotland (or Spain) may appear to be out of place; however, statistically, its placement is correct.

FIGURE 3:
Average Achievement of Nations Meeting, and Not Meeting, International Guidelines

COUNTRIES COMPLYING WITH SPECIFICATIONS

NATION	MATH AVERAGE	SCIENCE AVERAGE
BELGIUM-FLEMISH °	565	550
CANADA	527	531
CYPRUS	474	463
CZECH REPUBLIC	564	574
ENGLAND *°	506	552
FRANCE	538	498
HONG KONG	588	522
HUNGARY	537	554
ICELAND	487	494
IRAN, ISLAMIC REPUBLIC	428	470
IRELAND	527	538
JAPAN	605	571
KOREA	607	565
LATVIA (LSS) °	493	485
LITHUANIA *	477	476
NEW ZEALAND	508	525
NORWAY	503	527
PORTUGAL	454	480
RUSSIAN FEDERATION	535	538
SINGAPORE	643	607
SLOVAK REPUBLIC	547	544
SPAIN	487	517
SWEDEN	519	535
SWITZERLAND °	545	522
UNITED STATES °	**500**	**534**

MATHEMATICS INTERNATIONAL AVERAGE=527
SCIENCE INTERNATIONAL AVERAGE=527

COUNTRIES WITH LOW PARTICIPATION RATES

NATION	MATH AVERAGE	SCIENCE AVERAGE
AUSTRALIA	530	545
AUSTRIA	539	558
BELGIUM-FRENCH	526	471
BULGARIA	540	565
NETHERLANDS	541	560
SCOTLAND	498	517

COUNTRIES TESTING OLDER-THAN-SPECIFIED STUDENTS

NATION	MATH AVERAGE	SCIENCE AVERAGE
COLOMBIA	385	411
GERMANY	509	531
ROMANIA	482	486
SLOVENIA	541	560

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS

NATION	MATH AVERAGE	SCIENCE AVERAGE
DENMARK	502	478
GREECE	484	497
THAILAND	522	525

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS AND OTHER DEPARTURES FROM GUIDELINES

NATION	MATH AVERAGE	SCIENCE AVERAGE
ISRAEL	522	524
KUWAIT	392	430
SOUTH AFRICA	354	326

Notes:

1. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
2. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
3. The international average is 527 for both mathematics and science. This is the average of the national averages of the 25 countries meeting international guidelines.
4. The international average based on all 41 countries listed is 513 for mathematics and 516 for science.

Source: Beaton et al. (1996) *Mathematics achievement in the middle school years.* Table 1.1. Boston College: Chestnut Hill, MA., and Beaton et al. (1996) *Science achievement in the middle school years.* Table 1.1. Boston College: Chestnut Hill, MA.

tions that occurred. It should be kept in mind that we cannot have the same amount of confidence in the scores of the 16 nations in which major difficulties arose.

If the international average is calculated only from the 25 countries in which no major difficulties arose in carrying out the international specifications, the U.S. mathematics score is still below the international average. In science, however, our score is no longer significantly different from the average of the 25 nations. Our comparative position in science becomes lower because many of the countries who are removed from consideration are those that we outperformed. Figure 3 on page 22 shows our mathematics and science standing in comparison to these 25 nations, and the types of anomalies that occurred in the other 16 countries. The difference in U.S. standing between Figure 3 and the previous figures demonstrates that the selection of countries against which the U.S. is compared can change our international standing.

Which comparison should we emphasize as TIMSS' main finding – the comparison to 25 countries, or to 41? NCES has chosen as the primary finding our standing with respect to 41 countries because the international TIMSS reports present the results in terms of all 41 nations.

What do the test scores mean? Due to the complex nature of the TIMSS test design, scoring, and analysis, a score of 600 does not mean either 600 items, or 60 percent correct. One can interpret the scores by considering where they fall along the range of scores from 0 to 1000 of other eighth-grade students who took the test. In mathematics, a score of 656 would put a student in the top 10 percent of all students in the 41 TIMSS countries, and a score of 587 would put a student in the top 25 percent. In mathematics, 509 was the average student score. In science, a score of 655 would put a student in the top 10 percent, a score of 592 would put a student in the top 25 percent, and 522 was the average student score.

WHICH COUNTRIES OUTPERFORM THE U.S. IN BOTH SUBJECTS?

We can say with confidence that five nations outperformed us in both mathematics and science. They are:

- Three Asian nations - Singapore, Korea, and Japan.
- Two Central European nations - Czech Republic and Hungary.

The Netherlands, Austria, Slovenia, and Bulgaria also outperformed us in both subjects, but because these countries did not carry out TIMSS according to strict international standards, we can be less certain about their scores. These nine countries were the only ones that outperformed us in science, and they were also among the 20 countries that outperformed us in mathematics.

WHICH COUNTRIES DOES THE U.S. OUTPERFORM IN BOTH SUBJECTS?

We can say with confidence that the U.S. outperformed four countries in both mathematics and science:

- Three European countries - Lithuania, Cyprus, and Portugal.
- One Middle Eastern country - Iran.

The U.S. also outperformed Kuwait, Colombia, and South Africa in both subjects, but due to deviations in their administration of TIMSS, we have less confidence in their scores. These seven countries were the only ones that we outperformed in mathematics, and they were also among the 15 countries that we outperformed in science.

HOW DO WE COMPARE TO OUR MAJOR ECONOMIC PARTNERS?

The "Group of Seven" or G-7 countries are major U.S. economic and political allies. The other six nations in this group are the United Kingdom, France, Germany, Canada, Japan, and Italy. Italy did not administer the TIMSS test, so the U.S. can only be compared to the remaining five. The United Kingdom includes England, Scotland, Northern Ireland, and Wales. Northern Ireland and Wales did not participate in TIMSS, and England and Scotland both have the same international standing in comparison to the U.S. Therefore, in this section, we describe our standing in relation to England.

In mathematics, Japan, France, and Canada outperform the U.S., while our scores are not significantly different from those of England and Germany. In science, we score lower than Japan; were not significantly different than England, Canada, and Germany; and score higher than France. **Considering our standing in relation to these five major economic partners, it can be said that the U.S. is in the bottom half in mathematics, and about the middle in science.**

Among the G-7 countries, Germany is the only nation which appears in parentheses, indicating problems in the implementation of the international guidelines for carrying out the study. In Germany, the problem was a discrepancy in the age of the students tested. Because German children start school somewhat later than children in other countries, the average age of the German eighth-graders who took the TIMSS test was about four months older than the international target age. Some would say that this means that other nations' eighth graders should be compared with Germany's seventh graders for a better age comparison. However, this provides a less-than-ideal grade comparison.

In a grade-based comparison, there is no significant difference between German and U.S. eighth graders. If we were to approximate an age-based comparison by matching the scores of our eighth graders to those of German seventh graders, our eighth graders do significantly better. Both comparisons are useful because most experts believe that achievement is based partly on cognitive maturation which comes with age, and partly on years of study which come with grade in school.

HOW FAR BEHIND THE TOP COUNTRIES ARE WE?

Particularly in mathematics, our students are far behind Singapore and Japan which are among the top-scoring nations in the world in both math and science. One way to compare two nations' scores is by considering their comparative standing with relation to the international percentiles. In mathematics, the scores of our very best U.S. eighth graders, who perform at the 95th percentile for our nation, are not significantly different than the scores of average eighth graders in Singapore, who perform at their nation's 50th percentile. In comparison to Japan, the scores of our best students, who are at the 95th percentile for our nation, are significantly below the scores of the top quarter of Japanese students, who perform at their nation's 75th percentile.

In science, the gap is not so large. Students at the U.S. 95th percentile are significantly better than students at the 75th percentile in Singapore. In comparison to Japan, there is no significant difference between U.S. and Japanese students at the 95th percentile.

Another way to estimate distance between the U.S. and top scoring countries is to use the difference between our seventh and our eighth graders as a unit of measure. In mathematics, the difference between our seventh and eighth graders' scores was 24 points. The difference between the scores of eighth graders in the U.S. and in Singapore was 143 points. This means that the difference in eighth-grade mathematics performance between the two countries is almost six times the difference between U.S. seventh and eighth graders. The difference between U.S. and Japanese eighth graders' mathematics performance is about four times this difference.

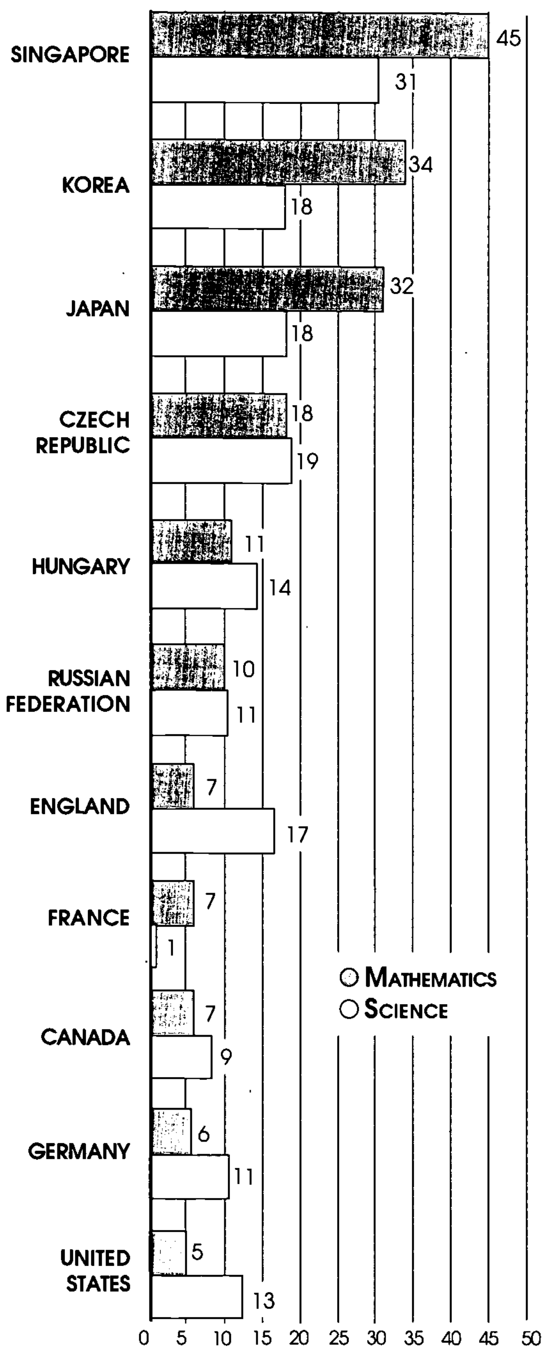
In science, the gap is smaller, but still substantial. The difference between U.S. seventh and U.S. eighth graders' scores is 26 points. The difference between the scores of the U.S. and Singapore was 73 points. The difference in science performance between eighth graders in the U.S. and Singapore is almost three times the difference between our seventh and eighth graders. The difference between U.S. and Japanese eighth graders' science performance is almost one and a half times this difference.

HOW DO OUR BEST STUDENTS COMPARE WITH OTHERS' BEST?

Comparisons of averages tell us how typical students perform, but they do not tell us about the performance of our nation's best students - those who are likely to become the next generation of mathematicians, scientists, doctors, and engineers. **If an international talent search were to select the top ten percent of all students in the 41 TIMSS countries combined, what percentage of U.S. students would be included?**

In mathematics, 5 percent of U.S. eighth graders would be selected. High-scoring nations would have more of their students represented in the "international top ten percent." Figure 4 on page 26 shows that 45 percent of all Singaporean students and 32 percent of all Japanese students would be chosen in the international talent search in mathematics. **In science, 13 percent**

FIGURE 4:
PERCENT OF STUDENTS FROM SELECTED NATIONS SCORING AMONG THE TOP 10 PERCENT OF EIGHTH GRADERS IN THE 41 TIMSS COUNTRIES



of U.S. students would be selected, in comparison to 31 percent of Singaporean students and 18 percent of Japanese students.

If the international talent search were to lower its standards considerably to choose the top half of all students in the 41 TIMSS countries, 94 percent of eighth graders in Singapore and 83 percent in Japan would be selected in mathematics, compared to 45 percent of eighth graders in the U.S. In science, 82 percent of the students in Singapore and 71 percent of students in Japan would be selected, compared to 55 percent in the U.S.

HOW DOES THE U.S. MATHEMATICS AND SCIENCE GENDER GAP COMPARE TO OTHER COUNTRIES'?

In the U.S. and in other countries, policy makers have made great efforts to make math and science more accessible to girls, and to encourage gender equity in these subjects. More TIMSS countries have achieved gender equity in their students' scores in mathematics than in science. **The U.S. is one of 11 TIMSS nations in which there is no significant gender gap in eighth-grade mathematics and science achievement.** The U.S. was one of 33 countries in which there was no statistically significant difference between the performance of eighth-grade boys and

Source: Beaton et al. (1996) *Mathematics achievement in the middle school years*. Table 1.4. Boston College: Chestnut Hill, MA., and Beaton et al. (1996) *Science achievement in the middle school years*. Table 1.4. Boston College: Chestnut Hill, MA.

girls in mathematics. In science, we were one of 11 nations with no statistically significant difference. All 11 nations with no significant different in science also demonstrated no difference in mathematics. They are the United States, Singapore, the Russian Federation, Thailand, Australia, Ireland, Romania, Flemish Belgium, Cyprus, Colombia, and South Africa.

HOW DO WE SCORE IN THE DIFFERENT CONTENT AREAS OF MATHEMATICS AND SCIENCE?

Representing student achievement in mathematics and science as a total score is a useful way to summarize achievement. However, mathematics and science contain different content areas, which are emphasized and sequenced differently in curricula around the world. Based on these national priorities, in each country, some content areas have been studied more than others at a particular grade level.

The TIMSS eighth-grade mathematics test included sets of items designed to sample students' ability to do work in the following areas:

- *Algebra* (patterns, relations, expressions, equations).
- *Data Representation, Analysis, and Probability* (representation and analysis of data using charts and graphs involving uncertainty and probability).
- *Fractions and Number Sense* (fractions, decimals, percentages, estimation and rounding).
- *Geometry* (visualization and properties of geometric figures, including symmetry, congruence, and similarity).
- *Measurement* (units of length, weight, time, area, volume, and interpretation of measurement scales).
- *Proportionality* (proportionality and ratios).

Figure 5 on pages 28 and 29 shows that among these content areas, **U.S. students' performance is at about the international average in Algebra; Data Representation, Analysis, and Probability; and Fractions and Number Sense. Compared to other countries, we do less well in Geometry; Measurement; and Proportionality.** Our weaker performance in these latter three topics may pull the overall U.S. score down to below average.

In science, the TIMSS eighth-grade test sampled students' ability to do work in the following subjects:

- *Chemistry* (classification of matter, chemical properties and transformations).
- *Earth Science* (earth features, earth processes, and the earth in the universe).
- *Environmental Issues and the Nature of Science* (environmental and resource issues, the nature of scientific knowledge, and the interaction of science and technology).

(Continued on page 32)

FIGURE 5:
National Averages in Mathematics Content Areas

FRACTIONS & NUMBER SENSE

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	84
JAPAN	75
KOREA	74
HONG KONG	72
BELGIUM-FLEMISH °	71
CZECH REPUBLIC	69
SWITZERLAND °	67
SLOVAK REPUBLIC	66
(AUSTRIA)	66
IRELAND	65
HUNGARY	65
FRANCE	64
CANADA	64

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(SLOVENIA)	63
SWEDEN	62
(BELGIUM-FRENCH)	62
RUSSIAN FEDERATION	62
(NETHERLANDS)	62
(AUSTRALIA)	61
(ISRAEL) *	60
(BULGARIA)	60
(THAILAND)	60 (58)
UNITED STATES °	59
(GERMANY) *°	58
NORWAY	58
NEW ZEALAND	57
ICELAND	54

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
ENGLAND *°	54
(SCOTLAND)	53
(DENMARK)	53
(GREECE)	53
LATVIA (LSS) °	53
SPAIN	52
LITHUANIA *	51
CYPRUS	50
(ROMANIA)	48
PORTUGAL	44
IRAN, ISLAMIC REPUBLIC	39
(COLOMBIA)	31
(KUWAIT)	27
(SOUTH AFRICA)	26

GEOMETRY

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
JAPAN	80
SINGAPORE	76
KOREA	75
HONG KONG	73
CZECH REPUBLIC	66
FRANCE	66
(BULGARIA)	65
BELGIUM-FLEMISH °	64
RUSSIAN FEDERATION	63
SLOVAK REPUBLIC	63
(THAILAND)	62
(SLOVENIA)	60
HUNGARY	60
SWITZERLAND °	60
(NETHERLANDS)	59
(BELGIUM-FRENCH)	58
CANADA	58
(AUSTRALIA)	57
(ISRAEL) *	57
(AUSTRIA)	57
LATVIA (LSS) °	57 (56)
NEW ZEALAND	54
ENGLAND *°	54
(DENMARK)	54

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
LITHUANIA *	53
(ROMANIA)	52
(SCOTLAND)	52
IRELAND	51
(GERMANY) *°	51
ICELAND	51
NORWAY	51
(GREECE)	51
SPAIN	49
SWEDEN	48
UNITED STATES °	48
CYPRUS	47
PORTUGAL	44

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
IRAN, ISLAMIC REPUBLIC	43
(KUWAIT)	38
(COLOMBIA)	29
(SOUTH AFRICA)	24

ALGEBRA

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	76
JAPAN	72
HONG KONG	70
KOREA	69
CZECH REPUBLIC	65
HUNGARY	63
RUSSIAN FEDERATION	63
BELGIUM-FLEMISH °	63
SLOVAK REPUBLIC	62
(BULGARIA)	62
(SLOVENIA)	61
(ISRAEL) *	61
(AUSTRIA)	59

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(AUSTRALIA)	55
SPAIN	54
FRANCE	54
CANADA	54
IRELAND	53
(BELGIUM-FRENCH)	53
(THAILAND)	53
SWITZERLAND °	53
(NETHERLANDS)	53
(ROMANIA)	52 (52)
UNITED STATES °	51
LATVIA (LSS) °	51
NEW ZEALAND	49
ENGLAND *°	49
(GERMANY) *°	48
CYPRUS	48
LITHUANIA *	47
(SCOTLAND)	46

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(GREECE)	46
NORWAY	45
(DENMARK)	45
SWEDEN	44
ICELAND	40
PORTUGAL	40
IRAN, ISLAMIC REPUBLIC	37
(KUWAIT)	30
(COLOMBIA)	28
(SOUTH AFRICA)	23

NOTES:

1. Nations not meeting international study guidelines are shown in parentheses.
2. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
4. The international average is the average of the national averages of the 41 nations.

DATA REPRESENTATION, ANALYSIS, & PROBABILITY

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	79
KOREA	78
JAPAN	78
BELGIUM-FLEMISH ○	73
SWITZERLAND ○	72
(NETHERLANDS)	72
HONG KONG	72
FRANCE	71
SWEDEN	70

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
IRELAND	69
CANADA	69
(AUSTRIA)	68
CZECH REPUBLIC	68
(BELGIUM-FRENCH)	68
(AUSTRALIA)	67
(DENMARK)	67
NORWAY	66
NEW ZEALAND	66
(SLOVENIA)	66
ENGLAND *○	66
HUNGARY	66
UNITED STATES ○	65
(SCOTLAND)	65
(GERMANY) *○	64
(ISRAEL) *	63
ICELAND	63
(THAILAND)	63
(BULGARIA)	62
SLOVAK REPUBLIC	62 (62)
RUSSIAN FEDERATION	60

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SPAIN	60
(GREECE)	56
LATVIA (LSS) ○	56
PORTUGAL	54
CYPRUS	53
LITHUANIA *	52
(ROMANIA)	49
IRAN, ISLAMIC REPUBLIC	41
(KUWAIT)	38
(COLOMBIA)	37
(SOUTH AFRICA)	26

MEASUREMENT

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	77
JAPAN	67
KOREA	66
HONG KONG	65
CZECH REPUBLIC	62
(AUSTRIA)	62
SWITZERLAND ○	61
SLOVAK REPUBLIC	60
BELGIUM-FLEMISH ○	60
(SLOVENIA)	59
(NETHERLANDS)	57
FRANCE	57
HUNGARY	56
RUSSIAN FEDERATION	56
SWEDEN	56
(BELGIUM-FRENCH)	56
(BULGARIA)	54
(AUSTRALIA)	54
IRELAND	53
NORWAY	51
CANADA	51 (51)
(GERMANY) *○	51
(THAILAND)	50
ENGLAND *○	50
(DENMARK)	49
NEW ZEALAND	48
(ISRAEL) *	48
(SCOTLAND)	48
(ROMANIA)	48
LATVIA (LSS) ○	47

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
ICELAND	45
SPAIN	44
CYPRUS	44
(GREECE)	43
LITHUANIA *	43
UNITED STATES ○	40
PORTUGAL	39

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
IRAN, ISLAMIC REPUBLIC	29
(COLOMBIA)	25
(KUWAIT)	23
(SOUTH AFRICA)	18

PROPORTIONALITY

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	75
HONG KONG	62
KOREA	62
JAPAN	61
BELGIUM-FLEMISH ○	53
SWITZERLAND ○	52
CZECH REPUBLIC	52
(NETHERLANDS)	51
(THAILAND)	51
IRELAND	51
(SLOVENIA)	49
SLOVAK REPUBLIC	49
(AUSTRIA)	49
FRANCE	49
RUSSIAN FEDERATION	48
CANADA	48
(BELGIUM-FRENCH)	48
HUNGARY	47

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(BULGARIA)	47
(AUSTRALIA)	47 (45)
SWEDEN	44
(ISRAEL) *	43
NEW ZEALAND	42
UNITED STATES ○	42
(GERMANY) *○	42
(ROMANIA)	42
ENGLAND *○	41
(DENMARK)	41
NORWAY	40
SPAIN	40
(SCOTLAND)	40
CYPRUS	40
(GREECE)	39
LATVIA (LSS) ○	39
ICELAND	38

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
IRAN, ISLAMIC REPUBLIC	36
LITHUANIA *○	35
PORTUGAL	32
(COLOMBIA)	23
(SOUTH AFRICA)	21
(KUWAIT)	21

SOURCE:
Beaton et al. (1996) *Mathematics achievement in the middle school years.* Table 2.1. Boston College: Chestnut Hill, MA.

(#) INTERNATIONAL AVERAGE PERCENT CORRECT, ALL NATIONS

FIGURE 6:
National Averages in Science Content Areas

EARTH SCIENCE

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	65
(SLOVENIA)	64
CZECH REPUBLIC	63
KOREA	63

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
BELGIUM-FLEMISH °	62
(AUSTRIA)	62
SWEDEN	62
NORWAY	61
IRELAND	61
(NETHERLANDS)	61
JAPAN	61
SLOVAK REPUBLIC	60
HUNGARY	60
ENGLAND *°	59
RUSSIAN FEDERATION	58
(BULGARIA)	58
UNITED STATES °	58
SWITZERLAND °	58
CANADA	58
(AUSTRALIA)	57
(GERMANY) *°	57
SPAIN	57
(THAILAND)	56
NEW ZEALAND	56
(ISRAEL) *	55
FRANCE	55
HONG KONG	54

(55)

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(SCOTLAND)	52
PORTUGAL	50
(BELGIUM-FRENCH)	50
ICELAND	50
(ROMANIA)	49
(GREECE)	49
(DENMARK)	49
LATVIA (LSS) °	48
LITHUANIA *	46
CYPRUS	46
IRAN, ISLAMIC REPUBLIC	45
(KUWAIT)	43
(COLOMBIA)	37
(SOUTH AFRICA)	26

LIFE SCIENCE

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	72
JAPAN	71
KOREA	70
CZECH REPUBLIC	69

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(NETHERLANDS)	67
(THAILAND)	66
HUNGARY	65
(AUSTRIA)	65
(SLOVENIA)	65
(BULGARIA)	64
ENGLAND *°	64
BELGIUM-FLEMISH °	64
(AUSTRALIA)	63
(GERMANY) *°	63
UNITED STATES °	63
SWEDEN	63
RUSSIAN FEDERATION	62
CANADA	62
HONG KONG	61
NORWAY	61
(ISRAEL) *	61
NEW ZEALAND	60
SLOVAK REPUBLIC	60
IRELAND	60
SWITZERLAND °	59
ICELAND	58

(59)

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SPAIN	58
(SCOTLAND)	57
FRANCE	56
(DENMARK)	56
(ROMANIA)	55
(BELGIUM-FRENCH)	55
(GREECE)	54
PORTUGAL	53
LATVIA (LSS) °	53
LITHUANIA *	52
IRAN, ISLAMIC REPUBLIC	49
CYPRUS	49
(KUWAIT)	45
(COLOMBIA)	44
(SOUTH AFRICA)	27

PHYSICS

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	69
JAPAN	67
KOREA	65
CZECH REPUBLIC	64
(NETHERLANDS)	63
(AUSTRIA)	62
ENGLAND *°	62
SLOVAK REPUBLIC	61
(SLOVENIA)	61
BELGIUM-FLEMISH °	61
(BULGARIA)	60
(AUSTRALIA)	60
HUNGARY	60

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
CANADA	59
HONG KONG	58
NEW ZEALAND	58
SWITZERLAND °	58
RUSSIAN FEDERATION	57
(GERMANY) *°	57
SWEDEN	57
(ISRAEL) *	57
(SCOTLAND)	57
NORWAY	57
IRELAND	56
UNITED STATES °	56
SPAIN	55
FRANCE	54
(THAILAND)	54
ICELAND	53
(GREECE)	53
(DENMARK)	53

(55)

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(BELGIUM-FRENCH)	51
LATVIA (LSS) °	51
LITHUANIA *	51
(ROMANIA)	49
PORTUGAL	48
IRAN, ISLAMIC REPUBLIC	48
CYPRUS	46
(KUWAIT)	43
(COLOMBIA)	37
(SOUTH AFRICA)	27

CHEMISTRY

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	69
(BULGARIA)	65
KOREA	63
JAPAN	61
CZECH REPUBLIC	60
HUNGARY	60
(AUSTRIA)	58

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
SLOVAK REPUBLIC	57
RUSSIAN FEDERATION	57
(SLOVENIA)	56
SWEDEN	56
ENGLAND *°	55
HONG KONG	55
(GERMANY) *°	54
IRELAND	54
(AUSTRALIA)	54
(ISRAEL) *	53
UNITED STATES °	53
NEW ZEALAND	53
(NETHERLANDS)	52
IRAN, ISLAMIC REPUBLIC	52
CANADA	52
SPAIN	51
(GREECE)	51
BELGIUM-FLEMISH °	51 (51)
(SCOTLAND)	51
PORTUGAL	50
SWITZERLAND °	50
NORWAY	49

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
LATVIA (LSS) °	48
LITHUANIA *	48
FRANCE	47
(ROMANIA)	46
CYPRUS	45
(THAILAND)	43
ICELAND	42
(BELGIUM-FRENCH)	41
(DENMARK)	41
(KUWAIT)	40
(COLOMBIA)	32
(SOUTH AFRICA)	26

ENVIRONMENTAL ISSUES & THE NATURE OF SCIENCE

NATIONS WITH SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	74

NATIONS WITH SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(NETHERLANDS)	65
ENGLAND *°	65
KOREA	64
(AUSTRALIA)	62
(THAILAND)	62
UNITED STATES °	61
CANADA	61
IRELAND	60
JAPAN	60
(BULGARIA)	59
CZECH REPUBLIC	59
NEW ZEALAND	59
(SLOVENIA)	59
BELGIUM-FLEMISH °	58
(SCOTLAND)	57

NATIONS WITH SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
NORWAY	55
HONG KONG	55
(AUSTRIA)	55
SLOVAK REPUBLIC	53
HUNGARY	53 (53)
FRANCE	53
SPAIN	53
(ISRAEL) *	52
SWEDEN	52
(GERMANY) *°	51
SWITZERLAND °	51
(GREECE)	51
RUSSIAN FEDERATION	50
ICELAND	49
(DENMARK)	47
LATVIA (LSS) °	47
CYPRUS	46
(BELGIUM-FRENCH)	46
PORTUGAL	45
(ROMANIA)	42
(COLOMBIA)	40
LITHUANIA *	40
(KUWAIT)	39
IRAN, ISLAMIC REPUBLIC	39
(SOUTH AFRICA)	26

NOTES:

1. Nations not meeting international study guidelines are shown in parentheses.
2. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
4. The international average is the average of the national averages of the 41 nations.

SOURCE:

Beaton et al. (1996) *Science achievement in the middle school years.* Table 2.1. Boston College: Chestnut Hill, MA.

(#) **AVERAGE PERCENT CORRECT**

- *Life Science* (structure, diversity, classification, processes, cycles, and interactions of plants and animals).

- *Physics* (energy forms, physical transformations, force and motion, and physical properties of matter).

Figure 6 on pages 30 and 31 shows our comparative standing in these content areas. The U.S. is among the top countries in the world in Environmental Issues and the Nature of Science, and we are also above the international average in Earth Science and Life Science. **In Chemistry and Physics, our performance is not significantly different from the international average. Our better-than-average scores in Environmental Issues, Earth Science, and Life Science may pull our overall science score up to above average.**

WHAT DID PRIOR STUDIES SHOW ABOUT HOW U.S. STATES COMPARE TO OTHER COUNTRIES?

Comparison of U.S. states with other nations reminds us that not all U.S. school systems are alike, and that wide differences in achievement exist within our own nation. Some would say that comparisons of U.S. states and other nations are fair for two reasons. First, most U.S. states are larger either in size or population than many countries in the TIMSS study. For example, California is larger in size than Japan, Germany, or England. New Jersey has a larger population than Austria, Denmark, or Switzerland. A second reason that such comparisons are fair is that each U.S. state is responsible for its own education system, similar to the way in which most other TIMSS national governments are responsible for their own education system.

Future analyses may make possible such comparisons between U.S. states and the TIMSS nations. Efforts are now underway to create an experimental linkage between the TIMSS study and the mathematics and science portions of the National Assessment of Educational Progress (NAEP). This linkage will allow an estimation of how states would have performed on TIMSS if their students had taken the test. The results for eighth-grade mathematics and science will be announced in 1997.

Until those findings are released, however, we can look at the results of a similar linkage which was performed in 1991 for eighth-grade mathematics students' scores on NAEP and on the International Assessment of Educational Progress[4]. **In that comparison, the mathematics scores of Iowa, North Dakota, and Minnesota were similar to top-scoring Taiwan and Korea. In contrast, Alabama, Louisiana, and Mississippi scored about the same as lowest-scoring Jordan.** These findings underscore the considerable variation in achievement that exists among states within our own nation.

HAS U.S. INTERNATIONAL STANDING IMPROVED OVER TIME?

Results from the National Assessment of Education Progress show that our eighth-grade students' scores in math and science have improved somewhat in comparison to our own performance during the past decades. If our domestic performance over time is improving, how does this affect our international standing? It is possible that only U.S. achievement has improved over time, while achievement in other countries has not. Of course, it is also possible that improvements in the U.S. have been matched or exceeded by improvements in other countries.

International comparisons over time are difficult. The first international studies of math and science achievement were conducted in the 1960s, and there have been three previous assessments in each subject since that time. However, each assessment has been done differently. A different set of nations participated, different topics in math and science were included in the tests, the age and type of students sampled in each country changed slightly, and indeed even the borders and names of some of the nations have changed. Furthermore, the field of assessment has matured greatly over the past thirty years, rendering the methods of the then-revolutionary early studies crude by today's standards. These and other factors complicate comparisons over time, and require that any conclusions that are drawn be necessarily tentative.

In TIMSS mathematics, we have seen that our eighth-graders scored below the international average. This is basically the same relative international standing reported for U.S. thirteen-year-olds in the IEA First and Second International Mathematics Studies in the 1960s and 1980s, and the mathematics portion of the International Assessment of Educational Progress in the early 1990s[5]. **Relative to their international counterparts, it is not likely that U.S. eighth-graders' standing in mathematics has improved significantly.**

In the three previous international science assessments in the 1960s, 1980s, and early 1990s, the U.S. performed below the international average of thirteen or fourteen-year-olds. However in TIMSS, our students scored at or above the international average. **Because comparisons over time are difficult, caution should be exercised in assuming there has been significant improvement in our international standing in science, but it is a possibility.**

We have now examined what TIMSS tells us about what eighth-grade students have learned. Learning, of course, is closely related to what students are taught. Next we turn to an examination of how the U.S. mathematics and science curricula compare with those of other nations.

CHAPTER 2: CURRICULUM

KEY POINTS:

The content taught in U.S. eighth-grade mathematics classrooms is at a seventh-grade level in comparison to other countries.

Topic coverage in U.S. eighth-grade mathematics classes is not as focused as in Germany and Japan.

In science, the degree of topic focus in the eighth-grade curriculum may be similar to that of other countries.

Our nation is atypical among TIMSS countries in its lack of a nationally-defined curriculum.

U.S. eighth graders spend more hours per year in math and science classes than German and Japanese students.

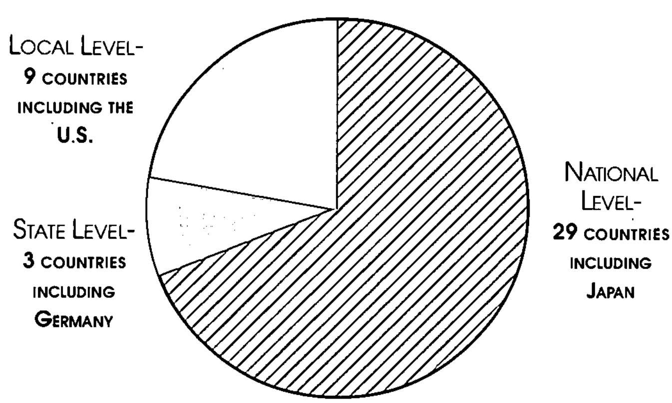
U.S. policy makers are concerned about whether standards for our students are high enough, and, in particular, whether they are as challenging as those of our foreign economic partners. There is a widespread belief that our nation's economic productivity is related to our students' performance in mathematics and science, and that this in turn is related to the expectations that are set for student performance.

However, the relationship between standards, teaching, and learning is not a simple one. Formal and informal decisions at many levels affect what students are taught. National, state, and local authorities as well as publishers set forth the officially intended curriculum in both curriculum guidelines and textbooks. Teachers also make decisions about what should be taught. Depending on the country, their decisions are based more or less closely on the officially intended curriculum. What teachers actually teach their students is sometimes called the "implemented curriculum." Both the officially intended curriculum and the implemented curriculum must be considered when discussing a nation's goals for student learning.

WHO SETS CURRICULUM STANDARDS?

In most TIMSS countries, the curriculum is determined by national authorities. Figure 7 shows that curriculum is determined at the national level in 29 of the TIMSS countries, at the state or region in 3 countries, and at the local or district level in 9 countries. Germany, Japan, and the U.S. differ in this respect, which makes comparisons among the three countries interesting. Which authority sets a country's official curriculum standards makes a difference in whether or not there is a single

FIGURE 7
NUMBER OF TIMSS COUNTRIES DETERMINING CURRICULUM AT VARIOUS LEVELS



SOURCE:
Beaton et al. (1996) *Mathematics achievement in the middle school years.* Figure 1. Boston College: Chestnut Hill, MA.

official core curriculum for the entire nation, or whether there are as many official curricula as there are states or districts in the country.

Japan is one of the countries that determines curriculum at the national level. The National Ministry of Education specifies one set of curriculum guidelines that details the topics of study and the number of instructional hours required in every accredited elementary and junior high school. For these schooling levels, it also approves textbooks published by six commercial publishers. Textbooks resemble each other in content because they must be based closely on the national guidelines. Local school boards make only minor modifications to the national guidelines, and choose textbooks from among the approved list. However, the Ministry itself does not monitor whether or not the standards are adhered to, leaving the issue of oversight to the local boards of education. Teachers of each subject in a school work together closely to be sure that they cover the material in the textbooks at approximately the same depth and rate. This is partly due to the oversight of local authorities, and partly due to teachers' desire that their students score well on the high-school entrance examination, which is based directly on the national curriculum.

In Germany, each of the 16 states sets its own curriculum standards for students. To encourage some degree of similarity across states, the national Conference of Ministers of Education discusses various issues related to standards and adopts broad recommended guidelines concerning curriculum, hours of instruction, and examination guidelines. State curriculum standards vary widely in their level of specificity, and the degree to which schools and teachers are held accountable for following them. Teachers in states where curriculum guidelines are not highly specific, and where schools and districts are allowed to develop their own secondary school exit examinations, have considerable flexibility in determining what and how they teach.

In the U.S., most of the nearly16,000 districts design their own curriculum or standards, usually within broad guidelines issued by each of the 50 states. There are many different commercially published textbooks. Because most textbooks are designed with an eye to sales in as many districts as possible, they include the content specified by the guidelines from a number of different states. As a result, textbooks usually contain much more material than a teacher can cover fully in a year. Each of the many different textbooks includes somewhat different topics from which teachers in various districts can choose. Few states or districts closely monitor or enforce compliance with state or district standards, and U.S. teachers usually have the latitude to design the content and pace of their courses to suit their perception of their students' needs.

IS CURRICULUM IN THE U.S. AS FOCUSED AS IN OTHER COUNTRIES?

Evidence from a variety of sources in TIMSS shows us that the U.S. mathematics curriculum is less focused than that of other countries. The U.S. science curriculum more closely resembles international practices.

The TIMSS curriculum analysis studied the officially intended curriculum by asking U.S. curriculum experts to judge which topics were recommended to be taught at each grade level. Their judgments were compared with those of experts in the other TIMSS countries. This effort revealed that the number of topics recommended to be covered in the U.S. was greater than the international average at each of grades 1 through 8 for mathematics.

Textbooks are another aspect of the officially intended curriculum. Videotapes of mathematics classes in Germany, Japan, and the U.S. showed that textbooks were used during class in almost half of U.S. lessons and a third of German lessons, but in only 2 percent of Japanese lessons. Teacher-developed worksheets were common in U.S. and Japanese lessons. In Japan, students also use supplementary practice books which are usually purchased from the school for use in home study.

The TIMSS curriculum analysis compared the most commonly used textbooks in the various countries. For the U.S. portion of this analysis, mathematics experts were asked to recommend the most commonly-used U.S. eighth-grade textbooks in these subjects. The TIMSS questionnaire surveys of teachers found that these chosen texts were indeed among the most widely used books in the U.S, although they accounted for the textbooks used by only 28 percent of the students. This finding that the five recommended textbooks covered a fairly small proportion of students is an indication of the great diversity of textbooks in our country. In Japan, close to 90 percent of the students used one of the five most common textbooks. Analysis found that the set of 5 U.S. eighth-grade texts included more different topics across all the texts than the set of texts in Japan and Germany.

Of course, not all teachers cover every topic recommended by curriculum experts, or included in textbooks. Therefore, TIMSS also studied the implemented curriculum—what teachers actually cover in their classrooms. Using the same definitions of mathematics topics that the curriculum analysis used, the videotape study of eighth-grade mathematics lessons in Germany, Japan, and the U.S. revealed that U.S. lessons include a greater number of topics. On average, U.S. teachers taught 1.9 topics per lesson, compared with 1.6 in Germany and 1.3 in Japan. The variety of topics was much wider in the U.S., too.

In science, the officially intended curriculum as reflected by U.S. curriculum experts' recommendations about topics to be taught was close to the international average for grades 3 through 8. Science experts in each country chose the three most common textbooks used in their classrooms, which were found to be used by 16 percent of students in the U.S., and 84 percent of students in Japan.

Thus, the evidence from a variety of TIMSS sources reinforces the finding that our eighth-grade mathematics curriculum is less focused than the curricula of other nations, if focus is defined as number and variety of topics in the intended and implemented curriculum. Although less information is available for science, U.S. curricular focus may be more similar to the average of the TIMSS countries in this subject.

IS CURRICULUM IN THE U.S. AS ADVANCED AS IN OTHER COUNTRIES?

The U.S. mathematics curriculum is not as advanced as in Germany and Japan. Concerning the intended curriculum, analysis of textbooks found that Geometry occupied more space in the German and Japanese books than in the U.S. texts. The Japanese textbooks also devoted more space to algebra than did the books studied by the majority of U.S. eighth graders, who are in non-algebra tracks.

The implemented curriculum in the U.S. is also less advanced than that of Germany and Japan. In the videotapes studied, 40 percent of U.S. eighth-grade mathematics lessons included arithmetic topics such as whole number operations, fractions, and decimals, whereas these topics were much less common in Germany and Japan. In contrast, German and Japanese eighth-grade lessons were more likely to cover algebra and geometry.

The topics being taught in U.S. mathematics classrooms were at a seventh-grade level in comparison to other countries, while the topics observed in the German and Japanese classrooms were at a high eighth-grade or even ninth-grade level. This was discovered based on a comparison of the TIMSS curriculum analysis and videotape studies. The curriculum analysis asked experts in each of the TIMSS countries to report the grade level at which their country focused on various topics. These findings were compared to the topics which the TIMSS videotape study observed eighth-grade teachers in Japan, Germany, and the U.S. to be actually teaching.

TIMSS does not have data to judge whether the U.S. curriculum in science is as advanced as that of other countries because the videotape study was conducted only in mathematics.

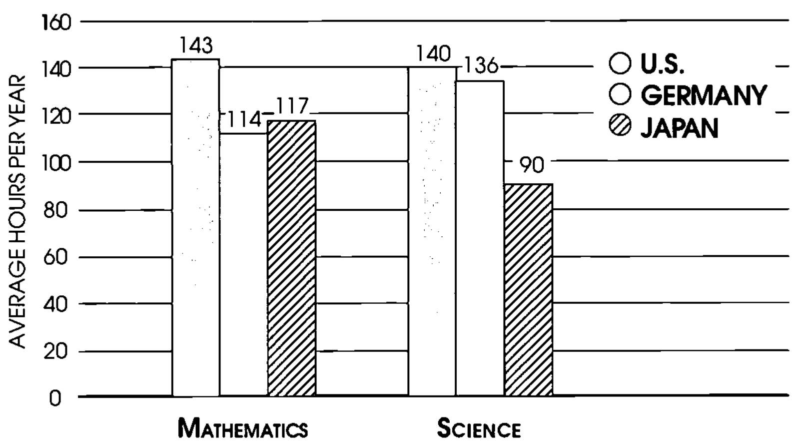
HOW MUCH TIME IS SPENT IN CLASS?

Lengthening the school year or school day has often been proposed as a measure to improve U.S. students' achievement, as it has been thought that U.S. students spend less time at school than their international counterparts. TIMSS compared the amount of time that teachers report U.S. students spend in mathematics and science classes with the amount of time reported for students in Germany and Japan. In contrast to previous analyses, TIMSS carefully took into account differences between countries in the length of the school year, school week, and class period, as well as differences between the amount of time required for students in high and low tracks. On this basis, the average number of hours per year that a student in each country spends in mathematics and science class was calculated.

U.S. eighth-graders spend considerably more hours per year in mathematics classes than their Japanese and German counterparts. U.S. students also spend much more time in science classes than students in Japan. Figure 8 on page 39 shows the amount of time that students in the different countries spend in math and science classes per year. U.S. students' instructional time is both longer and more compressed, because it takes place within a school year of approximately 180 days, as compared to 188 in Germany and 220 in Japan. Of course, time spent in homework, after-school classes, and out-of-school study is also an important factor in learning, and findings concerning these topics will be examined in Chapter 5.

Taken together, TIMSS curriculum-related findings show that **lack of sufficient class time is not the easy answer to the question of why U.S. students are below the international average in mathematics. Instead, findings suggest that our students receive a less-advanced curriculum, which is also less focused.** Next we will consider how this curriculum is taught by examining the findings concerning classroom teaching.

FIGURE 8
HOURS OF MATHEMATICS AND SCIENCE INSTRUCTIONAL TIME PER YEAR FOR EIGHTH-GRADERS



SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, U.S., German, and Japanese school and teacher surveys; Westat, Inc., 1996.

CHAPTER 3: TEACHING

KEY POINTS:

The content of U.S. mathematics classes requires less high-level thought than classes in Germany and Japan.

U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help them understand mathematical concepts.

Japanese teachers widely practice what the U.S. mathematics reform recommends, while U.S. teachers do so less frequently.

Although most U.S. math teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.

During the past several years, mathematics professional organizations, concerned about the quality of instruction in U.S. classrooms, have issued calls for reform. In 1989, the National Council of Teachers of Mathematics (NCTM) set forth *Curriculum and Evaluation Standards*, followed in 1991 by *Professional Standards for Teaching Mathematics,* and in 1995 by *Assessment Standards*. The essence of the recommendations in these reform documents is that instruction should be more than mere mastery of facts and routine skills. It should require students to understand and apply mathematical concepts in new situations.

Publication and discussion of documents such as these, however, do not change the behavior of all of America's hundreds of thousands of mathematics teachers within a few years. Recommendations for major changes in other areas of American life, such as improving health through regular exercise and proper diet, have required decades of sustained effort by public health organizations at all levels to assist individual citizens in changing ingrained personal habits and attitudes. Indeed, the campaign still continues. Changing our nation's habits of teaching and public attitudes toward mathematics and science may also require a similarly long and concerted effort by many committed people.

TIMSS was not designed as an evaluation of the U.S. mathematics reform efforts described in the documents listed above. There are three reasons why TIMSS is unsuitable as such an evaluation. First, because it is an international study, it was designed to measure those aspects of mathematics and science knowledge and practice considered important by the majority of TIMSS nations, rather than those specifically recommended by the U.S. reform community. Second, TIMSS tested U.S. students in the spring of 1995, which was too soon after the publication of the reform documents for states and districts to have designed their own reform programs, retrained teachers in the new practices, and nurtured a generation of students according to the new approach. Third, a proper evaluation requires matching "before and after" measurements between which progress can be judged, and we have no prior measurement which matches TIMSS. For these reasons, TIMSS is not suitable as an evaluation. It should be studied as a baseline measurement against which future progress can be gauged.

Until TIMSS, no large nationally-representative study had observed U.S. classrooms to watch how teachers actually teach. To overcome this lack, and to understand how U.S. classroom teaching compares to that of other countries, NCES added an innovative new research methodology to the TIMSS project— videotaping and quantitative coding of a national sample of eighth-grade mathematics classes in Germany, Japan, and the U.S.

In the U.S. and Germany, half of the eighth-grade mathematics classrooms in which students were scheduled to take the TIMSS test were randomly chosen to be filmed. In Japan, 50 classrooms from the schools in which the TIMSS test was administered were chosen by the principal and officials at the National Institute for Educational Research. Teachers whose classrooms were chosen and who agreed to participate were videotaped teaching a typical lesson. In this way, videotapes of 230 lessons were collected in the three countries combined. The videotapes were then coded and analyzed to compare the teaching techniques and lesson content typical of the three countries. Teachers also completed a questionnaire concerning the lesson that was videotaped. The findings can be considered representative of the type of instruction received by German, Japanese, and U.S. eighth-grade mathematics students. The results provide a window on actual teaching in U.S. classrooms, and also show how U.S. mathematics classes compare to those in Germany and Japan.

HOW DO MATHEMATICS TEACHERS STRUCTURE AND DELIVER THEIR LESSONS?

When studying what teachers do in their classrooms, we should first understand what they mean to do. Therefore, the videotape study asked teachers about their goals for the lesson. **In contrast to expert recommendation that well-taught lessons focus on having students think about and come to understand mathematical concepts, U.S. and German eighth-grade mathematics teachers usually explained that the goal of their lesson was to have students acquire particular skills,** i.e. to learn how to do something. Learning a skill, such as being able to solve a certain type of problem, or using a standard formula, was listed as the goal by about 60 percent of the U.S. and German teachers, compared with 27 percent of the Japanese teachers. Japanese teachers' goals were more likely to resemble the recommendations of U.S. reform experts. Mathematical thinking, such as exploring, developing, and understanding concepts, or discovering multiple solutions to the same problems, was described as the goal of the lesson by 71 percent of the Japanese teachers,

FIGURE 9:
COMPARISON OF THE STEPS TYPICAL OF EIGHTH-GRADE MATHEMATICS LESSONS IN JAPAN, THE U.S., AND GERMANY

The emphasis on understanding is evident in the steps typical of Japanese eighth-grade mathematics lessons:

- Teacher poses a complex thought-provoking problem.
- Students struggle with the problem.
- Various students present ideas or solutions to the class.
- Class discusses the various solution methods.
- The teacher summarizes the class' conclusions.
- Students practice similar problems.

In contrast, the emphasis on skill acquisition is evident in the steps common to most U.S. and German math lessons:

- Teacher instructs students in a concept or skill.
- Teacher solves example problems with class.
- Students practice on their own while the teacher assists individual students.

SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, Videotape Classroom Study, UCLA, 1996.

compared with 29 percent of German and 24 percent of U.S. teachers. This difference in goals is played out in the typical sequences of activities, or cultural scripts, which characterize mathematics lessons in the three countries. Figure 9 on page 42 describes the steps typical of these cultural scripts.

The U.S. and German emphasis on skills rather than understanding is also carried over into the type of mathematical work that students are assigned to do at their desks during class. Students were coded as practicing routine procedures if their seatwork required them to carry out a previously-learned solution method or procedure on a routine problem. In the U.S., 96 percent of seatwork time was spent on routine procedures, in comparison to 89 percent in Germany, and 41 percent in Japan. Students were assigned to invent new solutions, proofs, or procedures on their own which require them to think and reason in 44 percent of Japanese; 4 percent of German lessons, and less than 1 percent of U.S. lessons. Clearly, Japanese students much more often engage in the type of mathematical thinking recommended by experts and the U.S. reform movement.

When a lesson included a mathematical concept, it was usually simply stated in U.S. classrooms, whereas it was developed in Japanese and German ones. For example, consider a lesson on the Pythagorean theorem. When the concept is merely stated, the teacher or a student might simply say "we find the length of the hypotenuse of a right triangle by using $a^2+b^2=c^2$." In contrast, a concept was coded as having been developed if it was proven, derived, or explained in some detail.

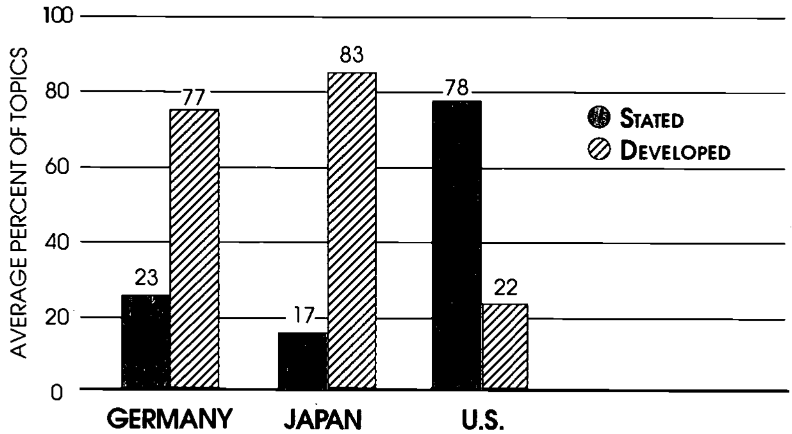
Figure 10 on page 44 shows that **U.S. teachers rarely developed concepts, in contrast to German and Japanese teachers, who usually did.** In Germany, the teacher usually did the mental work in developing the concept, while the students listened or answered short questions designed to add to the flow of the teacher's explanation. Japanese teachers, however, designed the lesson in such a way that the students themselves derived the concept from their own struggle with the problem.

These findings from the videotape study are corroborated by the TIMSS questionnaire findings. Teachers were asked to choose activities that were characteristic of their teaching from among those listed on the questionnaire. U.S. math teachers were more likely to report asking students to practice computational skills, in most or every class than were their German and Japanese colleagues. Similarly, Japanese teachers were more likely to report they ask students to analyze relationships, write equations, explain their reasoning, and solve problems with no obvious solution in most or every class than teachers in the U.S. and Germany.

Linking concepts used in one part of the lesson to ideas or activities in another part of the lesson is believed by experts to improve students' ability to learn and understand a subject in an integrated way. The videotape study found that 96 percent of Japanese lessons included such explicit linkages in comparison to about 40 percent of U.S. and German lessons. Talking about such relationships may help make lessons more coherent

FIGURE 10

AVERAGE PERCENTAGE OF TOPICS IN EIGHTH-GRADE MATHEMATICS LESSONS THAT ARE STATED OR DEVELOPED



SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, Videotape Classroom Study, UCLA, 1996.

for students by showing them the relationships between ideas and activities used in different parts of the lesson.

Interruptions present a threat to the coherence of lesson activities. The study found that the flow of mathematics lessons was more frequently interrupted than in Germany and Japan. One U.S. math lesson in four was temporarily halted by an outside interruption, typically a loudspeaker announcement, or a visitor at the door. In contrast, interruptions in German lessons were much less common, and the Japanese lessons observed in the study never experienced outside interruptions. Interruptions coming from within the classroom were also more common in U.S. mathematics lessons, such as substantial discussion of non-mathematical subjects like recent sports events, or extended disciplinary incidents. In the U.S., 23 percent of lessons were broken up in this way, compared to 9 percent in Japan, and 4 percent in Germany.

Taken together, these findings suggest that Japanese rather than U.S. or German lessons more often resembled the recommendations of experts and the U.S. reform movement. U.S. lessons typically focused on acquiring mathematical skills rather than conceptual understanding, and were less coherently presented.

IS THE MATHEMATICAL CONTENT OF U.S. LESSONS AS RICH AS THAT IN GERMANY AND JAPAN?

As noted earlier, the U.S. eighth-grade mathematics curriculum focuses more on arithmetic, while the German and Japanese curricula focus more on geometry and algebra. Furthermore, U.S. eighth graders are studying topics usually learned at the seventh grade in most other TIMSS countries.

How does the quality of the mathematical reasoning used in U.S. classrooms compare with that in

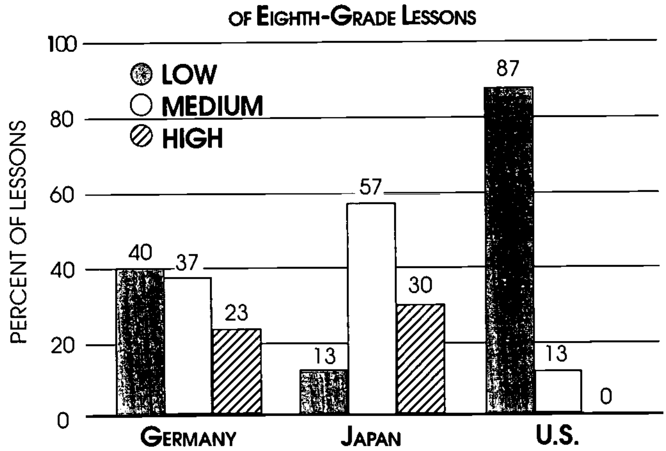
Germany and Japan? Videotape researchers requested the assistance of 3 mathematics professors and one professor of mathematics education in evaluating the quality of the mathematics contained in the videotaped lessons. This group of four experts was asked to judge the quality of the "story" formed by the sequence of mathematical ideas in a random sample of 90 of the lessons divided evenly among each of the three countries. They studied such factors as the coherence of the sequencing, the type of reasoning required of students, the increase in cognitive complexity between the beginning and end of the lesson, and the way in which the problems and examples contributed to the lesson's central concept.

To ensure that the experts were not unconsciously biased toward any country, they were not allowed to actually see the videotapes. Instead, they were provided with a written summary of each lesson's sequence of mathematical statements and equations, as well as how these were embedded in learning activities. The summaries were carefully reviewed to disguise any words such as "yen," or "football," or other hints which might indicate the country in which the lesson was taught. Each expert first independently rated the overall quality of the mathematical content of each lesson as either low, medium, or high. After comparing their ratings, they found high agreement among their judgments. Figure 11 below shows their judgments.

None of the U.S. lessons was considered to contain a high-quality sequence of mathematical ideas, compared to 30 percent of the Japanese, and 23 percent of the German lessons. Instead, the lowest rating was assigned to the mathematical reasoning used in 87 percent of the U.S. lessons, in comparison to 40 percent of the German and 13 percent of Japanese lessons. This finding does not mean that there are no lessons with high-quality mathematical reasoning anywhere in the U.S. However, it does indicate that they are probably a rare phenomenon.

FIGURE 11

EXPERT JUDGEMENTS OF THE QUALITY OF THE MATHEMATICAL CONTENT OF EIGHTH-GRADE LESSONS



SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, Videotape Classroom Study, UCLA, 1996.

These findings that our nation's eighth-grade mathematics classes are based on less challenging material, and lack mathematically rich content suggest that our students have less opportunity to learn challenging mathematics than their counterparts in Germany and Japan.

TO WHAT EXTENT ARE THE RECOMMENDATIONS OF THE MATHEMATICS REFORM MOVEMENT BEING IMPLEMENTED?

A great deal of effort has been invested in the reform of mathematics teaching in the U.S. in recent years. There is considerable agreement among experts about what good instruction should look like. The main goal of the reform is to create classrooms in which students are challenged to think deeply about mathematics and science, by discovering, understanding and applying concepts in new situations. For many years, Japanese mathematics educators have closely studied U.S. education reform recommendations, and attempted to implement these and other ideas in their own country.

Has the message about mathematics reform penetrated to U.S. classrooms? TIMSS data suggest that it is beginning to, but still only in limited ways. **Ninety-five percent of U.S. teachers stated that they were either "very aware" or "somewhat aware" of current ideas about teaching and learning mathematics.** When asked to list titles of books they read to stay informed about current ideas, one third of U.S. teachers wrote down the names of two important documents by the National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards* and *Professional Teaching Standards*.

U.S. teachers believe that their lessons are already implementing the reform recommendations, but the findings described so far in this chapter suggest that their lessons are not. When asked to evaluate to what degree the videotaped lesson was in accord with current ideas about teaching and learning mathematics, almost 75 percent of the teachers respond either "a lot" or "a fair amount." This discrepancy between teachers' beliefs and the TIMSS findings leads us to wonder how teachers themselves understand the key goals of the reform movement, and apply them in the classroom.

Teachers in the study were asked to describe which aspects of the videotaped lesson exemplified current ideas about teaching and learning mathematics. Most U.S. teachers' answers fall into one of three categories:

- Hands-on, real-world math - 38 percent of the teachers mentioned lesson activities that apply math to daily life, such as temperature in Alaska, or that use a physical representation of a mathematical concept, such as geometric blocks.
- Cooperative learning - 31 percent of the teachers mentioned the use of peer tutoring, "study buddies," or math discussion groups.
- Focus on thinking - 19 percent of the teachers mentioned focusing on conceptual thinking about math in preference to computational skills, or mention focusing on problem solving.

Over 80 percent of the teachers in the study referred to something other than a focus on thinking, which is the central message of the mathematics reform movement. The majority of the teachers cited examples of hands-on math or cooperative learning, which are techniques included among the reform recommendations. However, these techniques can be used either with or without engaging students in real mathematical thinking. In fact, the videotape study observed many examples of these techniques being conducted in the absence of high-quality mathematical content.

These findings suggest that the instructional habits and attitudes of U.S. mathematics teachers are only beginning to change in the direction of implementation of mathematics reform recommendations. Teachers' implementation of the reform still concentrates on isolated techniques rather than the central message, which is to focus lessons on high-level mathematical thought. The finding that almost 20 percent of the teachers believed that they had implemented this focus on mathematical thinking, despite experts' judgments that a high-quality sequence of mathematical ideas was virtually absent in their lessons, suggests that teachers may not yet understand what the reform movement means by this term.

The videotape study found that, in many ways, Japanese teaching resembled the recommendations of the U.S. reform movement more closely than did American teaching. Japan also scored among the top nations in the world on the TIMSS test. However, until more studies of other high-scoring nations are carried out, we cannot be sure that there is a relationship between Japan's high scores and its style of teaching.

WHAT DO INITIAL FINDINGS SHOW ABOUT SCIENCE TEACHING?

TIMSS provides less data about science teaching than about mathematics teaching, because the videotape study was conducted only in mathematics. However, the TIMSS teacher and student questionnaires included some items about instructional practices which help us understand something about the teaching of science in Germany, Japan, and the U.S.. The questionnaire data has only begun to be analyzed, and more analyses will soon be completed. Preliminary analyses suggest that U.S. science teaching may resemble mathematics teaching in some respects, and differ in others. Therefore, one should not assume that the videotape findings in mathematics apply to science or to other subjects.

Taken together, the data suggest that the instruction in typical U.S. mathematics classes is not of as high a quality as that in other countries. Next, we turn to the TIMSS findings concerning the teachers themselves. Do the daily working lives of U.S. teachers provide as much support for their instructional activities as those of other countries?

CHAPTER 4: TEACHERS' LIVES

KEY POINTS:

Unlike new U.S. teachers, new Japanese and German teachers receive long-term structured apprenticeships in their profession.

Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.

U.S. teachers have more college education than their colleagues in all but a few TIMSS countries.

Student diversity and poor discipline are challenges not only for U.S. teachers, but for their German colleagues as well.

Hoping to improve U.S. classroom instruction, many policy makers have recommended improvements in various aspects of the U.S. teacher education system. Experts agree that both the quality of the college preparation prospective teachers receive as well as the quality of the in-service training existing teachers receive are important. However, each year, the percentage of newly-hired teachers is comparatively small in relation to the size of the existing teaching force. Therefore, many experts agree that, in the short run, the quickest way to improve students' learning opportunities is to improve the instruction provided by existing teachers.

To better understand how the characteristics of teachers' daily lives may or may not contribute to high-quality teaching, a team of twelve bilingual researchers each spent three months in German, Japanese, or U.S. schools, observing and interviewing teachers, principals, and students. This activity was carried out as a supplement to the U.S. TIMSS effort. As this chapter will describe, researchers found important differences between U.S. teachers' opportunities for professional learning and improvement of their teaching, and the opportunities of their Japanese and German counterparts.

WHO TEACHES MATHEMATICS AND SCIENCE?

U.S. teachers report that they have spent more years in college than teachers in all but a few of the 41 TIMSS countries. Nearly half of the teachers of U.S. eighth-graders had a masters' degree, a proportion which was exceeded by only four other TIMSS countries. In Japan, few teachers had more than a Bachelors' degree with teacher training. In Germany, teachers complete 13 years of primary and secondary school, followed by about six years of study at the university, after which they write a thesis and pass an examination to receive a degree considered equivalent to a U.S. masters' degree.

Spending many years in college, however, does not necessarily result in teachers who are experts in their fields. Many U.S. policy makers consider it important for mathematics and science teachers to have a strong college background in those subjects. TIMSS, however, was unable to collect information on this topic due to the great variety of ways in which university training in mathematics and science is organized in the participating countries.

Japanese and German teachers enjoy the security of the benefits and tenure which come from their status as civil servants. As civil servants, their jobs are highly protected, and they are comparatively free from concerns about labor-force downsizing or termination for incompetence.

The typical teacher of U.S. eighth-grade math and science students was a woman in her forties, with about 15 years of prior teaching experience. Forties was the norm for most of the other TIMSS countries. The typical teacher of German students was a man nearly fifty, who had been teaching for about 19 years; and the typical teacher of Japanese students was a man in his late thirties, who had been teaching for 14 years.

HOW DO TEACHERS SPEND THEIR TIME?

Teachers of the U.S. and German eighth-grade students teach more classes per week than Japanese teachers. Questionnaires asked teachers to report the number of periods they teach each week. Mathematics teachers in the U.S. most commonly reported teaching 26 periods per week. German teachers reported teaching 24, and Japanese teachers reported teaching 16 periods. Science teachers in the U.S. and Germany most often reported teaching 25 periods per week, and Japanese science teachers 18. Most mathematics teachers in all three countries taught few periods outside of their subject, and the same was true of science teachers.

In addition to teaching, U.S. and Japanese teachers are formally scheduled to perform considerable additional duties during the school day. In the U.S., teachers reported that these additional responsibilities are primarily in student supervision and lesson planning. In Japan, the time was roughly balanced between student counseling, administrative duties, and lesson planning. Most German teachers were scheduled for very few hours of non-teaching tasks at school, and they did their lesson planning at home.

Eighth-grade math and science class sizes in the U.S. and Germany were about the same, averaging 24 to 25 students per class. Japanese math and science classes were much larger, averaging 37 students.

The rhythm of U.S. and Japanese teachers' daily school life was more similar than for their German colleagues. Observations of U.S. teachers showed that they usually were at school around eight hours a day. They were expected to be in the building during school hours, although many came earlier, or stayed later. Japanese teachers were usually at school around nine hours a day. They were expected to be at school from the time it started in the morning until about 4:00 or 5:00, when student club activities end. Many worked later on some evenings. Japanese schools also were in session for a half day two Saturdays per month.

German teachers of eighth-grade students spent the shortest amount of time at school. The hours during which they were in the building usually varied from day to day, depending on their teaching schedule. During periods when they were not scheduled to teach, teachers often were not at school and felt free to come and go from the school much as college professors do in the United States. Most returned home when school was over around 1:30, ate their lunch at home, and planned lessons and reviewed student work during the afternoon and evening.

U.S. and German teachers do not have the rich informal opportunities to learn from each other and to share questions about teaching-related issues that are enjoyed by their Japanese colleagues. Japanese schools are designed with one very large teachers' room, in which all teachers have their main desks, and the seating is arranged so that all teachers from a particular grade or subject sit near each other. When they were not actually instructing classes, teachers spent most of their time in this large room with their colleagues, providing many casual opportunities each day to share advice, ideas and teaching materials. Japanese cultural norms expect junior teachers to query their older colleagues for teaching tips and rely on their advice.

Formal discussions between teachers were more frequent in Japan, as well. When asked how often they meet to discuss curriculum, 76 percent of the teachers of the Japanese TIMSS students reported "at least once a month," compared to 60 percent of the U.S. and 44 percent of the German teachers.

HOW DO TEACHERS LEARN TO TEACH?

U.S. teachers lack the long and carefully mentored introduction to teaching that Japanese and German teachers receive. In Germany this period of intensive training comes before being hired as a teacher. In Japan, it comes during the first year on the job. In all three countries, prospective teachers first take a mixture of courses in education and in academic subject areas leading to graduation from college. After this, however, their experiences diverge sharply.

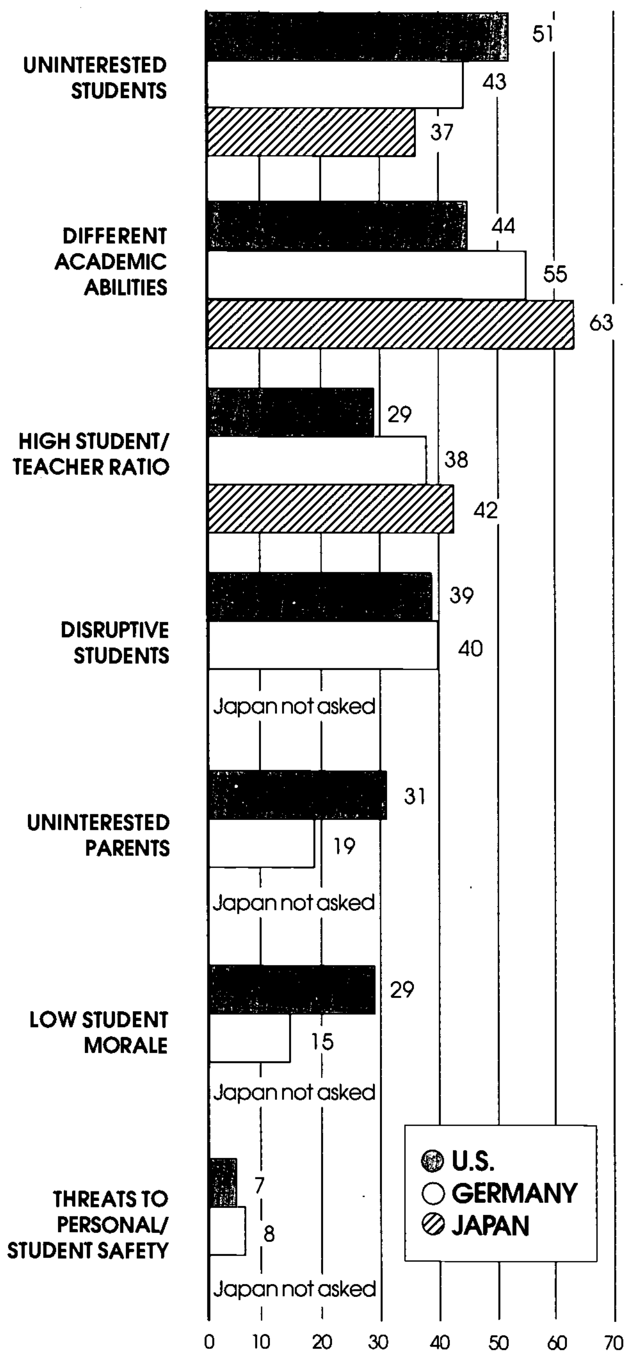
In Germany, after passing a state examination at the end of college, prospective teachers spend two years in student teaching in a program resembling a traditional apprenticeship. During the two years, prospective teachers have a reduced teaching load that begins with classroom observation, then progresses to assisted teaching, and finally to unassisted teaching under the close direction of a mentor teacher. They also attend seminars in their subjects once or twice a week, and their seminar instructor joins the mentor in observing and evaluating the prospective teacher. At the end of the second year, candidates take another state examination and apply for jobs. Placement is not guaranteed.

In Japan, after passing the teacher certification and employment selection examinations, successful candidates are hired by various prefectures, which are similar to U.S. states. New teachers then undergo intensive mentoring and training during their first year on the job. New teachers' first year includes at least 60 days of closely mentored teaching and 30 days of further training at resource centers run by the local and prefectural boards of education. Their teaching load is reduced to allow time for these activities. As is typical of Japanese society, mentoring and assistance between junior and senior teachers continues throughout teachers' working lives.

In comparison to the intensive on-the-job training that German and Japanese teachers receive, U.S. teachers' induction is less structured and comprehensive. Prospective U.S. teachers typically spend 12 weeks or less in student teaching near the end of their undergraduate training. After meeting state licensing requirements and being hired by a school district, the nature of the induction program varies by district, and may include some type of in-service training, and some mentoring by a more experienced teacher.

FIGURE 12

Percentage of Eighth-Grade Mathematics Teachers Reporting That Various Circumstances Limit Their Teaching "Quite a Lot" or "A Great Deal"



SOURCE: Third International Mathematics and Science Study: Unpublished Tabulations, U.S., German, and Japanese teacher surveys, Westat, 1996.

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WHAT CHALLENGES DO TEACHERS FACE?

Although teaching students is their job, dealing with students can be teachers' greatest challenge. **During interviews, teachers in all three countries frequently described student diversity as a challenge.** Diversity takes different forms in each country, however. U.S. teachers referred primarily to differences in American students' social, economic, or ethnic background, or to the challenges of dealing with non-English-speaking students. German teachers referred to differences in ethnic background, language, and national origin between the children of German citizens and their country's foreign workers. Japanese teachers referred to the wide differences in academic ability within each classroom, which arise from their nation's policy of not separating students by ability in any way until high school, and not retaining low-performing students in grade.

What circumstances do teachers in the three countries believe limit their effectiveness? TIMSS questionnaires asked teachers to rate the extent to which various factors limited their ability to teach. Figure 12 on page 52 shows the results.

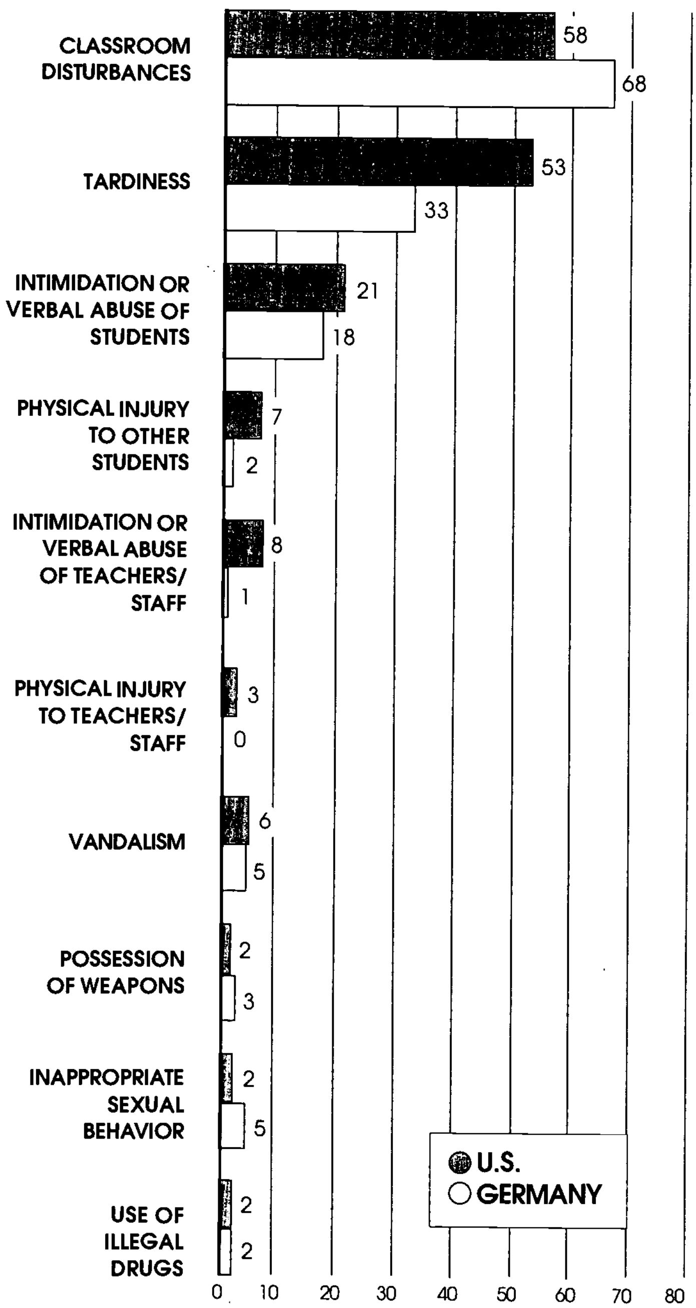
Uninterested students and a wide range of academic abilities challenge teachers in all three countries. Over a third of U.S. and German eighth-grade teachers also felt that disruptive students limited their effectiveness as teachers. The Japanese chose not to include any questionnaire items relating to discipline or morale problems in their schools.

Severe discipline problems and threats to student and teacher safety are neither widespread nor unique to the U.S., despite stories in the popular media that sometimes give the impression that these problems do not exist in other countries. An approximately equal and small number of German and U.S. eighth-grade teachers reported feeling that threats to themselves or their students' safety limited their effectiveness as teachers. Most teachers, however, never experience such serious problems. Seventy-six percent of the U.S. and 65 percent of German teachers reported that threats to their own or students' safety did not limit their effectiveness at all. TIMSS researchers who observed and interviewed teachers in their schools reported that, in both countries, the schools with such serious problems were generally in poorer areas of the city.

Science teachers in all three countries reported hindrances similar to those of their mathematics colleagues, except that they added shortages of demonstration and instructional equipment to the circumstances which limit the effectiveness of their teaching.

Students themselves reported somewhat more discipline problems than their teachers, possibly because children often do not report all incidents to school authorities. About 25 percent of the eighth-graders in both Germany and the U.S. reported on the questionniares that, during the past month, they had been afraid that another student might hurt them. About 40 percent in each country said that one of their friends had been hurt by another student. Theft was

FIGURE 13
Discipline Problems Eighth-Grade Principals Deal with on a Daily Basis



SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, U.S. and German School Surveys; Westat, 1996.

more common in the U.S. than Germany. Fifty-eight percent of U.S. students but only 32 percent of German students said that one of their friends had something stolen during the past month. Skipping classes was more common in Germany, with 66 percent of German students reporting that one of their friends had skipped class during the past month, compared with 50 percent in the U.S.

Figure 13 on page 54 shows the percentage of U.S. and German principals who reported that they dealt with various kinds of discipline problems on a daily basis. Principals in both countries responded that their most common discipline problems were classroom disturbances, tardiness, and intimidation or verbal abuse of students by other students. More serious problems such as physical injury of students, teachers, or staff were rare. Use of illegal drugs and possession of weapons was reported as a daily problem by only about 2 percent of the U.S. and German principals. Over 90 percent of principals reported that they and their staff dealt with these problems rarely or never.

Teachers in all three countries found dealing with student diversity to be a challenge to their effectiveness. Many German teachers also experienced problems with student misbehavior. Many teachers in all three countries believed their effectiveness was limited by the range of student abilities represented in their classes, and also by disruptive and disinterested students. The next chapter turns to the questions of how nations deal with student ability differences, as well as the supports and incentives offered to students in their academic endeavors.

CHAPTER 5: STUDENTS' LIVES

KEY POINTS:

Eighth-grade students of different abilities are typically divided into different classrooms in the U.S., and different schools in Germany. In Japan, no ability grouping is practiced.

In the U.S. students in higher-level mathematics classes study different material than students in lower-level classes. In Germany and Japan, all students study the same material, although in Germany, lower-level classes study it less deeply and rigorously.

Japanese eighth-graders are preparing for a high-stakes examination to enter high school at the end of ninth grade.

U.S. teachers assign more homework and spend more class time discussing it than teachers in Germany and Japan. U.S. students report about the same amount of out-of-school math and science study as their Japanese and German counterparts.

Heavy TV watching is as common among U.S. eighth graders as it is among their Japanese counterparts.

On the surface, the lives of eighth graders in most TIMSS countries are fairly similar. School and family occupy the biggest portions, with friends, TV, homework, clubs, and fun added around the side. Yet below the surface, the way in which societies choose to structure the schooling process gives rise to different opportunities and expectations for young people. The motivators, supports, and obstacles to study in each country are outgrowths of the choices provided by society and schools. In each country, the expectations which adult society sets for young people form a framework within which students organize their lives.

WHAT DOES THE SYSTEM REQUIRE OF STUDENTS?

Some U.S. education policy makers have looked admiringly at other nations which use periodic gateway examinations to control student access to the next level of education. Such high-stakes tests are believed to encourage students to study hard. The German and Japanese systems are frequently cited as examples by the proponents of such practices. TIMSS allows us to compare the pathways through schooling in these two countries to those of our own, to understand how the expectations built into the system motivate students of different ability levels.

Japan

Japanese public schools offer a single curriculum for all students through the end of 9th grade. Students in elementary and junior high schools are virtually never tracked or grouped by academic ability. There is a widespread belief that, to be fair to all students, the nine years of compulsory education must offer the same nationally determined curriculum to all, regardless of individual differences in motivation or ability. Until the end of ninth grade, there are no gateway exams, and all students are promoted whether or not they understand the material. Students who are overly or insufficiently challenged by classroom assignments may receive extra help after school from a teacher, or their parents may pay to enroll them in a *juku*, which is a private after-school class. In Japan, a substantial amount of remedial and enrichment instruction is provided by the private sector.

In mathematics, all eighth-grade Japanese students receive a curriculum heavily focused on algebra and geometry. Review of arithmetic is not included in the official curriculum goals and textbooks. TIMSS observers noted that there are differences in students' ability to keep up with the curriculum within each classroom, and also between schools where students come from families with predominantly high or low economic backgrounds. However, the Japanese system is designed such that teachers throughout the country strive to meet similar standards for presentation of content, while allowing almost unlimited variation in the standards of performance attained by students.

At the end of ninth grade, virtually all Japanese students continue on to high school. Before they do, however, all must take the high school entrance exam. This examination covers the five core subjects, including mathematics and science. Scores on the examination serve as a gateway which divides students into high, medium, and low-level high schools on the basis of each student's scores on the exam and prior academic performance. The best of the graduating ninth-graders are accepted at the best academic high schools in each city, which prepare students for application to the best universities. The slowest students are accepted only by the lesser-ranked commercial or vocational high schools, which prepare graduates to enter the labor force. Students and parents clearly understand the consequence of this examination at the end of ninth grade for future career and life choices. Japanese students say that the examination motivates them to study harder during their junior high school years. For the majority of Japanese students, this is the only high-stakes exam they will experience.

Once Japanese students enter high school, they are again promoted each year, until they graduate. Most students then enter the labor force or vocational training. Approximately one third of the high school graduates decide to apply to a university or two-year college, most of which require an entrance examination. Competition on the entrance examinations for prestigious universities is intense, although some lower-ranked colleges will accept most high-school graduates who apply.

Germany

Various exceptions and experiments notwithstanding, the German school system basically sorts students into one of three types of schools at the end of the fourth grade of elementary school. This is accomplished through a system of gateway examinations and ability grouping which differs considerably from the Japanese. Most German students attend one of three types of schools:

- *Gymnasium*, which provides a demanding, academic curriculum through grade 13 and leads to the *Abitur* exit examination and university study.

- *Realschule* which provides a moderately-paced curriculum ending at grade 10 and leads to a school-leaving certificate and vocational training or further study at a *Gymnasium*.

- *Hauptschule*, which provides practically-oriented instruction ending at grade 9 and leads to a school leaving certificate and vocational training or employment. Immigrant and non-German students are over-represented in the *Hauptschule*.

The gateway into one of these schools is controlled by teacher recommendations at the end of fourth grade. Parents can, and frequently do, override teacher recommendations if they believe that their child deserves to be placed in a higher track. If the student is unable to keep up with his classmates, however, he or she will be retained in grade and after repeated failure will be returned to the next lower level of schooling. Most German parents and teachers are relatively comfortable with the fairness of this system, because they believe that it allows each child an education best suited to his or her abilities, interests and future career. However, there is a substantial current of opinion within Germany which would prefer to delay the sorting of students into different school types until later in the student's life, and to make it easier for students to change upward to a higher school type. Most recent policy reforms have made small changes to modify the system in this direction.

Classes in grades 5-9 basically cover the same content in all three types of German schools, although there is considerable difference in the depth and rigor of instruction between the three school types. Typically, *Gymnasium* students receive a theoretical approach, and *Hauptschule* students receive a practical approach to the same content. In eighth-grade mathematics, the German curriculum focuses mostly on Geometry and Algebra for all three types of schools, with some mixture of other topics.

Within most schools, eighth graders all follow the same course of study in math and science, regardless of their ability level. Seventy-five percent of the schools reported that they provide only one course of study in mathematics, and 90 percent provide only one course in science. Generally speaking, the German system separates students into different ability levels primarily between, rather than within, schools.

In Germany, students who have not learned the material may be required to repeat the grade, or may be moved to a less demanding school type. Principals reported that 5 percent of students were required to repeat grade eight. Most students finishing the *Hauptschule* at the end of grade 9, or *Realschule* at the end of grade 10 receive a diploma, and most states do not require an exit exam. About 10 percent of the students receive only a school-leaving certificate instead of a diploma. Approximately one-third of German students are enrolled in a *Gymnasium*, and about a quarter of these end their studies before taking the *Abitur* examination at the end of 13th grade. Very few students who sit for the *Abitur* fail it, although those with a lower score may not be able to enter their chosen university or field of study.

United States

It is more difficult to generalize about the United States, because practices differ among the thousands of school districts in the country. Generally speaking, however, within-class grouping or individuation of instruction is fairly common in elementary schools in the subjects of reading and mathematics. **In middle schools and high schools, students are frequently grouped by ability into different mathematics classes.** In the U.S., 80 percent of principals of eighth graders reported that they provided different ability-based classes in mathematics, but only 17 percent reported this in science. Course content and textbooks usually differ between the higher and lower-level classes. **In the eighth grade,**

lower-level classes typically focus on a review of arithmetic and other basic skills with a small amount of algebra. Higher-level classes focus more heavily on algebra, with a small amount of geometry.

In the U.S., educational expectations and teaching standards can also differ substantially between communities, based on a neighborhood's economic status and parental expectations for their children's futures. Minority students are over-represented in lower-level classes and in schools in poorer areas.

There are various procedures for dealing with students who teachers judge have not learned the course material. They may be promoted anyway, retained in grade, moved to a lower-tracked class, or given remedial assistance. Principals reported that 4 percent of the students in their schools were required to repeat grade eight.

Generally speaking, the U.S. system does not have high-stakes gateway examinations which regulate entrance to further schooling before the end of twelfth grade. Seventeen states currently have an exit examination as a requirement for high-school graduation. In most cases, this is a minimum-competency test. Students may take the test several times if necessary, and few students repeatedly fail. Scores on college entrance examinations such as the SAT and ACT are given considerable weight by most selective universities, although non-selective schools may not require them at all.

This section has examined the learning expectations embedded in the school systems in the three countries. **Japan is the only one of the three countries which requires a high-stakes entrance examination for all students.** Mathematics and science are included on this examination, and Japanese eighth-graders are therefore likely to be studying these subjects harder than usual in preparation. Methods of sorting students by ability into schools and classes differ among the three countries, but both **Germany and Japan teach algebra and geometry to all of their eighth-grade students, although the level of rigor may differ by track. In contrast, in the U.S. a heavy focus on algebra is usually reserved for students in the higher tracks, and few U.S. eighth-graders in any track study much geometry.**

In all three countries, the standards of performance for students at each grade level are set in such a way that almost all students are passed from one grade to the next, and all who complete secondary education can obtain some type of secondary school diploma, regardless of their level of academic ability.

HOW DO STUDENTS SPEND THEIR TIME DURING SCHOOL?

United States

U.S. students attend school approximately 180 days per year, five days per week. Each day, school usually runs from about 8:00 in the morning until mid-afternoon, with a lunch break and five to seven-minute breaks between classes. Schools vary in how they organize students. Middle schools commonly include either grades 7-9, or 6-8, although variations exist. In some schools, the student body is subdivided into "houses" or "blocks" which include several classes of students and a single group of teachers, to strengthen continuity in student-teacher and student-student relationships. In other schools, students change teachers and classmates at the end of each period.

Most U.S. schools offer a variety of teacher-led after-school activities, including sports, music, art, theater, and academic clubs. The range of after-school activities varies by school and often reflects the district's and school's resources and socioeconomic status. Participation in clubs is voluntary, and students can participate in more than one activity, as some are seasonal or do not meet every day. Ten percent of U.S. students said that they participate in some type of math or science club each week.

Germany

German students attend school approximately 188 days per year. School usually starts around 7:45 in the morning, and ends around 1:15, with 10 to 25 minute breaks between classes. There is no lunch period, and most students return home for lunch. *Gymnasium* usually include students from grades 5-13, *Realschule* grades 5-10, and *Hauptschule* grades 5-9. Eighth-grade students remain together throughout the day, with teachers changing classrooms. Classes are usually kept together for several years and develop a strong sense of unity.

Most German schools offer few extracurricular activities. Schools visited by TIMSS observers offered mostly sports, arts, and student government. Student participation was low, and some clubs rarely met. Six percent of German students said that they participate in a math or science club each week. Over half of all German students under the age of 15 are involved in organized sports, but these are sponsored by a national organization's local sports clubs rather than the school.

Japan

Japanese schools are in session 220 days per year, five days per week, and two Saturday mornings per month. School usually starts at 8:00 in the morning and ends in the middle of the afternoon, with a lunch break, 5 to 15 minute breaks between various periods, and a homeroom meeting at the beginning and end of each day. The number of classes per day is frequently reduced for special seasonal events, school-wide meetings, and other activities. Junior high schools include grades 7-9. Students in a given class remain together throughout the day, and a different teacher for each subject comes to the students' classroom.

Extracurricular or "club" activities are a very important part of Japanese eighth-graders' lives, and well over half of all students participate. Clubs meet daily throughout the year from the time that classes are over until about 5:00 or 6:00. Four percent of Japanese students reported participating in a math or science club.

In contrast to their German and U.S. counterparts, Japanese junior-high school students are required to wear uniforms to school, and must follow a strict dress code. Regular uniform inspections chastise such deviations as non-regulation belts, shoes, hairstyles, jewelry, and non-regulation book bags. The students themselves play a major role in the enforcement of school rules and discipline. Between students, there is a complicated senior-junior system of deference and behavior training. Younger students speak to students in upper grades using the respectful term *sempai* (upper-class man/woman). Particularly within the clubs, upper-class students are in charge of overseeing the younger students.

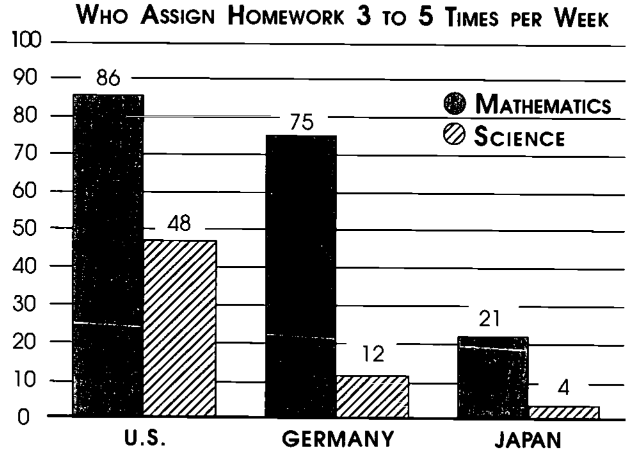
HOW MUCH STUDY DO STUDENTS DO AFTER SCHOOL?

Study at home is not the same as homework. Ideally, students would be self-motivated to study mathematics and science more than the minimum required by homework assignments. The degree to which this actually happens depends on the individual student, and the degree to which the culture encourages or requires eighth-graders to take responsibility for their own learning.

Interviews with students about their daily lives found that, in all three countries, most students tended to put in extra non-assigned study before examinations and relax after they were finished. In Germany and the U.S., the

FIGURE 14

PERCENT OF MATHEMATICS AND SCIENCE TEACHERS WHO ASSIGN HOMEWORK 3 TO 5 TIMES PER WEEK



SOURCE:
Third International Mathematics and Science Study; unpublished tabulations, U.S., German, and Japanese National Surveys; Westat, 1996.

only tests with some consequences for students' academic lives were periodic teacher-prepared in-class examinations. There were broad similarities across countries in students' strategies of study for these examinations. High-achieving students described doing extra hours of non-assigned review and preparation, while this was much less common among low achievers. In Japan, consciousness about the examinations at the end of ninth grade caused all eighth graders to be mindful of the need for extra personal study and preparation, although high achievers were more likely to translate this into substantial home study.

Most Americans believe that homework is an important part of the learning process. Some have recommended assignment of more homework as a means of improving mathematics achievement. It is frequently assumed that teachers in high-achieving countries assign more homework than do U.S. teachers.

However, **TIMSS found that Japanese teachers actually assigned less homework than U.S. and German teachers**. The teacher questionnaire results and videotapes of classroom practices both agree on this finding. Figure 14 on page 62 shows that 86 percent of U.S. mathematics and 75 percent of German teachers assigned homework 3 to 5 times per week, in comparison to 21 percent of Japanese teachers. When asked about the amount of homework they assign, U.S. and German math teachers' most common response was about thirty minutes or less, three or more times per week. Japanese teachers typically assigned the same amount, but once or twice per week.

U.S. and German teachers not only assign more homework than Japanese, but they also spent more class time talking about or doing it. Time spent on assigning, working on, or sharing homework occupied 11 percent of U.S. and 8 percent of German lessons, in comparison to 2 percent of Japanese lessons. Furthermore, most U.S. teachers reported that they counted homework toward student grades, whereas this practice was not common in Germany and Japan. It was only in the U.S. that some teachers allocated class time for students to begin their homework in class.

The picture changes, however, when students themselves were asked how much time they spend studying math and science. **On average, Japanese, German, and U.S. students reported that they spent about the same amount of time each day — between 30 minutes and an hour — studying mathematics outside of school, and about the same amount studying science.** These questionnaire findings are in line with what interviewers found when they spoke with eighth graders in each country about their study habits.

Between 30 minutes and an hour of after-school study per night is an average in each country. Of course there were wide differences between students everywhere in how willing they were to complete assignments or go beyond them in extra personal study. Some German, Japanese, and U.S. teachers noted that low-achieving students, particularly those from troubled family backgrounds were less likely to complete assignments, either because they lacked the motivation, or did not have a family environment which was conducive to home study. In contrast, some high-achieving students in each country engaged in extra study beyond what was assigned.

If Japanese teachers assigned less homework than German and U.S. teachers, but Japanese students reported that they studied about as much as their counterparts in these countries, how were typical Japanese students motivated and supported in this extra study? Researchers who observed and interviewed in Japanese schools and homes reported that parents, teachers, and friends encouraged students to study hard during their eighth and ninth grade years in preparation for the high school entrance examinations. Students are believed to have considerable personal responsibility for this process. Some popular teen magazines even run articles on how to devise a personal study and review plan. Japanese students described a combination of peer support and competition that encouraged them to study harder during these years. For students who enter a commercial or vocational high school, however, extra study tends to fall off again after entrance to high school.

Another important source of outside assistance for Japanese students is the *juku*, which are private after-school classes offered in a variety of subjects to help slower students catch up, or faster students study in more depth to prepare for entrance examinations. Parents must pay to send their children to these private classes, which are run by companies or neighborhood tutors. Researchers reported that some mothers take an extra job to provide the tuition. Although the purpose of *juku* is academic, students enjoy attending them, because they are able to spend time with their friends walking or riding subway trains to and from the classes. **Sixty-four percent of Japanese eighth graders reported attending weekly extra lessons in math, and 41 percent in science.** Most students attend *juku* one or two hours per week. Attendance drops off substantially once high school entrance examinations are completed. Other types of non-academic after-school classes, such as music or marital arts, were also popular among Japanese students.

Japanese experts report that instruction in mathematics *juku* focuses more on review and practice of basic skills than is typical of Japanese classrooms. This assists slower students who need review of prior material, and provides all students extra practice with concepts learned but not drilled upon in class. Although more systematic study of *juku* instruction is needed, the hypothesis might be entertained that Japanese students benefit from the different but complementary nature of *juku* and classroom instruction.

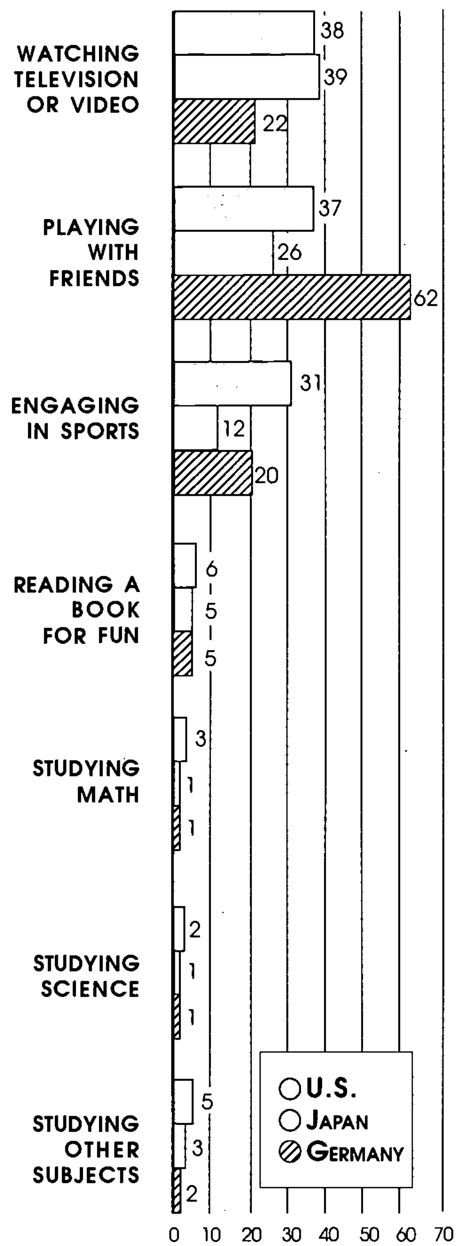
WHAT DO STUDENTS THINK ABOUT MATHEMATICS AND SCIENCE?

At least half the students in Germany, Japan, and the U.S. reported that they like math and science. In the U.S., boys and girls were equally positive, but German and Japanese girls were less positive than boys in those countries.

How *much* students like math and science is a different question. **Students in all three countries were more inclined to agree that that it was important to have time to have fun than that to do well in mathematics and science.** More students in the U.S. also agreed that it was important to do well in sports than to do well in math and science. In Germany and Japan, however, fewer students considered it important to do well in sports than in mathematics.

Japanese policy makers are currently discussing an emerging social phenomenon they term *risu kirai*, or "dislike of mathematics and science." Although much discussed among Japanese experts, it is not clear how widespread this phenomenon is in Japan. About 10 percent of Japanese students reported that they disliked mathematics "a lot," which was comparable to the number of U.S. students who reported strongly disliking the subject. Interviews with Japanese students who disliked the subject suggest that they disliked it because they saw it as difficult and uninteresting. Japanese teachers speculated that many of these students may have fallen behind in earlier grades and never caught up. The teachers thought that the demanding pace of

FIGURE 15
PERCENT OF EIGHTH-GRADERS SPENDING 3 OR MORE HOURS IN VARIOUS AFTER-SCHOOL ACTIVITIES ON A NORMAL SCHOOL DAY



SOURCE:
Third International Mathematics and Science Study: Unpublished Tabulations, U.S., German, and Japanese Surveys, Westat, 1996.

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the curriculum and the need to keep instruction focused on the material which will be covered on the high school entrance examination caused students to fall behind.

Most Japanese students experience mathematics and science as difficult. Eighty-seven percent disagreed with the statement "math is an easy subject," and 85 percent disagreed with a similar statement in science. About half of U.S. students on the other hand, reported that math and science are easy. Given the findings reported in Chapter 3 that the U.S. mathematics curriculum focuses on easier topics, and that classroom activities are based mostly on routine procedures rather than conceptual thinking, the hypothesis might be entertained that U.S. students' classroom experiences, at least in mathematics, lead them to believe that these subjects are easy.

WHAT DO STUDENTS DO AFTER SCHOOL BESIDES STUDY?

What other choices and opportunities do societies offer their eighth-graders besides focus on school and study? The way in which societies structure the choices available to young people shows something about the priority assigned to schooling and the society's investment in education.

Figure 15 on page 65 shows that **eighth-graders in all three countries were more likely to spend extended periods after school watching television or videos, playing with friends, or engaging in sports than taking part in more academically-related activities.** Students who watched a lot of television each day after school were fairly common in all three countries, especially the U.S. and Japan. After-school sports were more popular in the U.S than in Germany or Japan. Almost one third of U.S. eighth-graders reported spending three hours per day engaged in sports activities. In Germany, friends were more popular than television. Two-thirds of German students spent at least three hours per day playing with friends, possibly because German schools finish before lunch, and students have more time to spend with their friends in the afternoon. Very few students in any of the three countries spent extended periods of time reading books for fun or studying school subjects.

The priorities that nations assign to schooling are evident in the opportunities provided for students outside of school. Japan tries to encourage eighth-graders to focus primarily on school, family, and study. In contrast to U.S. and German schools, Japanese schools set and enforce policies for behavior off school grounds. Examples include policies regarding curfews; clothing to be worn in public; use of bicycle helmets: and prohibitions against entering game arcades, dating, employment, smoking, and alcohol. In some towns, teachers and parents check shopping malls, parks, and other areas where students are likely to congregate to monitor student compliance with the rules. These policies may contribute to Japanese students' reports that they spent less time with their friends than German and U.S. teenagers.

In the U.S. and Germany, working at a paid job was not uncommon even for eighth graders. About a quarter of all students in these countries reported that they worked at a paid job before or after school at least an hour per week. In Japan, this percentage was 4 percent.

In summary, eighth-graders' lives in Germany, Japan, and the U.S. share broad similarities in their focus on school, friends, TV, and sports. However, the way in which each society has designed its schooling process, and the expectations that it sets for students provide different motivators, supports, and distractions from study. Considering the choices that other nations have made in this regard may help us to better understand our own.

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CONCLUSIONS

KEY POINTS:

No single factor can be considered to influence student performance in isolation from other factors. There are no single answers to complex questions.

The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.

Most U.S. mathematics teachers report familiarity with reform recommendations, although only a few apply the key points in their classrooms.

Evidence suggests that U.S. teachers do not receive as much practical training and daily support as their German and Japanese colleagues.

This report has presented highlights from initial analyses of U.S. eighth-graders in international perspective. These findings lightly sketch only a corner of the entire picture of U.S. performance in mathematics and science which will be painted over the next years as further analysis of the eighth-grade data is carried out and findings from grades four and twelve are added.

This section looks across the findings presented in the previous pages for insights into the key questions with which the study started: How do our eighth-graders compare to their international counterparts? What have we learned about mathematics achievement and the factors that may be associated with it? What have we learned about science? What have we learned about how our education system as a whole compares to that of other countries?

Looking for insights into factors associated with student performance is complicated because achievement after eight years of schooling and thirteen years of life is the product of many different influences. Furthermore, education in our country is a vast system with many interrelated parts. **No single factor can be properly considered in isolation from others. Realizing that there are no single answers to complex questions, let us review the data.**

WHERE DO WE STAND?

The U.S. is far from being among the top nations of the world in mathematics and science. We are far from this goal. Singapore, Korea, Japan, the Czech Republic, and Hungary outperform us in both subjects. Particularly in mathematics, our students lag far behind top-ranking countries. **Compared to our goal of excellence among nations, we are not where we aim to be.**

However, we are on a par with many of our international trading partners. Our students stand not far from the international average: somewhat below in mathematics, and somewhat above in science. Our math scores are not significantly different than those of Germany and England. Our science scores are not significantly different than those of Germany, England, Canada, and Russia. We rank near the middle of the 41 TIMSS countries, among other nations to whom we frequently compare ourselves.

WHAT HAVE WE LEARNED ABOUT MATHEMATICS?

Our eighth graders score below the international average in mathematics. Although international comparisons over time are difficult, there does not appear to have been much improvement during the past three decades in U.S. students' international standing in this subject. The following factors may be associated with this performance:

- **The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries.**

  U.S. eighth-grade curriculum and instruction both appear to be less challenging than those in other countries. Concerning curriculum, topics covered in U.S. mathematics classrooms are at a seventh-grade level in comparison to other countries. Virtually all German and Japanese students study algebra and geometry in the eighth grade, while in the U.S., only students in higher-level classes receive significant exposure to algebra, and few students study geometry.

Concerning instruction, the content of U.S. classes requires less high-level thought than classes in Germany and Japan. The sequence of mathematical ideas used in lessons was judged to be of low quality in a majority of U.S. classrooms, while this was less frequently the case in the other two countries.

- **Topic coverage is not as focused in U.S. eighth-grade mathematics classes as in the classrooms of other countries.**

  In the U.S., curriculum is determined at the state and local level, which is atypical among TIMSS countries, most of whom determine curriculum nationally. In all grades 1-8, the U.S. mathematics curriculum recommends coverage of more topics than the international average. U.S. mathematics lessons also include a greater number of topics and activities than those in Germany and Japan.

- **Most U.S. eighth-grade math teachers report familiarity with reform recommendations, although only a few apply the key points in their classrooms.**

  Ninety-five percent of U.S. eighth-grade mathematics teachers say that they are aware of current ideas about teaching and learning mathematics. Most believe that the lessons they teach exemplify elements of the recommendations. However, the way in which U.S. teachers understand and implement these recommendations suggests that they are focusing on isolated techniques rather than the central message that teaching and learning should involve high-level mathematical thought. Our mathematics teachers' typical goal is to teach students how to do something, rather than how to think about and understand mathematical concepts. In a variety of respects, Japanese mathematics teaching more closely resembles the recommendations of the U.S. reform movement.

WHAT HAVE WE LEARNED ABOUT SCIENCE?

U.S. eighth graders score above the international average in science. In the three previous international science assessments, the U.S. scored below the international average. Because comparisons of different international assessments over time are difficult, caution should be exercised in assuming that there has been significant improvement in our international standing in science, but it is a possibility.

This initial report contains less information about science than about mathematics because the questionnaire data have not yet been fully analyzed, and the videotape study of classroom instruction was conducted only in mathematics. Furthermore, because we are unable to use multiple research methods to verify the science findings from different perspectives, our findings are more tentative than for mathematics.

Fuller description of eighth-grade science teachers' instructional practices must await further questionnaire analysis.

WHAT HAVE WE LEARNED ABOUT U.S. EDUCATION AS A WHOLE?

TIMSS provides several insights about U.S. eighth-grade teachers and students, which are true of both mathematics and science education.

- **Evidence suggests that U.S. teachers do not receive as much practical training and daily support as their German and Japanese colleagues.**

  In contrast to new German and Japanese teachers, new U.S. teachers do not receive a long-term structured apprenticeship in their profession. Once on the job, they have fewer formal and informal opportunities to discuss and share teaching-related issues and questions. Schools are managed in such a way that lessons are frequently interrupted by loudspeaker announcements or visitors at the door.

- **Our eighth-graders spend at least as much time studying mathematics and science as students in Germany and Japan.**

  During school, our eighth graders spend more hours in mathematics and science classes per year than students in Germany and Japan. U.S. teachers assign more homework, and spend more class time discussing it than teachers in those countries. Outside of school, our students report doing about as much math and science-related homework and other study as German and Japanese students, although most Japanese eighth graders also attend after-school classes in mathematics for an hour or two per week in preparation for the entrance exams to high school.

QUESTIONS FOR FURTHER STUDY

The initial findings described in this report raise many important questions for further study. Some of these may be answered through continued analysis of the eighth-grade data. Others must await the design of future international studies. For this reason, TIMSS is an important national resource for secondary analysis and further research. Some examples are:

- **Why is our international standing lower in mathematics than in science?**

  Deeper analysis of the TIMSS data will help us to compare the curriculum and instructional practices used in mathematics with those in science, to better understand the similarities and differences.

- **How is student achievement related to curriculum coverage?**

  Comparison of the curriculum analysis with achievement scores in the various content areas can illuminate the degree to which our students' performance in algebra, earth science, and other content areas is related to curricular emphasis in these areas.

- **Does mathematics teaching in high performing countries resemble the reform movement's recommendations?**

  The videotape study found that in many ways, Japanese mathematics teaching resembles the recommendations of the U.S. reform movement more closely than does U.S. and German teaching. Is this an important factor in understanding why Japan also scores among the top nations of the world in mathematics? Undertaking similar videotape observational studies of other high-performing nations and further analysis of the TIMSS teacher questionnaire data could provide insight into this question.

TIMSS' LONG TERM UTILITY TO THE NATION

TIMSS is not an answer book, but a mirror through which we can see our own education system in international perspective. It helps us view with new eyes those aspects of our system which we may take for granted. Its findings make us think more deeply about the cultural assumptions and unconscious choices which form the underpinnings of our society's approach to schooling. We come to understand our own system better by comparing it to others. Careful study of our country's reflection in the mirror of international comparisons can provide information to assist educators, business leaders, teachers, and parents as they guide our nation in the pursuit of excellence.

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APPENDIX 1
ADDITIONAL TIMSS REPORTS

For more information visit the TIMSS website at: http://www.ed.gov/NCES/timss.

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Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.

A Splintered Vision: An Investigation of U.S. Science and Mathematics Education.

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TIMSS - NAEP Link for Eighth-Grade Mathmatics and Science in 41 Nations and 43 States.

Various International and U.S. Reports Based on 4th Grade TIMSS Data.

Various International and U.S. Reports Based on 12th Grade TIMSS Data.

APPENDIX 2
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APPENDIX 3

NATIONAL AVERAGE SCORES AND STANDARD ERRORS

The 95 percent "plus or minus" confidence interval around each nation's score is two times the standard error.

COUNTRY	MATHEMATICS AVERAGE	MATHEMATICS STANDARD ERROR	SCIENCE AVERAGE	SCIENCE STANDARD ERROR
(AUSTRALIA)	530	4.0	545	3.9
(AUSTRIA)	539	3.0	558	3.7
BELGIUM-FLEMISH °	565	5.7	550	4.2
(BELGIUM-FRENCH)	526	3.4	471	2.8
(BULGARIA)	540	6.3	565	5.3
CANADA	527	2.4	531	2.6
(COLOMBIA)	385	3.4	411	4.1
CYPRUS	474	1.9	463	1.9
CZECH REPUBLIC	564	4.9	574	4.3
(DENMARK)	502	2.8	478	3.1
ENGLAND *°	506	2.6	552	3.3
FRANCE	538	2.9	498	2.5
(GERMANY) *°	509	4.5	531	4.8
(GREECE)	484	3.1	497	2.2
HONG KONG	588	6.5	522	4.7
HUNGARY	537	3.2	554	2.8
ICELAND	487	4.5	494	4.0
IRAN, ISLAMIC REPUBLIC	428	2.2	470	2.4
IRELAND	527	5.1	538	4.5
(ISRAEL) *	522	6.2	524	5.7
JAPAN	605	1.9	571	1.6
KOREA	607	2.4	565	1.9
(KUWAIT)	392	2.5	430	3.7
LATVIA (LSS) °	493	3.1	485	2.7
LITHUANIA *	477	3.5	476	3.4
(NETHERLANDS)	541	6.7	560	5.0
NEW ZEALAND	508	4.5	525	4.4
NORWAY	503	2.2	527	1.9
PORTUGAL	454	2.5	480	2.3
(ROMANIA)	482	4.0	486	4.7
RUSSIAN FEDERATION	535	5.3	538	4.0
(SCOTLAND)	498	5.5	517	5.1
SINGAPORE	643	4.9	607	5.5
SLOVAK REPUBLIC	547	3.3	544	3.2
(SLOVENIA)	541	3.1	560	2.5
(SOUTH AFRICA)	354	4.4	326	6.6
SPAIN	487	2.0	517	1.7
SWEDEN	519	3.0	535	3.0
SWITZERLAND °	545	2.8	522	2.5
(THAILAND)	522	5.7	525	3.7
UNITED STATES °	500	4.6	534	4.7
INTERNATIONAL AVERAGE	513		516	

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than 10 percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted, are shown with a °.
4. The international average is the average of the national averages of the 41 nations. It has no standard error.

SOURCE:

Beaton et al. (1996) *Mathematics achievement in the middle school years.* Table 1.1. Boston College: Chestnut Hill, MA., Beaton et al. (1996) *Science achievement in the middle school years.* Table 1.1. Boston College: Chestnut Hill, MA.

APPENDIX 4
SUMMARY OF NATIONAL DEVIATIONS FROM INTERNATIONAL STUDY GUIDELINES

Twenty-two of the 41 TIMSS countries experienced a more or less serious deviation from international guidelines for execution of the study. In 16 countries, the TIMSS International Study Center considered the deviations to be sufficiently serious to raise questions about the confidence to be placed in their scores. These 16 nations with major difficulties are noted with an asterisk in this appendix, and with parentheses in Figures 1, 2, 3, 5, and 6 in this report.

*Australia - Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 70 percent after replacements for refusals were substituted.

*Austria - Participation rate did not meet the international criterion of at least 50 percent participation by schools before replacement. The initial participation rate was 41 percent before replacement. Participation rate was 80 percent after replacements for refusals were substituted.

*Belgium (Flemish) - Participation rate of 75 percent of schools and students combined was achieved only after replacements for refusals were substituted.

Belgium (French) - Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 72 percent after replacements for refusals were substituted.

*Bulgaria - Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 63 percent after replacements for refusals were substituted.

*Colombia - The pair of grades tested was one grade higher than the international target. Average age of students in the upper grade was 15.7.

*Denmark - International guidelines requiring random selection of the classrooms to receive the assessment were not followed.

England - More than the international criterion of ten percent of schools and students were excused from the test for various reasons with resulting coverage of 89 percent of the desired population. Participation rate of 75 percent of schools and students combined was achieved only after replacements for refusals were substituted.

*Germany - The pair of grades tested was one grade higher than the international target. Average student age of students in the upper grade was 14.8. One of sixteen regions (Baden-Wuerttemberg) did not participate in the study, with resulting coverage of 88 percent of the desired population. Participation rate of 75 percent of schools and students combined was achieved only after replacements for refusals were substituted.

*Greece - International guidelines requiring random selection of the classrooms to receive the assessment were not followed.

*Israel - Test administered only in the Hebrew-speaking public school system, with resulting coverage of 74 percent of the desired population. International guidelines requiring random selection of the classrooms to receive the assessment were not followed. Participation rate did not meet the international criterion of at least 50 percent participation by schools in the sample before replacement. The participation rate before replacement was 45 percent.

*Kuwait - In contrast to other nations, which tested two adjacent grades, Kuwait tested only one grade; the ninth grade. This grade was higher than either of the grades which should have been the international target. Average student age was 15.3.

Latvia (LSS) - Test administered only in Latvian-speaking schools, with resulting coverage of 51 percent of the desired population. Because coverage falls below the international 65 percent population-coverage criterion, Latvia is designated (LSS) for Latvian Speaking Schools.

Lithuania - Test administered only in Lithuanian-speaking schools, with resulting coverage of 84 percent of the desired population.

*Netherlands - Participation rate did not meet the international criterion of at least 50 percent participation by schools before replacement. The initial participation rate before replacement was 24 percent.

*Romania - The pair of grades tested was one grade higher than the international target. Average student age in the upper grade was 14.6.

*Scotland - Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 73 percent after replacements for refusals were substituted.

*Slovenia - The pair of grades tested was one grade higher than the international target. Average student age was 14.8.

*South Africa - International guidelines requiring random selection of the classrooms to receive the assessment were not followed. Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 62 percent after replacements for refusals were substituted.

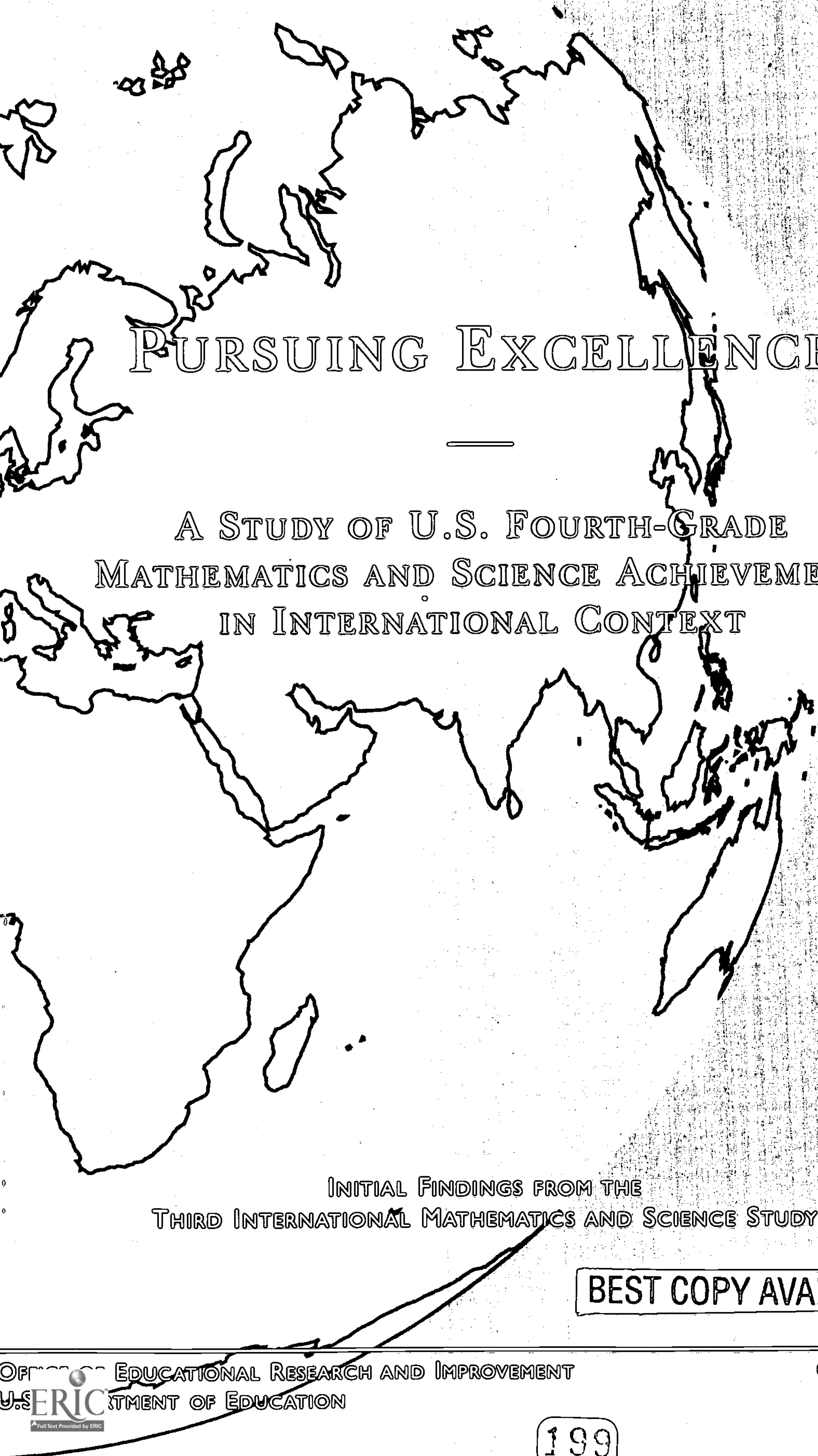
Switzerland - Test administered in 22 of 26 cantons, with resulting coverage of 86 percent of the desired population.

*Thailand - International guidelines requiring random selection of the classrooms to receive the assessment were not followed.

United States - Participation rate of 75 percent of schools and students combined was achieved only after replacements for refusals were substituted.

NATIONAL CENTER FOR EDUCATION STATISTICS
OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT
U.S. DEPARTMENT OF EDUCATION

ORAD 97-1017



Pursuing Excellence

A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context

Initial Findings from the
Third International Mathematics and Science Study

Office of Educational Research and Improvement
U.S. Department of Education

ORAD 97-1018

Pursuing Excellence

A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context

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The National Center for Education Statistics (NCES) is the primary federal entity for collecting, analyzing, and reporting data related to education in the United States and other nations. It fulfills a congressional mandate to collect, collate, analyze, and report full and complete statistics on the condition of education in the United States; conduct and publish reports and specialized analyses of the meaning and significance of such statistics; assist state and local education agencies in improving their statistical systems; and review and report on education activities in foreign countries.

NCES activities are designed to address high-priority education data needs; provide consistent, reliable, complete, and accurate indicators of education status and trends; and report timely, useful, and high quality data to the U.S. Department of Education, the Congress, the states, other education policymakers, practitioners, data users, and the general public.

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June 1997

Available for downloading at http://www.ed.gov/NCES/timss

COMMISSIONER'S STATEMENT

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and student achievement ever conducted. This report, *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context* summarizes data on fourth-grade students in 26 countries. It is the second of three major TIMSS reports by the National Center for Education Statistics (NCES) in its *Pursuing Excellence* series. The first report, outlining U.S. comparative eighth-grade results, was released last fall, while the third report, investigating student achievement in the last year of schooling, will be published early next year. Together, these three studies will paint a more complete picture than we have ever had about how U.S. schooling practices and achievement in mathematics and science compare with the rest of the world. The information is intended to help U.S. educators, parents, policymakers, and others evaluate the strengths and weaknesses of our schools from an international perspective.

The scope of TIMSS is unprecedented in the annals of education research. The international project involved the testing of more than a half-million students in mathematics and science at three grade levels in 41 countries. In contrast to previous international comparative studies, TIMSS also goes beyond the traditional "horserace" data on student performance to analyze the content of textbooks and curricula in participating countries and to administer written questionnaires to teachers and students regarding their academic practices both inside and outside the classroom. A particularly innovative technique used at the eighth grade was the videotaping of a random sample of actual mathematics classrooms in the United States, Germany, and Japan, in order to better understand key similarities and differences in instructional practices across these three countries.

This wealth of data is being analyzed and published by NCES and others around the world. Both individually and collectively, the various TIMSS reports constitute important tools that can improve the quality of primary and secondary education for all students. That is why the Center has been working cooperatively with other parts of the U.S. Department of Education to produce a multi-media resource kit designed for educators and those interested in using TIMSS data to improve teaching, curricula, and student achievement in states and local communities.

The TIMSS data provide a reference point with which we can begin to clarify what we mean by "world-class" education. They give us tools by which we can benchmark not only the performance of our students but also the way in which we deliver instruction. Most important, they allow the U.S. to learn unique lessons from other members of the world community so that we may better pursue the goal of an excellent education for all students.

NCES is releasing the information in a variety of new forms, including CD-ROM, videotape, and the World Wide Web (http://www.ed.gov/NCES/timss). We invite everyone who is dedicated to enhancing the quality of our nation's mathematics and science education to make the fullest possible use of this rich resource.

Pascal D. Forgione, Jr.
Commissioner of Education Statistics

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EXECUTIVE SUMMARY

PREFACE

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international comparison of education ever undertaken. During the 1995 school year, the study tested the mathematics and science knowledge of a half-million students from 41 nations at five different grade levels. This report presents findings from the tests, questionnaires, and curriculum analysis performed at the fourth grade. Twenty-six nations participated in the fourth-grade assessment.

- TIMSS' information not only compares achievement, but also provides insights into how life in U.S. schools differs from that in other nations.

- This report on fourth-grade students is the second of a series of three public-audience reports titled *Pursuing Excellence.* The first report presented findings on student achievement at eighth grade. The third report will be released in the spring of 1998, and will present findings from the twelfth grade. Additional reports will provide information on various other topics.

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is *not* a comparison of "all of our students with other nations' best students," a charge that some critics have leveled at previous international comparisons. The students who participated in TIMSS were randomly selected to represent all students in their respective nations, with the exception of a few nations which are clearly noted in this report. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose are clearly noted in this and other TIMSS reports.

ACHIEVEMENT

One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. In fourth-grade science achievement, we are close to this mark. Fourth graders in only one country—Korea—outperform U.S. students in this subject.

- In mathematics, U.S. fourth graders perform above the international average of the 26 TIMSS countries. U.S. students are outperformed by those in 7 countries and outperform those in 12 countries. Among our major economic partners who participated in the study, our students' scores are below those of Japan, not significantly different from those of Canada, and are significantly higher than those of England.

- In science, U.S. fourth graders also perform above the international average of the 26 TIMSS countries. U.S. students are outperformed by students in only one country—Korea. U.S. students outperform those in 19 countries. Among our major economic partners who participated in the study, our students' scores are not significantly different from those of fourth graders in Japan. Our students outperform those in England and Canada.

- In mathematics content areas, our fourth graders exceed the international average in five of the six areas assessed. These five areas are: whole numbers; fractions and proportionality; data representation, analysis, and probability; geometry; and patterns, relations, and functions. In one content area, the U.S. average is lower than the international average—measurement, estimation, and number sense.

- In science content areas, our fourth graders' performance exceeds the international average in all four of the areas assessed. In three of these content areas—earth science; life science; and environmental issues and the nature of science—U.S. fourth grade students are significantly outperformed by only one or two other nations. In physical science, five other nations perform significantly better than the U.S.

- If an international talent search were to select the top ten percent of all fourth-grade students in the 26 countries, in mathematics 9 percent of U.S. fourth-grade students would be included. In science, 16 percent would be included.

- The international standing of U.S. fourth graders is stronger than that of U.S. eighth graders in both mathematics and science.

- In comparison with their international counterparts, U.S. students perform better in science than in mathematics at both the fourth and eighth grades.

CONTEXTS OF LEARNING

- It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as particularly important.

- On most background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Therefore, these factors are unlikely to be strongly associated with our international standing.

- On those background factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries. Therefore, these factors are also unlikely to be strongly associated with our international standing.

- In general, preliminary analyses shed little light on factors which might account for the differences between our performance in mathematics and science, and our performance at the fourth and eighth grades. Further analyses are needed to provide more definitive insights on these subjects.

CONCLUSION

This report presents initial findings from TIMSS for fourth-grade mathematics and science, and evidence from early analyses concerning the context of U.S. education achievement. Adequate understanding of our nation's education in an international perspective must await findings from the twelfth-grade data and deeper analysis of data at all grade levels.

TIMSS is not an answer book, but a tool to examine our own national educational strengths and weaknesses in an international perspective. All countries, including the U.S., have something to learn from other nations, and have something from which other countries can learn. These TIMSS findings will be an important source of information to guide our nation in the pursuit of excellence into the next century.

PREFACE

OVERVIEW

The Third International Mathematics and Science Study is the largest and most comprehensive comparative international study of education that has ever been undertaken. A half-million students from 41 countries were tested in 30 different languages at five different grade levels to compare their mathematics and science achievement. Intensive studies of students, teachers, schools, curriculum, instruction, and policy issues were also carried out to understand the educational context in which learning takes place.

Twenty-six countries tested fourth-grade students and made their data available for presentation. Of these, 17 met or came close to meeting all of the quality control requirements for sampling and data collection. The other 9 countries experienced difficulties of various types. All deviations from international quality control requirements are described in Appendix 4. The 9 countries within which difficulties arose are shown in parentheses both below and in figures contained in this report.

COUNTRIES PARTICIPATING IN FOURTH-GRADE TIMSS

(Australia)	Japan
(Austria)	Korea
Canada	(Kuwait)
Cyprus	(Latvia)
Czech Republic	(Netherlands)
England	New Zealand
Greece	Norway
Hong Kong	Portugal
(Hungary)	Scotland
Iceland	Singapore
Iran, Islamic Republic	(Slovenia)
	(Thailand)
Ireland	United States
(Israel)	

Seventeen other countries participated in one or more aspects of TIMSS but not in the fourth-grade study. These countries are Belgium (Flemish), Belgium (French), Bulgaria, Colombia, Denmark, France, Germany, Lithuania, Mexico, the Philippines, Romania, Russian Federation, Slovak Republic, South Africa, Spain, Sweden, and Switzerland.

TIMSS is an important study for those interested in U.S. education. In 1983, the National Commission on Excellence in Education pointed to our nation's low performance in international studies as evidence that we were *A Nation at Risk.* In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the U.S. will be first in the world in mathematics and science achievement."

Mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989 and *Professional Standards for Teaching Mathematics* in 1991. In 1993, the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy,* and in 1996, the National Academy of Sciences published *National Science Education Standards.*

TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science. But TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. It was designed to look behind the scorecard to illuminate how our education policies and practices compare with those of the world community.

This report draws from the results of the fourth-grade part of the TIMSS study to summarize the initial findings concerning mathematics and science achievement and schooling at that grade level. It is the second of three reports in the *Pursuing Excellence* series. The first report presented initial findings on the eighth grade and was released in November 1996. The third report, to be published in spring 1998, will treat findings concerning students in the twelfth grade. Other reports on selected topics will be published over the next several years. Much more will be learned as further analysis of the TIMSS data continues.

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is *not* a comparison of "all of our students with other nations' best students," a charge that some critics have leveled at previous international comparisons. In most of the countries that participated in TIMSS, virtually all children attend elementary school, and the students who took the TIMSS test were randomly selected to represent all students in their respective nations. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose are clearly noted in this and other TIMSS reports.

At each step of its development, TIMSS used careful quality control procedures. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the tests reflect the mathematics and science curricula of the variety of TIMSS countries and do not overemphasize what is taught in only a few. International monitors carefully checked the test translations and visited many classrooms while the tests were being administered to make sure that the instructions were properly followed. The raw data from each country were scrutinized to be sure that no anomalies existed, and all analyses were double checked. Finally, this report has been written and carefully reviewed to avoid overgeneralization and inaccuracy.

STUDY DESIGN

TIMSS is the third comparison of mathematics and science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). Previous IEA studies of mathematics and science were conducted for each subject separately at various times during the 1960s, 1970s, and 1980s. TIMSS is the first IEA study that has assessed both mathematics and science at the same time. Comparative studies of other subjects, including reading literacy (1992)[1] and computers in education (1993)[2] have also been published by the IEA.

TIMSS was designed to focus on students at three different stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Because countries around the world set different ages at which children should begin and complete school, decisions about which students should be tested needed to take both age and grade level into account.

The populations tested are listed below. Participation in Population 2 was required of all TIMSS nations, but participation in Populations 1 and 3 was optional.

- Population 1 — Those students enrolled in the pair of adjacent grades that contained the most 9-year-olds. (Grades 3 and 4 in the U.S. and most of the world. Grades 2 and 3 or 4 and 5 in some nations.)

- Population 2 — Those students in the pair of adjacent grades that contained the most 13-year-olds at the time of testing. (Grades 7 and 8 in the U.S. and most of the world. Grades 6 and 7 in a few nations.)

- Population 3 — Those students in their final year of secondary school, whatever their age. (Grade 12 in the U.S. and most nations. Grades 9-13 in some nations.)

In all participating countries, students in both public and private schools were administered the TIMSS test. In all but a few of the TIMSS countries, virtually all Population 1 and 2 children are enrolled in school and were therefore eligible to take the test. Testing occurred 2 to 3 months before the end of the 1994-95 school year. Students with special needs and disabilities that would make it difficult for them to take the test were excused from the assessment. In each country, the test was translated into the primary language or languages of instruction. All testing in the U.S. was done in the English language.

Countries participating in TIMSS collected information primarily through assessments and questionnaires. Additional information on the content of textbooks and curriculum guides was also collected in a separate series of curriculum analyses. The 26 countries participating in the Population 1 part of the TIMSS study engaged in three types of data collection:

- Mathematics and science assessments — One and one-half hours in length, the assessments included both multiple-choice and free-response items. A smaller number of students also completed hands-on performance assessments that will be reported later.

- School, teacher, and student questionnaires — Students answered questions about their mathematics and science studies and beliefs. Teachers answered questions on their beliefs about mathematics and science and on teaching practices. School administrators answered questions about school policies and practices.

- Curriculum analysis — This exploratory study compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance.

THE TIMSS RESEARCH TEAM

TIMSS was conducted by the IEA, which is a Netherlands-based organization of ministries of education and research institutions in its member countries. The IEA delegated responsibility for overall coordination and management of the TIMSS study to Professor Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the IEA member nations that made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The costs of the international coordination were paid by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government.

TIMSS in the United States was also funded by NCES and NSF. Professor William Schmidt of Michigan State University was the U.S. National Research Coordinator. Policy decisions on the study were made by the U.S. National Coordinating Committee. Lois Peak of NCES monitored the international and U.S. TIMSS projects. The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. The many advisors to the study are listed in Appendix 2.

The U.S. TIMSS team also includes the approximately 4,000 third and 7,000 fourth graders who took the assessment, and their principals and teachers in 190 schools nationwide. Their cooperation has made this report possible.

ORGANIZATION OF THIS REPORT

This report summarizes early findings from the fourth-grade data. Both third- and fourth-grade students took the TIMSS test as part of Population 1, but this initial report focuses on findings for the fourth grade. Future reports based on a more complete and extensive analysis of the data will provide deeper understanding and investigate relationships among the findings from the different parts of the study. Extensive documentation of the data collection methodologies and statistical analyses used in all participating countries is available in technical reports[3] and quality control reports[4] published by the TIMSS International Study Center at Boston College. Similar technical detail for the United States will soon be available from NCES.

This report is based on the comparative data for 26 countries published by the TIMSS International Study Center at Boston College. The report's purpose is to highlight initial findings concerning the place of the United States among the participating nations.

Chapter 1 draws from the results of the student assessments to describe U.S. student achievement in mathematics and science in comparison with their international counterparts.

Chapter 2 summarizes the evidence from initial analyses to attempt to address the key findings illuminated in Chapter 1.

CHAPTER 1: ACHIEVEMENT

KEY POINTS:

U.S. fourth graders score above average in both mathematics and science compared with the 26 nations in the TIMSS fourth-grade assessment.

U.S. students' international standing is stronger at the fourth grade than it is at the eighth grade in both mathematics and science.

U.S. students' international standing is stronger in science than it is in mathematics at both the fourth and eighth grades.

In mathematics, 9 percent of U.S. fourth graders would rank among the world's top ten percent. In science, 16 percent of U.S. fourth graders would rank among the world's top ten percent.

There is no significant gender gap in fourth-grade mathematics achievement. However, in some content areas of fourth-grade science, U.S. boys outperform U.S. girls.

In the past, the mathematics and science achievement of U.S. students has been a cause for concern. International studies of these subjects conducted over the past 30 years show that our students have not performed as well as we might expect in comparison with their peers in other nations, especially in mathematics.

The patterns of academic achievement, however, vary widely. In a recent IEA study of reading literacy,[5] U.S. fourth graders were second only to Finland, and U.S. eighth graders ranked among the top nations. Data from the eighth-grade TIMSS study,[6] released in November 1996, showed that U.S. eighth graders score above the international average of the 41 TIMSS countries in science but below the international average in mathematics.

HOW WELL DO U.S. FOURTH GRADERS DO IN MATHEMATICS AND SCIENCE?

Compared with their international counterparts, U.S. fourth graders perform above the international average of the 26 TIMSS countries in both mathematics and science. In science, our students are outperformed by only one country—Korea.

Figures 1 and 2 on pages 20 and 21 show how U.S. students perform in these subjects.

Tempting though it may be, it is not correct to report U.S. scores by rank alone, as would be the case if one were to say U.S. fourth graders are "number x in the world in mathematics." This is because the process of calculating each country's score from the sample of students who took the test produces only an estimate of the country's score, not the true score itself. This estimate has a margin of error which is expressed as a "plus or minus" interval around the estimated score. In TIMSS, we can say with 95 percent confidence that comparisons of other countries' scores to those of the U.S. are accurate plus or minus about 15 points, depending on the design of the sample in the other countries. Comparisons of the U.S. with the international average are accurate plus or minus about 6 points. (Appendix 3 contains a list of country means and standard errors.) Because a precise score cannot be determined with perfect accuracy, to fairly compare the U.S. with other countries, nations have been grouped according to whether their performance is higher than, not significantly different from, or lower than the U.S.

In mathematics, fourth-grade students in 7 countries outperform our fourth graders (Singapore, Korea, Japan, Hong Kong, the Netherlands, the Czech Republic, and Austria). Student performance in 6 countries is not significantly different from ours (Slovenia, Ireland, Hungary, Australia, Canada, and Israel). U.S. fourth graders outperform their counterparts in 12 nations (Latvia, Scotland, England, Cyprus, Norway, New Zealand, Greece, Thailand, Portugal, Iceland, Islamic Republic of Iran, and Kuwait).

In science, students in only one country—Korea—outperform U.S. fourth graders. Student performance in 5 countries is not significantly different from ours (Japan, Austria, Australia, the Netherlands, and the Czech Republic), and U.S. fourth graders outperform their counterparts in 19 nations (England, Canada, Singapore, Slovenia, Ire-

FIGURE 1:
Nations' Average Mathematics Performance Compared with the U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**AVERAGE**
SINGAPORE	625
KOREA	611
JAPAN	597
HONG KONG	587
(NETHERLANDS)	577
CZECH REPUBLIC	567
(AUSTRIA)	559

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**AVERAGE**
(SLOVENIA)	552
IRELAND	550
(HUNGARY)	548
(AUSTRALIA)	546
UNITED STATES	**545**
CANADA	532
(ISRAEL)	531

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S	
NATION	**AVERAGE**
(LATVIA (LSS))	525
SCOTLAND °	520
ENGLAND *°	513
CYPRUS	502
NORWAY	502
NEW ZEALAND	499
GREECE	492
(THAILAND)	490
PORTUGAL	475
ICELAND	474
IRAN, ISLAMIC REPUBLIC	429
(KUWAIT)	400

INTERNATIONAL AVERAGE = 529

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.

land, Scotland, Hong Kong, Hungary, New Zealand, Norway, Latvia, Israel, Iceland, Greece, Portugal, Cyprus, Thailand, Islamic Republic of Iran, and Kuwait).

SOME SPECIAL NOTES ON THE TEST SCORES

TIMSS is a fair comparison of achievement for several reasons. The test was jointly developed and carefully reviewed by the participating countries to ensure that the items reflected curriculum topics considered important in all countries, and did not over-emphasize the curriculum content taught in only a few. International monitors carefully reviewed nations' adherence to guidelines to ensure that significant numbers of students were not excluded from the testing process for any reason. Those nations that did exclude more than ten percent

FIGURE 2:
NATIONS' AVERAGE SCIENCE PERFORMANCE COMPARED WITH THE U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**AVERAGE**
KOREA	597

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**AVERAGE**
JAPAN	574
UNITED STATES	**565**
(AUSTRIA)	565
(AUSTRALIA)	562
(NETHERLANDS)	557
CZECH REPUBLIC	557

INTERNATIONAL AVERAGE = 524

SOURCE: Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 1.1. Boston College: Chestnut Hill, MA.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S	
NATION	**AVERAGE**
ENGLAND *°	551
CANADA	549
SINGAPORE	547
(SLOVENIA)	546
IRELAND	539
SCOTLAND °	536
HONG KONG	533
(HUNGARY)	532
NEW ZEALAND	531
NORWAY	530
(LATVIA (LSS))	512
(ISRAEL)	505
ICELAND	505
GREECE	497
PORTUGAL	480
CYPRUS	475
(THAILAND)	473
IRAN, ISLAMIC REPUBLIC	416
(KUWAIT)	401

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.

of their students are clearly noted in this and other TIMSS reports. Therefore, we can be sure that the TIMSS scores in this report are a fair comparison of virtually all students at the appropriate grade in the various countries.

TIMSS required participating nations to adhere to extremely high technical standards at all stages of participation in the project. Of the 26 nations that participated at the fourth grade, 17 met or came close to meeting all technical standards for the study. The remaining 9 nations, however, experienced difficulties of various types. In some countries, the problems arose because a sizable proportion of schools, teachers, or students declined to participate. In others, the selection of schools or classrooms was not carried out according to international specifications. In still others, students were slightly older than the international target age. The names of those nations in which major difficulties arose are shown in parentheses in the figures in this report, and Appendix 4 describes the problems each encountered. Because of the problems, the same amount of confidence cannot be attached to the scores of these 9 countries as to the other 17.

When the international average is calculated only from the 17 countries that met the international specifications, the mathematics and science scores of U.S. fourth graders are still above the international average for these 17 countries. Figure 3 on page 23 shows our standing in comparison with these 17 nations.

What do the test scores mean? Due to the complex nature of the design, scoring, and analysis of the TIMSS test, a score of 600 does not mean either 600 items, or 60 percent, correct. Instead, this score indicates where the performance would fall if all fourth-grade scores were arranged along a scale running from 0 to 1,000.

In mathematics, the international average score is 529. A score of 658 or above would put a student in the top ten percent of all mathematics students in the 26 TIMSS countries, and a score of 601 would put a student in the top quarter.

In science, the international average score is 524. A score of 660 or higher would put a student in the top ten percent of all science students, and a score of 607 would put a student in the top quarter.

WHICH COUNTRIES OUTPERFORM U.S. FOURTH GRADERS IN BOTH SUBJECTS?

We can say with confidence that 5 countries outperform the U.S. in mathematics at the fourth grade (Singapore, Korea, Japan, Hong Kong, and the Czech Republic). The Netherlands and Austria also outperform us in fourth-grade mathematics, but due to deviations in their administration of TIMSS, we have less confidence in their scores. Only one nation outperforms the U.S. in science (Korea). **Therefore, at the fourth grade, only Korea outperforms the U.S. in both mathematics and science.** Four nations that outperform us in mathematics are not significantly different from us in science (Japan, Austria, the Netherlands, and the Czech Republic). Two nations that outperform the U.S. in mathematics score lower than the U.S. in science (Singapore and Hong Kong).

WHICH COUNTRIES DO U.S. FOURTH GRADERS OUTPERFORM IN BOTH SUBJECTS?

We can say with confidence that in both mathematics and science, U.S. fourth graders outperform their counterparts in 9 countries. These are:

- Seven European countries — Iceland, England, Scotland, Norway, Greece, Cyprus, and Portugal.
- Islamic Republic of Iran and New Zealand.

U.S. fourth graders also outperform Latvia, Kuwait, and Thailand in both subjects, but due to deviations in their

FIGURE 3:

Average Achievement of Nations Meeting, and Not Meeting, International Guidelines

COUNTRIES COMPLYING WITH SPECIFICATIONS

NATION	MATH AVERAGE	SCIENCE AVERAGE
CANADA	532	549
CYPRUS	502	475
CZECH REPUBLIC	567	557
ENGLAND *°	513	551
GREECE	492	497
HONG KONG	587	533
ICELAND	474	505
IRAN, ISLAMIC REPUBLIC	429	416
IRELAND	550	539
JAPAN	597	574
KOREA	611	597
NEW ZEALAND	499	531
NORWAY	502	530
PORTUGAL	475	480
SCOTLAND °	520	536
SINGAPORE	625	547
UNITED STATES	**545**	**565**

MATHEMATICS INTERNATIONAL AVERAGE = 531

SCIENCE INTERNATIONAL AVERAGE = 528

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Table 1.1. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 1.1. Boston College: Chestnut Hill, MA.

COUNTRIES WITH LOW PARTICIPATION RATES

NATION	MATH AVERAGE	SCIENCE AVERAGE
AUSTRALIA	546	562
AUSTRIA	559	565
LATVIA (LSS)	525	512
NETHERLANDS	577	557

COUNTRIES TESTING OLDER-THAN-SPECIFIED STUDENTS

NATION	MATH AVERAGE	SCIENCE AVERAGE
SLOVENIA	552	546

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS

NATION	MATH AVERAGE	SCIENCE AVERAGE
HUNGARY	548	532

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS AND OTHER DEPARTURES FROM GUIDELINES

NATION	MATH AVERAGE	SCIENCE AVERAGE
ISRAEL	531	505
KUWAIT	400	401
THAILAND	490	473

NOTES:

1. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
2. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
3. The international average is the average of the national averages of the 17 nations meeting international guidelines.

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administration of TIMSS, we have less confidence in their scores.

HOW DO OUR FOURTH GRADERS COMPARE WITH OUR MAJOR ECONOMIC PARTNERS?

The "Group of Seven" or G-7 countries are major U.S. economic and political allies. The other six nations in this group are Canada, France, Germany, Italy, Japan, and the United Kingdom. Italy did not administer the TIMSS test, and France and Germany did not participate in the testing of fourth-grade students. Thus the U.S. can only be compared with the United Kingdom, Canada, and Japan. The United Kingdom is made up of England, Scotland, Northern Ireland, and Wales; however, the latter two did not participate in TIMSS. England and Scotland both have the same international standing in comparison with the U.S. Therefore, in this section, we describe our standing in relation to England.

Except for Japanese students' scores in mathematics, U.S. fourth graders' mathematics and science scores are similar to or higher than those of the other three participating G-7 nations. Japanese fourth graders outperform their U.S. counterparts in mathematics. U.S. fourth graders' mathematics scores are not significantly different from those of Canada and are higher than those of England. In science, U.S. fourth graders' scores are not significantly different than those of Japan and are significantly higher than those of Canada and England.

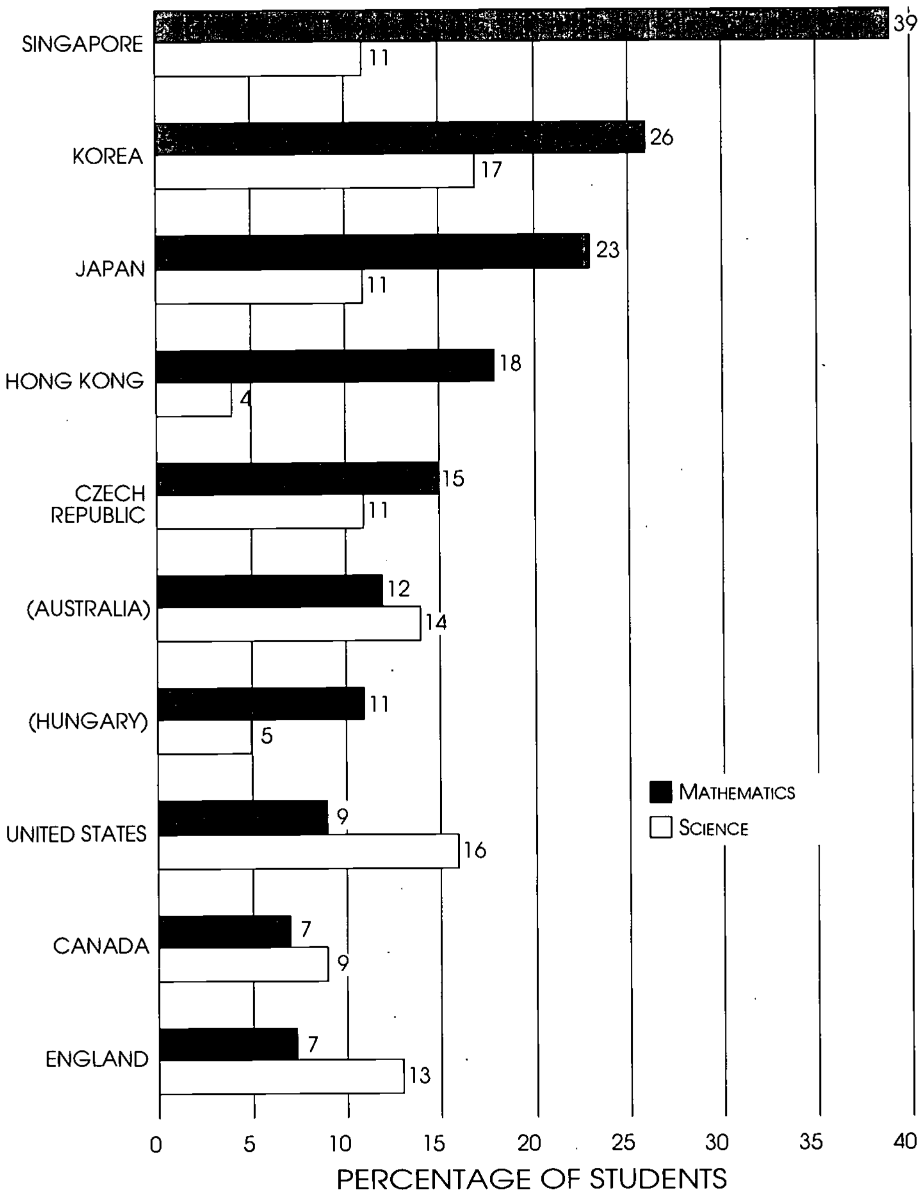
HOW DO OUR BEST FOURTH GRADERS COMPARE WITH OTHERS' BEST?

Comparisons of averages tell us how typical students perform, but they do not tell us about the performance of our nation's best students, including those who are likely to continue to study mathematics and science in secondary school and eventually become the next generation of mathematicians, scientists, doctors, and engineers. If an international talent search were to select the top ten percent of all fourth-grade students in the 26 TIMSS countries combined, what percentage of U.S. students would be included?

In mathematics, 9 percent of U.S. fourth graders are in the world's top ten percent. This is well below the 39 percent of Singaporean students, 26 percent of Korean students, and 23 percent of Japanese students who would be chosen in the international mathematics talent search. **In science, 16 percent of U.S. fourth graders would rank among the world's top ten percent.** No country has significantly more of their students in the top ten percent, and 21 nations have a smaller percentage. Figure 4 on page 25 shows results for selected countries.

If the international talent search were to lower its standards so as to choose the top half of all students in the 26 TIMSS countries, in mathematics 56 percent of U.S. fourth graders would be included. This compares with 85 percent in Korea, 82 percent in Singapore, and 79 percent in Japan. In science, 63 percent of U.S. fourth graders would be in the top half of the students in the TIMSS countries, compared with 81 percent of students in Korea and 68 percent in Japan.

FIGURE 4:
PERCENTAGE OF STUDENTS FROM SELECTED NATIONS SCORING AMONG THE TOP TEN PERCENT OF FOURTH GRADERS IN THE 26 TIMSS COUNTRIES



NOTE: Nations not meeting international guidelines are shown in parentheses.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.4. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years*. Table 1.4. Boston College: Chestnut Hill, MA.

HOW DO OUR FOURTH GRADERS SCORE IN THE DIFFERENT CONTENT AREAS OF MATHEMATICS AND SCIENCE?

Representing student achievement in mathematics and science as a total score is a useful way to summarize achievement. Mathematics and science, however, contain very different content areas which are emphasized and sequenced differently in curricula around the world. Based on national priorities, some content areas are emphasized more than others at a particular grade level.

The TIMSS fourth-grade mathematics test included sets of items designed to sample students' ability to do work in the following areas:

- *Whole Numbers* (place value; ordering; comparing; problem-solving using addition, subtraction, and multiplication).
- *Fractions and Proportionality* (recognition and work with fractions and decimals; word problems).
- *Measurement, Estimation, and Number Sense* (common measures of size, time, temperature; rounding and estimation).
- *Data Representation, Analysis, and Probability* (use of data in charts, tables, and graphs; basic concepts underlying probability).
- *Geometry* (visualization of two- and three-dimensional forms; basic terms and properties; equivalence of figures; coordinate points on grids).
- *Patterns, Relations, and Functions* (patterns of numbers and shapes; representation of simple numerical situations; relationships of sequences of numbers).

In five of the six TIMSS mathematics content areas, the scores of U.S. fourth graders are above the international averages for those content areas. U.S. fourth-graders' performance is above the international average in whole numbers; fractions and proportionality; data representation, analysis and probability; geometry; and patterns, relations, and functions. In only one content area is the U.S. average below the international average—measurement, estimation and number sense. Figure 5 on pages 28-29 shows these results.

In science, the TIMSS fourth-grade test sampled students' ability to do work in the following subjects:

- *Earth Science* (earth features; earth processes; earth in the solar system).
- *Life Science* (structure; diversity; classification; processes; cycles; and interactions of plants and animals).
- *Physical Science* (matter; energy and physical processes; forces and motion; physical and chemical changes).
- *Environmental Issues and the Nature of Science* (environmental and resource issues; nature of scientific knowledge; interaction of science and technology).

U.S. fourth graders score above the international average in all four science content areas. In three of these content areas—earth science; life science; and environmental issues and the nature of science—U.S. fourth-grade students are outperformed by one or two other nations. In physical science, U.S. students are outperformed by 5 other nations. Figure 6 on pages 30-31 shows these results.

IS THERE A GENDER GAP IN MATHEMATICS AND SCIENCE AT THE FOURTH GRADE?

Policymakers in the U.S. and other countries have made great efforts in recent years to make mathematics and science more accessible to girls and to encourage gender equity in these subjects. Overall, at the fourth grade, more TIMSS countries have gender equity in mathematics than in science.

The U.S. is one of 22 TIMSS nations in which there is no significant gender gap in fourth-grade mathematics achievement. For the overall science score, the U.S. is one of ten countries where a gender gap exists. Examining boys' and girls' scores in the various science content areas, U.S. boys significantly outperform U.S. girls in the content areas of earth science and physical science. There is no significant difference between U.S. boys' and girls' scores in life science and in environmental issues and the nature of science.

HAS U.S. FOURTH-GRADE INTERNATIONAL STANDING IMPROVED OVER TIME?

International comparisons over time are difficult. The first international studies of mathematics and science achievement were conducted in the 1960s, and there have been other assessments in each subject since that time. However, most assessments have focused on middle-school students and students in the final year of high school. Assessments of students in the elementary school grades have been conducted less frequently. Prior to TIMSS, only one international assessment of elementary-school children was undertaken in mathematics, although there were three prior assessments in science.

However, each assessment was done a little differently. A different set of nations participated, different topics in mathematics and science were included in the tests, the age and type of students sampled in each country changed slightly, and even the borders and names of some of the nations have changed. These and other factors complicate comparisons over time and require that any conclusions that are drawn be necessarily tentative.

Among the various international studies conducted over the past 30 years, only the International Assessment of Educational Progress (IAEP) tested the mathematics achievement of elementary-school students. In the 1991 IAEP assessment of 9-year-olds in 14 nations,[7] U.S. students scored below the international average in mathematics. However, as we have seen, in the 1995 TIMSS study reported here, U.S. fourth graders scored above the international average of 26 nations in this subject. **Comparisons over time are difficult, so caution should be exercised in assuming there has been significant improvement in our fourth graders' international standing in mathematics, but it is a possibility.**

Three previous international science assessments of elementary-school students were conducted in the 1960s, 1980s, and early 1990s. The U.S. scored above the international average in two of these three studies. In the other study,

FIGURE 5:
National Averages in Mathematics Content Areas

WHOLE NUMBERS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	88
SINGAPORE	83
JAPAN	82
HONG KONG	79
(HUNGARY)	76
(NETHERLANDS)	75
CZECH REPUBLIC	75
(AUSTRIA)	74
(SLOVENIA)	74

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(ISRAEL)	71
UNITED STATES	**71**
IRELAND	70
CANADA	68
(LATVIA (LSS))	68

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(AUSTRALIA)	67 (67)
CYPRUS	65
GREECE	62
SCOTLAND °	61
NORWAY	61
ENGLAND *°	58
(THAILAND)	58
PORTUGAL	57
NEW ZEALAND	57
ICELAND	56
IRAN, ISLAMIC REPUBLIC	51
(KUWAIT)	36

FRACTIONS AND PROPORTIONALITY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	74
HONG KONG	66
JAPAN	65
KOREA	65
(NETHERLANDS)	60
IRELAND	58

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
CZECH REPUBLIC	53
(AUSTRIA)	51
(AUSTRALIA)	51
UNITED STATES	**51**
(SLOVENIA)	50
(HUNGARY)	49 (49)
CYPRUS	48
(ISRAEL)	48
CANADA	48

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SCOTLAND °	46
ENGLAND *°	45
(LATVIA (LSS))	44
(THAILAND)	44
GREECE	42
NEW ZEALAND	41
NORWAY	38
PORTUGAL	38
ICELAND	36
IRAN, ISLAMIC REPUBLIC	32
(KUWAIT)	25

MEASUREMENT, ESTIMATION, AND NUMBER SENSE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
JAPAN	72
KOREA	72
(NETHERLANDS)	70
(AUSTRIA)	69
HONG KONG	69
CZECH REPUBLIC	68
SINGAPORE	67
(HUNGARY)	64
(SLOVENIA)	64
(LATVIA (LSS))	60
(AUSTRALIA)	60

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
IRELAND	56
NORWAY	56 (56)
CANADA	54
(ISRAEL)	54
SCOTLAND °	53
UNITED STATES	**53**
ENGLAND *°	52

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
PORTUGAL	49
NEW ZEALAND	49
GREECE	48
CYPRUS	48
ICELAND	44
(THAILAND)	44
IRAN, ISLAMIC REPUBLIC	36
(KUWAIT)	35

(#) Represents International Average

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

FIGURE 5 (CONTINUED): NATIONAL AVERAGES IN MATHEMATICS CONTENT AREAS

DATA REPRESENTATION, ANALYSIS, AND PROBABILITY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	81
KOREA	80
JAPAN	79

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
HONG KONG	76
(NETHERLANDS)	75
UNITED STATES	**73**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT	
IRELAND	69	
CANADA	68	
(AUSTRALIA)	67	
CZECH REPUBLIC	67	
(AUSTRIA)	66	
SCOTLAND °	66	
ENGLAND *°	64	
(ISRAEL)	64	
(SLOVENIA)	64	(62)
NEW ZEALAND	61	
(HUNGARY)	60	
NORWAY	59	
ICELAND	58	
(THAILAND)	56	
(LATVIA (LSS))	54	
CYPRUS	52	
GREECE	50	
PORTUGAL	43	
(KUWAIT)	26	
IRAN, ISLAMIC REPUBLIC	23	

GEOMETRY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
HONG KONG	74
(AUSTRALIA)	74

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
ENGLAND *°	74
SCOTLAND °	72
JAPAN	72
SINGAPORE	72
KOREA	72
CANADA	72
(SLOVENIA)	72
(NETHERLANDS)	71
UNITED STATES	**71**
CZECH REPUBLIC	71

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT	
(AUSTRIA)	67	
(LATVIA (LSS))	67	
IRELAND	66	
NEW ZEALAND	66	
(HUNGARY)	66	(64)
ICELAND	63	
(ISRAEL)	62	
NORWAY	58	
GREECE	53	
(THAILAND)	53	
CYPRUS	53	
PORTUGAL	52	
IRAN, ISLAMIC REPUBLIC	42	
(KUWAIT)	36	

PATTERNS, RELATIONS, AND FUNCTIONS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	83
JAPAN	76
SINGAPORE	76
HONG KONG	73

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(HUNGARY)	69
(SLOVENIA)	68
CZECH REPUBLIC	67
UNITED STATES	**66**
(LATVIA (LSS))	65
(NETHERLANDS)	65
(AUSTRIA)	64
(AUSTRALIA)	64
IRELAND	64
CANADA	62

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT	
(ISRAEL)	60	(60)
SCOTLAND °	57	
CYPRUS	55	
ENGLAND *°	55	
NEW ZEALAND	52	
NORWAY	50	
(THAILAND)	50	
ICELAND	48	
PORTUGAL	47	
GREECE	47	
IRAN, ISLAMIC REPUBLIC	40	
(KUWAIT)	33	

NOTES (continued):

3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusal were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.
5. The placement of England in Geometry may appear out of place; however, statistically its placement is correct.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 2.1. Boston College: Chestnut Hill, MA.

FIGURE 6:
National Averages in Science Content Areas

EARTH SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	72
JAPAN	66

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(SLOVENIA)	64
CZECH REPUBLIC	64
UNITED STATES	**64**
(HUNGARY)	62
(AUSTRIA)	62
CANADA	62
ENGLAND *°	61
(NETHERLANDS)	61
(AUSTRALIA)	61

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
HONG KONG	61
IRELAND	60
NORWAY	60
SINGAPORE	58
SCOTLAND °	58
NEW ZEALAND	57 (57)
(LATVIA (LSS))	57
ICELAND	55
GREECE	52
(ISRAEL)	51
PORTUGAL	50
(THAILAND)	48
CYPRUS	48
IRAN,ISLAMIC REPUBLIC	38
(KUWAIT)	36

LIFE SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	76

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
JAPAN	73
(NETHERLANDS)	73
(AUSTRALIA)	72
(AUSTRIA)	72
CZECH REPUBLIC	71
UNITED STATES	**71**
SINGAPORE	70

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
CANADA	68
ENGLAND *°	68
(SLOVENIA)	68
HONG KONG	68
NORWAY	67
NEW ZEALAND	66
IRELAND	66
(HUNGARY)	66
SCOTLAND °	65 (64)
(ISRAEL)	61
GREECE	61
(LATVIA (LSS))	60
ICELAND	60
CYPRUS	55
PORTUGAL	54
(THAILAND)	52
(KUWAIT)	45
IRAN, ISLAMIC REPUBLIC	44

PHYSICAL SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	75
JAPAN	70
(NETHERLANDS)	65
SINGAPORE	64
(AUSTRIA)	64

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(AUSTRALIA)	63
CZECH REPUBLIC	62
(SLOVENIA)	61
CANADA	61
UNITED STATES	**60**
ENGLAND *°	60
HONG KONG	60
(HUNGARY)	59

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SCOTLAND °	57
IRELAND	57 (57)
NEW ZEALAND	57
(ISRAEL)	55
NORWAY	55
(LATVIA (LSS))	54
ICELAND	52
CYPRUS	50
PORTUGAL	49
GREECE	49
(THAILAND)	46
IRAN, ISLAMIC REPUBLIC	40
(KUWAIT)	37

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**PERCENT CORRECT**
KOREA	70

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**PERCENT CORRECT**
UNITED STATES	**65**
(AUSTRALIA)	63
JAPAN	62

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.	
NATION	**PERCENT CORRECT**
(NETHERLANDS)	61
ENGLAND *°	56
CANADA	56
CZECH REPUBLIC	56
IRELAND	55
(SLOVENIA)	54
NEW ZEALAND	54
(AUSTRIA)	54
SINGAPORE	53
SCOTLAND °	53
NORWAY	53
(ISRAEL)	51 (51)
(HUNGARY)	50
HONG KONG	50
(THAILAND)	48
ICELAND	47
(LATVIA (LSS))	46
GREECE	43
CYPRUS	42
PORTUGAL	39
IRAN, ISLAMIC REPUBLIC	26
(KUWAIT)	25

(#) Represents International Average

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.
5. The placement of Hong Kong in Earth Science may appear out of place; however, statistically its placement is correct.

SOURCE: Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 2.1. Boston College: Chestnut Hill, MA.

the U.S. was not different than the international average. Moreover, in all three previous studies, only a few nations outperformed the U.S. In the 1960s study, one nation out of 11 (Japan); in the 1980s study, 5 nations out of 14 (Japan, Korea, Finland, Sweden, and Hungary)[8], and in the 1991 study, one nation out of 13 (Korea) outperformed the U.S.[9] Taken together with the TIMSS findings reported here, **it appears that U.S. students in the middle years of elementary school perform reasonably well in science in comparison with their peers in other nations. It is not clear whether this relative international standing has changed over time.**

HOW DOES THE PERFORMANCE OF U.S. FOURTH GRADERS COMPARE WITH THAT OF U.S. EIGHTH GRADERS IN MATHEMATICS AND SCIENCE?

In both mathematics and science, our international standing is higher at fourth grade than it is at eighth grade. Figure 7 on page 32 provides a quick overview of mathematics and science performance at each grade level, in comparison with all of the countries participating at each grade level.

In mathematics, our fourth-grade students score above the international average, while our eighth-grade students score below the international average. In science, U.S. students score above the international average at both grade levels. However, only one nation outperforms us at the fourth grade, while 9 nations outperform us at the eighth grade.

FIGURE 7:
U.S. Mathematics and Science Performance at a Glance

How Do U.S. Students Compare with the International Average in...?	At Grade 4? (26 nations)	At Grade 8? (41 nations)
Mathematics overall	Above	Below
Science overall	Above	Above
Mathematics Content Areas:		
Data representation, analysis, and probability	Above	Above
Geometry	Above	Below
Whole numbers	Above	x
Fractions and proportionality	Above	x
Patterns, relations, and functions	Above	x
Measurement, estimation, and number sense	Below	x
Fractions and number sense	x	Same
Algebra	x	Same
Measurement	x	Below
Proportionality	x	Below
Science Content Areas		
Earth science	Above	Above
Life science	Above	Above
Environmental issues and the nature of science	Above	Above
Physical science	Above	x
Chemistry	x	Same
Physics	x	Same

What Percentage of U.S. Students Would Be in the International Top Ten Percent In...?	At Grade 4?	At Grade 8?
Mathematics	9%	5%
Science	16%	13%

KEY:
Above = U.S. average performance higher than the average of participating nations at that grade.
Below = U.S. average performance lower than the average of participating nations at that grade.
Same = U.S. average performance not significantly different than the average of participating nations at that grade.
x = Separate content area score not reported for this grade level.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Boston College, Chestnut Hill, MA; Martin et al. (1997) *Science Achievement in the Primary School Years.* Boston College, Chestnut Hill, MA; and U.S. Department of Education, National Center for Education Statistics.(1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* NCES 97-198, Washington, DC: Government Printing Office.

This pattern in relative international standing is also evident when one takes into account the fact that 41 nations participated in eighth-grade TIMSS, whereas 26 nations participated in the fourth-grade study. Comparisons of U.S. total performance with the international average for the 26 nations that participated in both the fourth-grade and eighth-grade TIMSS studies confirm this observation. Among these 26 nations in mathematics, U.S. fourth graders score above the international average and are outperformed by 7 nations, whereas U.S. eighth graders score below the international average and are outperformed by 13 nations. In science, U.S. fourth graders score above the international average and are outperformed by only one other nation. U.S. eighth graders' scores are not significantly different from the international average and are lower than 8 other nations.

While the U.S. international standing is higher at fourth grade than at eighth grade, most other countries which participated in TIMSS at both grades (19 in both mathematics and science) have a similar standing relative to the international average at both grade levels. Five countries have a lower relative standing at eighth grade than at fourth grade in one subject, and 4 countries (the U.S., Scotland, Ireland, and Latvia) have a lower relative standing at eighth grade in both subjects. **Only one country—the U.S. in mathematics—falls from above the international average at fourth grade to below the international average at eighth grade.**

Another way of looking at the U.S. performance at fourth and eighth grade is to see how many countries compare more favorably to the U.S. at eighth grade than they did at fourth grade. Of the 25 other countries that participated at both grade levels, all perform as well or better relative to the U.S. at eighth grade than they do at fourth grade. That is, no country compares less favorably to the U.S. in eighth grade than it does in fourth grade, and most compare more favorably. In both subjects, most of the countries (5 out of 6 in mathematics and 4 out of 5 in science) with average scores similar to the U.S. in fourth grade have scores in eighth grade that are significantly higher than the U.S. Likewise, many of the countries (8 of 12 in mathematics and 9 of 19 in science) whose scores are below the U.S. in fourth grade have eighth-grade scores that are similar to the U.S., and in science, 3 countries (Singapore, Slovenia, and Hungary) have fourth-grade scores below the U.S. and eighth-grade scores above the U.S.

HOW DOES THE PERFORMANCE OF U.S. FOURTH GRADERS COMPARE WITH THAT OF U.S. EIGHTH GRADERS IN MATHEMATICS AND SCIENCE CONTENT AREAS?

The picture for the content areas of mathematics and science is somewhat more complicated. Figure 7 on page 32 displays the results by content area. In mathematics, the fourth-grade and eighth-grade tests have only two content areas in which scores are reported for both grade levels (data representation, analysis, and probability; and geometry). U.S. students' scores in data representation, analysis and probability are significantly higher than the international average at both grade levels. U.S. students' scores in geometry are above the international average at the fourth grade and below the average at the eighth grade.

With regard to the other mathematics content areas, U.S. fourth graders exceed the international average in three content areas (whole numbers; fractions and proportionality; and patterns, relations, and functions) but are below it in one (measurement, estimation, and number sense). Eighth graders are not different from the international average in two content areas (fractions and number sense; and algebra) and are below the international average in two areas (measurement and proportionality).

In science, the fourth-grade and eighth-grade tests have three content areas for which scores are reported at both grade levels. U.S. fourth-graders and eighth-graders' scores are higher than the international average in all three of these content areas (earth science; life science; and environmental issues and the nature of science). U.S. fourth-graders' scores are above the international average in physical science, whereas eighth-graders' scores are not different than the international average in physics and chemistry.

SUMMARY

The foregoing discussion of TIMSS achievement findings highlights three important patterns:

- **U.S. fourth graders are above the international average in both mathematics and science.**
- **The international standing of U.S. fourth graders is stronger than that of eighth graders in both subjects.**
- **U.S. students perform better in science than in mathematics at both the fourth and eighth grades in comparison with their international counterparts.**

The next chapter explores the initial evidence from TIMSS concerning various factors that may contribute to these patterns.

CHAPTER 2: CONTEXTS OF LEARNING

KEY POINTS:

It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as particularly important.

On most background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Therefore, these factors are unlikely to be strongly associated with our international standing.

On those background factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries. Therefore, these factors are also unlikely to be strongly associated with our international standing.

In general, preliminary analyses shed little light on factors which might account for the differences between our performance in mathematics and science, and our performance at the fourth and eighth grades. Further analyses are needed to provide more definitive insights on these subjects.

In Chapter 1, we found that U.S. fourth graders score above the international average in both mathematics and science, and that in science, our fourth-graders' average score is exceeded by only one other country. This chapter examines the early data available from TIMSS about the educational context within which our students learn for evidence that might contribute to the three major findings that:

- U.S. fourth graders score above the international average in both mathematics and science.
- The international standing of U.S. fourth graders is stronger than that of eighth graders in both subjects.
- Our students' international standing is better in science than in mathematics at both fourth and eighth grades.

The evidence presented in this chapter is not conclusive for two reasons. The first is that TIMSS questionnaire analyses are still in their early stages, and therefore much more information will be available later concerning family background, teacher beliefs about mathematics and science, and many other topics that experts believe are associated with student performance in these subjects. The second reason is that fourth-grade TIMSS lacks evidence that was available at the eighth grade from videotape and case studies from several other countries with which to supplement the questionnaires. For this reason, we do not have detailed information about classroom instruction, teacher training, students' daily lives, and other key topics in a variety of countries.

Furthermore, the TIMSS study was designed in such a way that more information was collected about mathematics than about science, and about the eighth grade than about the fourth or twelfth grade. This complicates comparisons between mathematics and science and across grade levels.

International studies have matured to the point that it is widely recognized that there is no "magic tonic" or single factor that is always present in every high-performing country and absent in every low-performing country. Indeed, education is a vast system of many interrelated parts. No single factor or easily identifiable set of factors is clearly responsible for high achievement. Furthermore, every characteristic of a high-performing country does not necessarily "cause" its high achievement.

Data on some factors such as student economic status, ethnicity, and others that are known to be associated with differences in achievement between students in the U.S. are not available for other countries. However, factors such as these cannot be an explanation for the differences in the international standing of the U.S. at the fourth grade in comparison with the eighth grade, or in mathematics in comparison with science, because the same students were tested in both subjects, and there is little difference between the economic status and ethnicity of fourth- and eighth-grade students in the U.S. This is also the case in other countries.

Definitive determination of which factors contribute to higher achievement is beyond the reach of initial analyses such as those reported here. However, such preliminary evidence can be helpful for two reasons. First, it can demonstrate which factors do not appear to be strongly related to differences in student performance. Second, it can indicate directions in which further research might look for explanations of student performance. Therefore, let us review the currently available initial evidence concerning factors that might contribute to these three major findings.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT U.S. FOURTH GRADERS SCORE ABOVE THE INTERNATIONAL AVERAGE IN BOTH MATHEMATICS AND SCIENCE?

Logically, if we are to suggest that any particular factor may be related to the U.S.' relatively high international standing in mathematics and science at fourth grade, then that same factor should be one on which the U.S. is significantly different from the international average in both mathematics and science. Furthermore, the factor should usually be found in other high-performing countries and not in low-performing ones.

If the pattern of evidence for a given factor does not fit both of these criteria simultaneously, logically, it is not likely to contribute strongly to the relatively high international standing of the U.S. at the fourth grade. Using these criteria for judging the evidence, the following section examines the factors for which TIMSS data are currently available to see how the educational context in which U.S. fourth graders learn differs from the international average.

HOW DOES THE U.S. FOURTH-GRADE MATHEMATICS AND SCIENCE CURRICULUM DIFFER FROM THE INTERNATIONAL AVERAGE?

When considering curriculum, a distinction should be made between the officially intended curriculum and what teachers actually teach. National, state, and local authorities, as well as publishers, set forth the officially intended curriculum in both curriculum guidelines and textbooks. Depending on the country, teachers make decisions about what to teach based more or less closely on the officially intended curriculum. What teachers actually teach their students is sometimes called the "implemented curriculum." Both the officially intended curriculum and the implemented curriculum must be considered when discussing a nation's goals for learning.

U.S. curriculum is not determined at the national level, as it is in most TIMSS countries. In 18 of the 26 countries that participated in TIMSS at the fourth grade, curriculum is primarily determined at the national level. It is primarily determined at the state level in one country, Canada. Decisions about curriculum are not centralized in the remaining 7 countries, one of which is the U.S. In many countries where curriculum decision-making is not centralized, decisions are made at the district or local level.

TIMSS studied the "intended curriculum," as set forth by state and local authorities in the approximately 40 countries that participated in the fourth-grade curriculum analysis. Experts in each country were provided with detailed lists of topics and asked to judge which topics were intended to be taught at various grades. Examples of detailed topics in mathematics are "common fractions" and "whole number operations." Examples in science are "weather and climate" and "electricity." The number of topics intended to be taught is defined here as a measure of curricular focus. Nations in which fewer topics are intended to be taught are considered to have a more focused curriculum. Some experts believe that having fewer topics in the intended curriculum may facilitate higher student achievement by allowing the teaching of each topic in more depth.

When the judgments of the U.S. experts were compared with the international average of the approximately 40 countries, it was found that the number of topics intended for coverage in the U.S. at the fourth grade was above the international average in mathematics, and somewhat below the international average in science. In grades one, two, and three, the number of topics intended for coverage in the U.S. is above the international average in both mathematics and science. **Thus, the evidence is mixed: the U.S. fourth-grade intended curriculum is more focused in science and less focused in mathematics than the international average,** but both are less focused compared with the international average at grades one, two, and three. Therefore, greater curricular focus (or fewer intended topics) could not be a strong factor contributing to our above-average fourth-grade performance in both subjects.

At this time, we are unable to say whether or not the U.S. fourth-grade implemented curriculum is more focused than the international average. We can only compare expert judgments of the officially intended curriculum because teacher reports from the TIMSS questionnaires of what they actually teach are not yet available for any country besides the U.S.

DO U.S. FOURTH GRADERS SPEND MORE TIME IN CLASS STUDYING MATHEMATICS AND SCIENCE?

Our fourth-grade students spend more time in class per week learning mathematics and science than do their average international counterparts. U.S. fourth graders receive an average of 4.2 hours of instruction per week in mathematics. This is 18 minutes more per week than the international average of 3.9 hours. When science is taught as a separate subject, U.S. students receive an average of 2.7 hours of instruction per week, which is 48 minutes more than the international average of 1.9 hours per week. Of the countries in which fourth-grade science is taught as a separate subject, only Portugal has significantly more hours of instruction.

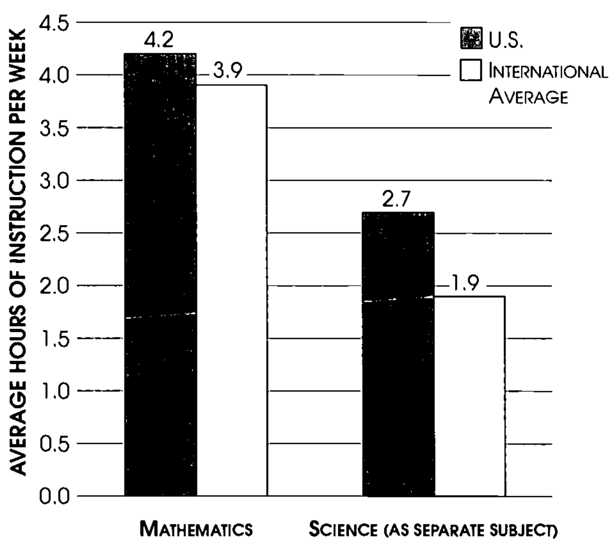
However, caution should be exercised in considering class time as a factor that might contribute to U.S. fourth graders' above-average performance in mathematics, given that 4 of the 7 nations that outperform us in mathematics spend less time in class per week than the U.S. and also less than the international average. Figure 8 on page 40 shows the comparison of U.S. weekly hours of instruction with the international averages.

IS HOMEWORK MORE COMMON IN THE U.S. THAN IN OTHER COUNTRIES?

U.S. fourth-grade teachers assign about the same amount of mathematics homework as teachers in most other countries. When teachers were asked how often they assign mathematics homework, the most common response in the majority of TIMSS countries was "three or more times a week." Teachers of 71 percent of U.S. fourth-grade students respond in this way, a figure slightly above the international average of 66 percent. Teachers of another 22 percent of U.S. students report that they assign homework once or twice a week. Figure 9 on page 41 shows these results. The percentage of U.S. fourth graders receiving mathematics homework three or more times per week is lower than 4 of the 7 countries that outperform us in mathematics, and higher than the other 3 countries that outperform us.

When asked, "If you assign homework, how many minutes do you usually assign?," teachers of most U.S. fourth graders respond "30 minutes or less," which is also the case in most other TIMSS countries. TIMSS did not ask teachers about the amount of science homework that they assign fourth-grade students.

FIGURE 8:
TEACHERS' REPORT ON AVERAGE HOURS OF MATHEMATICS AND SCIENCE INSTRUCTION PER WEEK



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Table 5.4. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 5.5. Boston College: Chestnut Hill, MA.

HOW DOES THE STRUCTURE OF U.S. MATHEMATICS AND SCIENCE INSTRUCTION DIFFER FROM THAT IN OTHER TIMSS NATIONS?

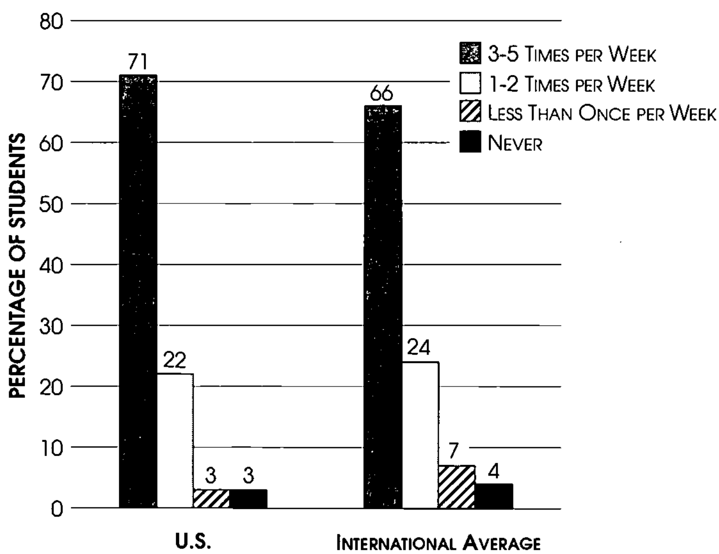
U.S. fourth graders usually study mathematics and science from the same teacher, and this is typical of fourth-grade students in most other TIMSS countries. **While three Asian countries have large class sizes of between 36 and 43 students, U.S. average class size (24) is close to the international average (25) for the other countries.** The three Asian countries with large class sizes outperform the U.S. in math, but only one of these countries outperforms us in science.

IS U.S. CLASSROOM ORGANIZATION DIFFERENT THAN THAT OF OTHER COUNTRIES?

Information about teaching collected in the fourth-grade TIMSS study is based on teacher questionnaire reports and does not provide as rich or detailed a picture as the TIMSS videotape study that was conducted in eighth-grade mathematics classrooms. However, initial analyses of the questionnaire data suggest that **organization for instruction in U.S. fourth-grade classrooms is similar to that in other countries.**

In most TIMSS countries, teachers of fourth graders report that their two most common patterns for organizing instruction used in most or every lesson

FIGURE 9:
PERCENTAGE OF STUDENTS WHOSE TEACHERS ASSIGN VARIOUS AMOUNTS OF MATHEMATICS HOMEWORK



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Table 5.19. Boston College: Chestnut Hill, MA.

in both mathematics and science is to teach the class as a whole, and to have the students work individually with assistance from the teacher. These two patterns are also the most common patterns in the U.S. in fourth-grade mathematics. Science in the U.S. is slightly different from mathematics because the second most common pattern is to have students work together as a class with students responding to each other, rather than individually with assistance from the teacher.

Teachers sometimes organize students to work in pairs, or in small groups with teacher assistance. The U.S. is close to the international average in the frequency with which teachers have students work in pairs or small groups with teacher assistance. Teachers of about one-fifth of students in the U.S. report that they use this pattern in most or every mathematics lesson and teachers of one-fourth of students use it in most or every science lesson.

ARE CALCULATORS AND COMPUTERS MORE COMMON IN U.S. FOURTH-GRADE CLASSROOMS THAN IN OTHER TIMSS COUNTRIES?

U.S. fourth graders use calculators and computers in mathematics class more frequently than do students in most other TIMSS countries. Use of calculators in U.S. fourth-grade mathematics classes is about twice the international average. In the U.S., teachers of 39 percent of the students report having students use calculators in their mathematics classes at least once or twice a week compared with the international average of 18 percent. Internationally, the teachers of two-thirds of the TIMSS students report that they never or hardly ever have students use calculators in their mathematics classes compared with the teachers of one-third of U.S. students. **In 6 of the 7 nations that outscore the U.S. in mathematics, teachers of 85 percent or more of the students report that students never use calculators in class.**

Among the 26 countries that participated in fourth-grade TIMSS, teachers in the U.S. and Canada are among the most likely to report that students use computers in at least some mathematics lessons. Teachers of 37 percent of the U.S. students report that computers are used in at least some lessons, in comparison with 13 percent of students internationally. Teachers in 5 of the 7 countries that outscore the U.S. in mathematics report that they never or almost never have students use computers in mathematics lessons.

In all countries, fourth-grade students were not allowed to use calculators or computers when taking the TIMSS test.

ARE U.S. FOURTH-GRADE TEACHERS BETTER TRAINED THAN THEIR COLLEAGUES IN OTHER TIMSS COUNTRIES?

The profile of a typical U.S. teacher of fourth graders is similar to that of teachers in most other TIMSS countries: a woman at least 40 years old with more than 10 years of teaching experience. However, **teachers of U.S. fourth graders have more university training than their counterparts in most TIMSS countries.** This is because the U.S. is one of only 10 of the 26 nations that participated in

TIMSS at the fourth grade that requires elementary school teachers to earn a university degree before being certified to teach. This university degree typically requires 4 years. Thirteen TIMSS countries require a degree from a non-university teacher-training institution, which usually requires 3 years to complete. Three nations certify teachers from either universities or teacher training institutions. **Among the 7 countries that outperform the U.S. in fourth-grade mathematics, 3 countries require a university degree and the other 4 countries require a degree from a 3-year teacher-training institution.** Almost all TIMSS countries, including the U.S., require some period of teaching or practice experience, as well as an evaluation or examination of the teacher before full teacher certification is granted.

U.S. fourth-grade teachers meet with other teachers to discuss curriculum about as frequently as their colleagues in other TIMSS countries. Mathematics teachers of about 60 percent of U.S. students report that they meet at least once a week with other teachers in their subject area to discuss and plan curriculum or teaching approaches; the same is true in science. About 40 percent say they meet less frequently. Teachers in many other TIMSS countries report meeting with similar frequency.

DO U.S. TEACHERS EXPERIENCE FEWER PROFESSIONAL CHALLENGES THAN DO TEACHERS IN OTHER TIMSS COUNTRIES?

U.S. teachers' perceptions of their professional challenges are similar to but possibly less limiting than teachers in most of the 26 TIMSS countries. Teachers of fourth graders in most TIMSS countries, including the U.S., most frequently cite varying academic abilities of students, and a high student-teacher ratio as factors that limit how they teach their class either "quite a lot" or "a great deal." The next most frequent challenges are shortages of equipment for use in demonstrations and other exercises, and disruptive students. However, teachers of a smaller percentage of U.S. students report that these factors limit how they teach their classes than the international average. Figure 10 on page 44 shows that the U.S. is below the international average with respect to all four of these challenges, including classroom discipline. It is important to remember, however, that this information represents teachers' subjective impressions rather than actual measures of the classroom environment in the various countries.

DO U.S. STUDENTS HAVE MORE EDUCATIONAL RESOURCES IN THEIR HOMES THAN DO TYPICAL STUDENTS IN OTHER TIMSS COUNTRIES?

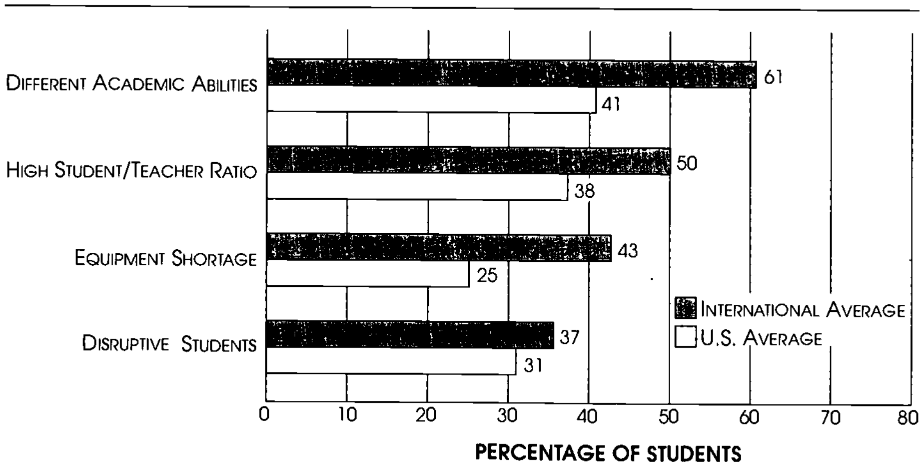
Experts believe that homes that have books, a desk in a quiet place for study, a dictionary, a computer, and other educational resources provide an environment that fosters academic development. **U.S. fourth graders have more educational resources in their homes than the average student in other TIMSS countries, but this is not true of most other high-performing countries.** About one-half of U.S. fourth graders report that they have three key resources in their home: a dictionary, their own study desk, and a computer, compared with about one-third of students in the 26

TIMSS countries. A smaller percentage of fourth graders in 4 of the 7 countries that outperform us in mathematics and the one country that outperforms the U.S. in science report having all three of these educational resources in their homes than in the U.S. Of the other 3 countries that outperform the U.S. in mathematics, in one country, the percentage is about the same as the U.S., in another country the percentage is larger, and in another nation the students were not asked this question.

Fifty-six percent of U.S. fourth graders report having at least 100 books in their homes, which is greater than the international average of 42 percent. A smaller percentage of students in 3 of the 7 nations that outperform us in mathematics report having more than 100 books, and about the same percentage report having at least this many books in the 3 other nations. One nation did not ask its students this question.

Computers are more common in the homes of U.S. fourth graders than the international average, but the U.S. does not lead the world in this respect. In the U.S., 56 percent of fourth graders report having a computer at home, compared with the international average of 49 percent. In 5 countries, 75 percent or more of fourth graders report having a computer at home: Scotland, England, the Netherlands, Iceland, and Ireland. Only one of these nations (the Netherlands) outscores the U.S. in mathematics and none in science. **In 4 of the 7 nations that outscore the U.S. in mathematics, fewer students report having a computer at home than do students in the U.S.**

FIGURE 10:
PERCENTAGE OF MATHEMATICS STUDENTS WHOSE TEACHERS REPORT VARIOUS CIRCUMSTANCES LIMIT THEIR TEACHING 'QUITE A LOT' OR 'A GREAT DEAL'



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Figure 5.4. Boston College: Chestnut Hill, MA.

DO U.S. FOURTH GRADERS HAVE MORE POSITIVE ATTITUDES TOWARD MATHEMATICS AND SCIENCE THAN DO STUDENTS IN OTHER COUNTRIES?

More U.S. fourth graders believe it is important to do well in math and science and have confidence about their performance in these subjects than their international counterparts.

Over 90 percent of students in most TIMSS countries believe that it is important to do well in mathematics and science. U.S. students are even more likely to agree that it is important to do well in these subjects. In the U.S., virtually all fourth graders think it is important to do well: 98 percent believe it is important to do well in mathematics, and 97 percent believe it is important to do well in science.

A large majority of fourth graders in the U.S. have confidence that they are doing well in mathematics and science, and this is the case in other countries as well. Ninety-one percent of U.S. fourth graders either agree or strongly agree that they are doing well in mathematics and science. In both mathematics and science, U.S. fourth graders are more likely than the international average to strongly agree that they are doing well in these subjects.

Fourth graders in the U.S. report they like both mathematics and science, and the percentage who report this is about the same as the average of all TIMSS students. In the U.S., 84 percent of fourth graders report that they either "like" mathematics or like mathematics "a lot." In science, this proportion is 85 percent.

IS HEAVY TELEVISION WATCHING LESS COMMON AMONG U.S. FOURTH GRADERS THAN AMONG STUDENTS IN OTHER COUNTRIES?

More U.S. fourth graders watch large amounts of TV than the international average. Thirty-two percent of U.S. students report watching three hours or more of television on a normal school day. This is higher than the international average of 25 percent of students who report watching this much. In 4 of the 7 nations that outperform us in mathematics, the percentage of students who report watching three or more hours of television per night is smaller than the international average. In one nation, the percentage is about the same as the international average, and in one it is larger. One nation did not ask this question of its students.

SUMMARY

Let us return to the question with which this section started: "What factors might contribute to the finding that U.S. fourth graders score above the international average in both mathematics and science?" We have examined the early evidence, from the TIMSS questionnaires about how various factors related to our fourth-grade education in general, and our mathematics and science education in particular, differ from the international average. We have also examined whether or not these differences are also characteristic of most high-performing countries. It is unlikely that any of the factors described in this chapter, when considered in isolation, contribute strongly to U.S. performance for two reasons. First, on most of the background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Second, on those factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries.

Rather than considering single factors in isolation, it is possible that the combined effect of several factors creates an educational environment that nurtures U.S. above-average performance. Caution should be exercised, however, in assuming that this is the case because most of the characteristics of U.S. fourth-grade education also characterize U.S. eighth-grade education, and at the eighth grade, U.S. students score below the international average in mathematics.

There may be other important factors about U.S. education that contribute to our above-average performance at the fourth-grade level that were not measured by the TIMSS study. There also are likely to be factors that were measured by the TIMSS study but have not yet been fully analyzed that will provide more information about what contributes to our students' above-average performance at this grade level.

Even though differences from the international average may not appear to have a strong relationship to our international performance, understanding such differences helps us view the context of U.S. education in comparative perspective. Therefore, let us summarize the initial questionnaire findings about how U.S. fourth-grade mathematics and science education differs from the international average.

- Curriculum is not determined at the national level in the U.S., as it is in most TIMSS countries.
- Students in the U.S. spend more class time per week studying mathematics and science than the international average.
- Teachers in the U.S. assign about the same amount of mathematics homework as teachers in other TIMSS countries.
- Students in the U.S. use calculators and computers in mathematics class more often than do students in most other TIMSS countries.
- Teachers in the U.S. have more university training than do their colleagues in many other TIMSS countries.
- U.S. teachers' professional challenges are perceived to be similar to, but possibly less limiting than, those experienced by teachers in other TIMSS countries.
- Students in the U.S. have more educational resources in their homes than the international average.
- More U.S. students believe it is important to do well in mathematics and science, and have more confidence about their performance in these subjects, than their average international counterpart.
- More U.S. fourth graders watch large amounts of TV than their international counterparts.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT THE INTERNATIONAL STANDING OF U.S. FOURTH GRADERS IS STRONGER THAN THAT OF U.S. EIGHTH GRADERS?

In Chapter 1, we have seen that in both mathematics and science our students' international standing is higher at the fourth grade than it is at the eighth grade. In mathematics, among the 26 nations that participated at the fourth grade, our students' total test scores are above the international average whereas our eighth-graders' scores are below the international average of the 41 nations that participated at this grade level. In science, our students score above the international average for the 26 nations at the fourth grade and the 41 nations at the eighth grade. However, comparing our performance with the 26 nations that participated at both grade levels, whereas one nation outperforms us at the fourth grade, 8 nations outperform us at the eighth grade. The pattern of U.S. younger students performing relatively better compared with their international peers is not unique to TIMSS. It is a pattern that has been observed in most previous international assessments in mathematics, science, and reading.[10]

Later analyses will allow more in-depth study of our students' better international standing at the fourth grade than at the eighth grade. At the time of these initial analyses, identical data are not available for some factors at both the fourth and eighth grades, and for both mathematics and science. Further data analysis will allow expanded investigation of these questions. In addition, some of the explanations may lie with factors that occur prior to the fourth grade or occur in the grades between fourth and eighth, for which there are little TIMSS data.

The following section examines the initial evidence about factors that might contribute to the international standing of our fourth graders being stronger than that of our eighth graders. Logically, for a factor to be strongly related to our better international performance at the fourth grade, it should be present in different amounts at the fourth and eighth grades relative to the international average, and this difference should be found in both subjects.

For example, to consider the amount of homework that U.S. students are assigned as an important factor contributing to differences in performance between the two grades, two pieces of evidence are desirable. First, the amount of homework fourth graders receive should be higher relative to the the international average at the fourth grade than it is at the eighth grade. Second, this should be the case in both mathematics and science. Using these criteria for judging the evidence, the following section examines the early TIMSS data available at this time.

IS THE U.S. FOURTH-GRADE CURRICULUM MORE FOCUSED THAN THAT OF THE EIGHTH GRADE?

Comparing expert judgments of the officially intended mathematics curriculum, there does not appear to be much difference between the fourth grade and the eighth grade. The number of mathematics topics judged as intended by experts is substantially above the international average at both grade levels. In science, the number of topics experts judged to be intended is slightly below the international average at the fourth grade and somewhat above at the eighth grade. If focus is defined as a smaller number of intended topics, **the evidence concerning the intended curriculum is mixed: in mathematics, there is little difference in the amount of focus relative to the international average between fourth and eighth grade. In science, the fourth-grade curriculum may be more focused than the eighth-grade curriculum, relative to the other TIMSS countries.** If the full span of grades from first to eighth is examined, the U.S. intended curriculum contains more topics than the international average at every grade in both subjects, except for fourth-grade science.

To learn about the implemented curriculum, or what is actually taught, teachers in the 26 nations that participated in fourth-grade TIMSS were given lists of broad categories of subject matter, referred to here as "topic areas." Examples of topic areas in mathematics are "whole numbers," and "fractions and decimals," and in science are "earth features" and "matter." Teachers were asked to check off those topic areas that they had already taught their fourth graders that year or planned to teach them before the school year ended in order to provide an estimate of teaching coverage for the whole year. At this time, only U.S. data are available on the implemented curriculum. Therefore, we can compare the differences between the fourth and eighth grades in the U.S., but we cannot tell how relatively focused the U.S. curriculum is compared to other countries.

In mathematics, on average, U.S. fourth graders are taught 14 out of 20 topic areas, and eighth graders are taught 16 out of 21 topic areas. In science, on average, U.S. fourth graders are taught 16 out of 22 topic areas, and eighth graders are taught 14 out of 22 topic areas.

ARE U.S. FOURTH GRADERS ASSIGNED RELATIVELY MORE MATHEMATICS HOMEWORK THAN ARE U.S. EIGHTH GRADERS?

U.S. fourth graders are less frequently assigned mathematics homework than are eighth graders, but the frequency of homework is higher than the international average in both grades. According to teacher reports, 71 percent of U.S. fourth graders and 86 percent of U.S. eighth graders are assigned mathematics homework three or more times per week. These percentages of students are greater than the international average for the fourth and eighth grades.

IS U.S. FOURTH-GRADE MATHEMATICS AND SCIENCE INSTRUCTION DIFFERENT FROM THAT IN THE EIGHTH GRADE?

U.S. fourth graders usually study mathematics and science from the same teacher, and eighth graders usually study it from different teachers, which is also true for the majority of students in most other TIMSS countries.

Mathematics class sizes in U.S. fourth and eighth grades are approximately equal and are not far from the international average for both grade levels.

Except for a few Asian countries with very large classes, U.S. class sizes are quite similar to the average of the rest of the countries at both grade levels.

IS U.S. FOURTH-GRADE MATHEMATICS CLASSROOM ORGANIZATION DIFFERENT FROM THAT IN THE EIGHTH GRADE?

Teachers of fourth- and eighth-grade students report similar patterns of organization in their mathematics classes, and at both grade levels these are comparable with the international averages. At both grade levels, in most or every lesson, the most common pattern of mathematics instruction is for the teacher to teach the whole class, or to have students work individually with assistance from the teacher during at least some part of most lessons.

ARE CALCULATORS USED MORE COMMONLY IN U.S. FOURTH-GRADE MATHEMATICS CLASSES THAN IN EIGHTH-GRADE CLASSES?

U.S. fourth graders use calculators less frequently in mathematics classes than do U.S. eighth graders. Teachers of 39 percent of U.S. fourth graders report that students use calculators in mathematics class at least once or twice a week, in comparison with 82 percent of eighth graders. At both grade levels, teachers of U.S. students are more likely to report that they have students who use calculators in class than the international average.

ARE U.S. FOURTH-GRADE TEACHERS MORE EXPERIENCED THAN EIGHTH-GRADE TEACHERS?

In mathematics, there is little difference between the fourth and eighth grades in the percentage of students whose teachers have more than 10 years of experience. In science, more fourth-grade teachers than eighth-grade teachers have this much experience. In mathematics, teachers of 62 percent of students at both grade levels have more than 10 years of teaching experience. In science, teachers of 62 percent of fourth-grade students and 52 percent of eighth-grade students have more than 10 years of experience. These percentages are close to the international average for fourth- and eighth-grade mathematics and fourth-grade science. For science, the percentage of U.S. eighth-grade students whose teachers have more than ten years of experience is less than the international average.

DO U.S. FOURTH-GRADE STUDENTS HAVE MORE EDUCATIONAL RESOURCES IN THEIR HOMES THAN DO EIGHTH GRADERS?

Fewer U.S. fourth graders have their own study desk, a computer, and a dictionary at home than do eighth graders, but the percentage of U.S. students who have all three of these study aids at home is larger than the international average at both grade levels. At the fourth grade, 49 percent of U.S. students have all three study aids, and at the eighth grade, 56 percent report having all three.

The percentage of students who report having a computer at home, and the percentage who report having at least three bookcases filled with books (or at least 200 books) at home is about the same for both grade levels, and both of these percentages are above the international averages.

DO U.S. FOURTH-GRADE STUDENTS WATCH RELATIVELY LESS TV THAN EIGHTH-GRADE STUDENTS?

U.S. students watch more hours of TV in both fourth and eighth grades than the international average.

DO U.S. FOURTH GRADERS LIKE MATHEMATICS AND SCIENCE MORE THAN DO U.S. EIGHTH GRADERS?

A majority of U.S. fourth and eighth graders report that they like both mathematics and science, but more fourth graders report liking these subjects than do eighth graders. In mathematics, 84 percent of fourth graders say that they "like" mathematics or "like it a lot," compared with 71 percent of eighth graders. In science, 85 percent of U.S. fourth graders say that they like the subject or like it a lot compared with 71 percent of eighth graders. These percentages are close to the international averages for fourth- and eighth-grade science and fourth-grade mathematics. For mathematics, the percentage of U.S. eighth graders who like mathematics or like it a lot is above the international average.

SUMMARY

None of the factors among those considered appear to strongly contribute to the better international standing of U.S. fourth graders in comparison with U.S. eighth graders in both subjects. Among the factors for which we have comparable data at both grades, some factors exhibit little or no difference between fourth and eighth grades or the pattern of evidence is mixed. In fact, each of the differences in the U.S. between the fourth and eighth grades listed below is typical of most other TIMSS countries and is also typical of the international averages for these two grade levels. For some factors, such as homework, in-class calculator use, and possession of study aids in the home, U.S. fourth graders have less of these factors than do U.S. eighth graders. However, compared with the international average on these factors, there is no difference in the U.S. standing between the fourth and eighth grades. Therefore, **evidence concerning why the international standing of U.S. fourth graders is stronger than that of eighth graders is inconclusive and incomplete. Further analyses will possibly shed more light on this question.**

To review the initial findings presented here concerning the differences between fourth grade and eighth grade:

- While U.S. fourth graders are less frequently assigned mathematics homework than are eighth graders, both are above the international average.
- In the U.S., as well as other TIMSS countries, fourth graders usually study mathematics and science from the same teacher, and eighth graders study it from different teachers. U.S. eighth graders are less likely to have

science teachers with more than ten years of experience than are U.S. fourth graders.

- U.S. fourth graders use calculators in mathematics classes less frequently than do eighth graders and both are above the international average.

- While fewer U.S. fourth graders have their own study desk, computer, and dictionary at home than eighth graders, the percentages are higher than the international average at both grades.

- U.S. fourth graders report that they like mathematics and science more than eighth graders, but only U.S. eighth graders in mathematics exceed the international average.

None of these factors, either in isolation or in combination, appear to contribute heavily to the relative difference between U.S. fourth- and eighth-grade performance.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT THE INTERNATIONAL STANDING OF U.S. STUDENTS IS STRONGER IN SCIENCE THAN IN MATHEMATICS?

In Chapter 1, we have seen that at both the fourth and eighth grades, our international standing is stronger in science than it is in mathematics. In science, our students are above the international average at both grade levels. Among the 26 nations that participated in TIMSS at both the fourth and eighth grades, only one nation outperforms us in science at the fourth grade, and 8 nations outperform us at the eighth grade. In mathematics, our students are above the international average at the fourth grade and below it at the eighth grade. Seven nations outperform us in mathematics at the fourth grade and 13 nations outperform us at the eighth grade.

Logically, if we are to suggest that any particular factor may be related to our students' stronger international standing in science than in mathematics, that factor should be present in different amounts in mathematics and science, relative to the international average. This difference should also be found at both the fourth and eighth grades.

Further analyses will allow more in-depth investigation of these questions. Based on the data available at this time, it is not always possible to compare background characteristics of U.S. eighth-grade education to the international average. Currently available TIMSS data allow within-U.S. comparison of differences between fourth-grade mathematics and science for only a few background factors. At the time of these initial analyses, comparable analyses of the data for the eighth grade have not been conducted. Later analyses will allow for much deeper investigation of these subjects.

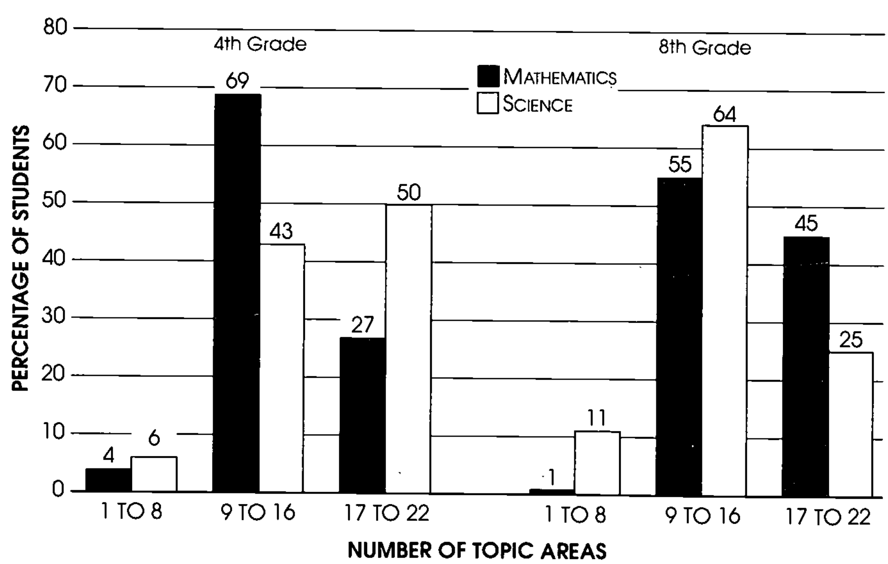
IS THE U.S. CURRICULUM MORE FOCUSED IN SCIENCE THAN IN MATHEMATICS?

In mathematics, according to expert judgment concerning the number of topics officially intended in mathematics, the U.S. intended curriculum includes more topics than the international average at both the grades, fourth and eighth. In science, the number of topics in the U.S. intended curriculum is somewhat below the international average at grade 4, and close to the international average at grade 8. If all grade levels between one and eight are examined, science appears closer to the international average than mathematics. Thus, the U.S. intended curriculum may be more focused in science than in mathematics.

When asked what they actually teach, teachers of 73 percent of U.S. fourth-grade students report teaching fewer than 17 mathematics topic areas per year. In science, the comparable figure is 50 percent. At the eighth grade, mathematics teachers of 55 percent of U.S. students teach less than 17 topics per year, in comparison to science teachers of 75 percent of U.S. students. Figure 11, below, shows these findings. At this time, only U.S. data are available on the implemented curriculum. Therefore, we cannot compare these U.S. findings to those of other countries.

In summary, **evidence concerning curriculum focus is mixed. Relative to other countries, the U.S. intended curriculum is more focused in science than in mathematics at both the fourth and eighth grades.**

FIGURE 11:
PERCENTAGE OF FOURTH- AND EIGHTH-GRADE STUDENTS WHOSE TEACHERS REPORT TEACHING VARIOUS NUMBERS OF MATHEMATICS AND SCIENCE TOPICS



SOURCE: Third International Mathematics and Science Study teacher questionnaires; unpublished tabulations by Michigan State University and Westat.

DO U.S. STUDENTS SPEND RELATIVELY MORE TIME IN CLASS STUDYING SCIENCE THAN MATHEMATICS?

As described above, U.S. fourth graders spend more time in class per week studying mathematics than studying science. In mathematics, U.S. fourth graders receive 4.2 hours per week of instruction and 2.7 hours per week in science. In both subjects, U.S. fourth graders receive more instruction per week than the international average. However, **relative to the international average, U.S. fourth graders receive considerably more additional science instruction than mathematics instruction.** U.S. fourth graders receive 48 minutes more science instruction per week than the international average, and 18 minutes more mathematics instruction per week than the international average.

Initial analyses do not provide comparable information for the eighth grade in both subjects, nor do they provide an estimate of total amount of class time per year, taking into account the number of weeks in the school year.

ARE CLASS SIZES DIFFERENT IN SCIENCE THAN IN MATHEMATICS?

At the fourth grade, there is usually no difference between class sizes in mathematics and science because most students in the U.S. and in the majority of TIMSS countries study mathematics and science in the same class from the same teacher.

ARE U.S. SCIENCE TEACHERS MORE EXPERIENCED THAN MATHEMATICS TEACHERS?

Evidence concerning teacher experience is mixed. Both absolutely, and compared with the international average, U.S. eighth graders are less likely to have teachers with more than 10 years of experience in science than in mathematics. In the U.S., 52 percent of eighth-grade students have science teachers with more than 10 years of experience, compared with the international average of 62 percent. In mathematics, 62 percent of U.S. students have teachers with more than 10 years of experience, which is not significantly different from the international average.

At the fourth grade, in the U.S. and most countries, mathematics teachers have the same amount of teaching experience as science teachers because the same teacher teaches both subjects.

ARE U.S. STUDENT ATTITUDES MORE POSITIVE TOWARD SCIENCE THAN THEY ARE TOWARD MATHEMATICS?

Approximately equal percentages of U.S. students have positive attitudes toward mathematics as have positive attitudes toward science. In both subjects, at both the fourth and eighth grades, a majority of students report that they like these subjects and feel that they usually do well in them. In both subjects, the percentage of U.S. students who express positive attitudes is similar to the international average except in eighth-grade mathematics where the percentage of U.S. students who like the subject is above the international average.

SUMMARY

Evidence concerning why the international standing of U.S. students is stronger in science than in mathematics is inconclusive and incomplete. Further analyses will shed more light on this question. For most of the factors for which data are currently available, there is no difference between mathematics and science, or evidence from the fourth and eighth grades is mixed. The only factor among those reviewed here that exhibits a difference between mathematics and science is:

- Compared with the international average, U.S. fourth graders receive considerably more additional instruction per week in science than in mathematics.

However, it is not clear if this difference is also characteristic of the eighth grade, or if it represents more total class time per year. Therefore, caution should be used in assuming that it contributes strongly to U.S. students' stronger performance in science than in mathematics.

CONCLUSIONS

This report has presented highlights from initial analyses of the academic performance of U.S. fourth graders in comparison with countries that participated in the TIMSS fourth-grade study. The report has also presented the evidence available from early analyses concerning why U.S. students perform above the international average at the fourth grade, and why their comparative international standing is stronger at the fourth grade than at the eighth grade, and stronger in science than in mathematics. Adequate understanding of the answers to these questions must await deeper analysis.

TIMSS does not suggest any single factor or combination of factors that leads to high academic performance in every country. If anything, TIMSS suggests that there may be multiple recipes for excellence and that different combinations of factors may contribute to high achievement in different countries. There are no educational characteristics that are present in every high-performing TIMSS country.

Although the evidence presented in this report does not point to any factors that are strongly related to high achievement, the evidence does suggest that some factors commonly thought to be related are not necessarily so. For example, more time in class, more homework, less television, and smaller class sizes have often been thought to be strongly related to higher achievement. The TIMSS evidence presented here shows that these factors are not necessarily characteristic of most high-performing countries, and also that they cannot explain the difference between our nation's relative international standing at the fourth and eighth grades, and in science and mathematics.

International comparisons have matured to the point where we no longer search for single factors that always produce world-class performance. Instead, we need to use these findings as an objective assessment of the strengths and weaknesses characteristic of each specific national education system. All countries, including the U.S., have something to learn from other nations, and have something from which other countries can learn. TIMSS allows us to examine our own national educational strengths and weaknesses in the mirror of other nations.

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APPENDIX 1
ADDITIONAL TIMSS REPORTS

WHERE CAN I FIND A GOOD SUMMARY OF TIMSS FINDINGS THAT PUTS U.S. EDUCATION IN COMPARATIVE PERSPECTIVE?

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context, **November 1996—This report draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in the eighth grade. Paperback, 80 pp. $9.50.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. GPO #065-000-00959-5. Also may be downloaded from http://www.ed.gov/NCES/timss.

Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context**—This report summarizes the most important findings concerning U.S. achievement and schooling in the fourth grade. Paperback.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. NCES 97-255. Also may be downloaded from: http://www.ed.gov/NCES/timss.

TIMSS: A Video Report, **February 1997—This video summarizes the TIMSS' key findings concerning U.S. eighth-grade education and includes the views of business leaders, policymakers, educators, and researchers on the study's implications for America's schools. 13 minutes. $20.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. GPO #065-000-01003-8.

Highlights of Results from TIMSS, **November 1996—Glossy brochure, 8 pp.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu.

Web Sites**—There are several web sites devoted to TIMSS. For general information about the study as well as direct access to many TIMSS publications, please see:**

http://www.ed.gov/NCES/timss
http://wwwcsteep.bc.edu/timss
http://uttou2.to.utwente.nl/
http://ustimss.msu.edu/

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF EIGHTH-GRADE STUDENTS?

Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS), **November 1996—This report focuses on mathematics achievement in 41 countries at the two grades with the largest proportion of 13-year-olds—the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 176 pp. + 60 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS), **November 1996—This report focuses on science achievement in 41 countries at the two grades with the largest proportion of 13-year-olds—the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 168 pp. + 62 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF FOURTH-GRADE STUDENTS?

Mathematics Achievement in the Elementary School Years: IEA's Third International Mathematics and Science Study (TIMSS), **June 1997—This report focuses on mathematics achievement in 26 countries at the two grades with the largest proportion of 9-year-olds—the third and fourth grades in most countries. The report includes selected background information about students and teachers. Paperback. $20 (+ $7 shipping and handling, if international).**

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Science Achievement in the Elementary School Years: IEA's Third International Mathematics and Science Study (TIMSS), **June 1997—This report focuses on science achievement in 26 countries at the two grades with the largest proportion of 9-year-olds—the third and fourth grades in most countries. The report includes selected background informa-**

tion about students and teachers. Paperback. $20 (+ $7 shipping and handling, if international).

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HOW CAN I GET A FIRST HAND GLIMPSE OF ACTUAL CLASSROOM LESSONS IN THE UNITED STATES, GERMANY, AND JAPAN?

***VHS VIDEO Examples from the Eighth-Grade Mathematics Lessons in the United States, Japan, and Germany*—Actual footage of eighth-grade mathematics classes in Germany, the U.S., and Japan lets viewers see firsthand an abbreviated geometry and algebra lesson in each of three countries: Germany, Japan, and the United States. 72 minutes.**

To order, contact: National Center for Education Statistics, 555 New Jersey Ave., Suite #402A, NW, Washington, DC 20208; Telephone: (202) 219-1333; Fax: (202) 219-1736; E-mail: TIMSS@ed.gov.

***CD-ROM Video Examples from the TIMSS Videotape Classroom Study: Eighth-Grade Mathematics in Germany, Japan, and the United States*—Actual footage of eighth-grade mathematics classes lets viewers see first hand an abbreviated geometry and algebra lesson in each of three countries: Germany, Japan, and the United States.**

Minimum System Requirements:
IBM PC or 100 percent compatible, MS Windows ® (Windows 95 ® recommended), Pentium ® 90, 16 mb of RAM, 256 color SVGA or better, Double-speed or higher CD-ROM drive, Sound Card, or
Macintosh ® PowerPC 100 ® or 100 percent compatible System 7.5.3, 16 mb of RAM, 256-color or better, Netscape Navigator ® 3.0 with MPG plug-in Double-speed or higher CD-ROM drive.

To order, contact: National Education Data Resource Center, c/o Pinkerton Computer Consultants, Inc., 1900 N. Beauregard St., Suite 200, Alexandria, VA 22311-1722; Telephone: (703) 845-3151; Fax: (703) 820-7465; E-mail: ndrc@inet.ed.gov; Internet address: http://www.ed.gov/pubs/ncesprograms/elementary/others/ndrc.html

WHERE CAN I FIND OUT WHAT TIMSS HAS LEARNED ABOUT CURRICULUM?

***A Splintered Vision: An Analysis of U.S. Mathematics and Science Curricula*, 1997—This book enunciates the argument that mathematics and science curricula in U.S. schools suffer from a lack of focus. The authors contend that in their effort to canvas as many topics as possible, both teachers and textbook publishers fail to delve into the most important subjects with sufficient depth. 176 pp. Hardback ISBN: 0-7923-4440-5, $87; Paperback ISBN: 0-7923-4441-3, $49.**

To order, contact: Kluwer Academic Publishers Group, Order Department, P.O. Box 358, Accord Station, Hingham, MA 02018-0358; Telephone: (617) 871-6600; Fax (617) 871-6528; E-mail: kluwer@wkap.com; Internet: http://www.wkap.nl or http://ustimss.msu.edu/publicat.htm.

***Many Visions, Many Aims: Volume 1, A Cross-National Exploration of Curricular Intentions in School Mathematics*, 1997—An analysis of mathematics curriculum guides and textbooks in 50 countries. This report looks at the sequence and the topics covered from kindergarten through the end of secondary school, analyzed in a comparative framework. 286 pp. Hardback ISBN: 0-7923-4436-7, $120; Paperback ISBN: 0-7923-4437-5, $55.**

To order, contact: Kluwer Academic Publishers Group, Order Department, P.O. Box 358, Accord Station, Hingham, MA 02018-0358; Telephone: (617) 871-6600; Fax (617) 871-6528. E-mail: kluwer@wkap.com; Internet: http://www.wkap.nl or http://ustimss.msu.edu/publicat.htm.

***Characterizing Pedagogical Flow: An Investigation of Mathematics and Science Teaching in Six Countries*, 1996—Describes the results of the Study of Mathematics and Science Opportunity (SMSO) survey, which investigated curriculum content and instructional methods in France, Japan, Norway, Spain, Switzerland, and the United States using case studies in each participating country. 229 pp. Hardback ISBN: 07923-42720, $110; Paperback ISBN: 07923-42739, $49.**

To order, contact: Kluwer Academic Publishers Group, Order Department, P.O. Box 358, Accord Station, Hingham, MA 02018-0358; Telephone: (617) 871-6600; Fax (617) 871-6528. E-mail: kluwer@wkap.com; Internet: http://www.wkap.nl or http://ustimss.msu.edu/publicat.htm.

***TIMSS Monograph Series No. 3 Mathematics Textbooks: A Comparative Study of Grade 8 Texts*, 1995—Geoffrey Howson, Emeritus Professor of Mathematical Curriculum Studies at the University of Southhampton, England, examines eight mathematics textbooks for 13-year-olds for their pedagogical and philosophical similarities and differences. Texts are from the United States, the Netherlands, the United Kingdom, Norway, Spain, France, Switzerland, and Japan. Paperback, 96 pp. ISBN: 1-895766-03-6. $16.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca.

WHERE CAN I FIND OUT MORE ABOUT THE METHODOLOGY OF TIMSS?

***Third International Mathematics and Science Study: Quality Assurance in Data Collection*, 1996—A report on the quality assurance program that ensured the comparability of results across participating countries. The program emphasized instrument translation and adaptation, sampling response rates, test administration and data collection, the reliability of the coding process, and the integrity of the database. 93 pp. + 91 pp. Appendix.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax (617) 552-8419; E-mail: timss@bc.edu; Also, may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

Third International Mathematics and Science Study: Technical Report, Volume 1 Design and Development, **1996—This report describes the study, design, and development of TIMSS up to, but not including, the operational stage of main data collection. Paperback, 149 pp. + 40 pp. Appendix.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu; Also, may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

TIMSS Monograph Series No. 1 Curriculum Frameworks for Mathematics and Science, **1993—This monograph explains the study's foci and its key first step – the development of the curriculum frameworks that served as the guide for designing the study's achievement tests. The frameworks are included in the appendices. Paperback, 102 pp. ISBN: 0-88865-090-6. $16.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4. Telephone: (604) 822-5385. Fax: (604) 822-6603. E-mail: cedwards@interchange.ubc.ca.

TIMSS Monograph Series No. 2 Research Questions and Study Design, **1996—This monograph presents the study's research objectives along with discussions that include: the impact of prior studies on the design of TIMSS; how the research questions were derived from TIMSS' conceptual framework; and how the research questions and test items were tailored to meet the contexts of the participating countries. Paperback, 112 pp. ISBN: 1-895766-02-8. $17.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca.

WHERE CAN I READ THE ACTUAL TEST ITEMS GIVEN TO STUDENTS?

TIMSS Mathematics Items Released Set for Population 2 (Seventh and eighth grades)—**All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 142 pp. $20 (+ $5 shipping and handling, if international).**

TIMSS Science Items Released Set for Population 2 (Seventh and eighth grades)—**All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 127 pp.**

$20 (+ $5 shipping and handling, if international).

TIMSS Mathematics Items Released Set for Population 1 (Third and fourth grades)—**All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback. $20 (+ $5 shipping and handling, if international).**

TIMSS Science Items Released Set for Population 1 (Third and fourth grades)—**All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback. $20 (+ $5 shipping and handling, if international).**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu; Also, can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

HOW CAN I FIND OUT MORE ABOUT EDUCATION IN VARIOUS TIMSS COUNTRIES?

National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS, **1997—Each participating country's education system is discussed in a separate chapter, considering geographic and economic influences, school governance, teacher education, curriculum, and other factors. Hardback, 423 pp. $75.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca

APPENDIX 2
ADVISORS TO THE U.S. TIMSS STUDY

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University of California

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Global M

Kenneth Travers
University of Illinois

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APPENDIX 3
NATIONAL AVERAGE SCORES AND STANDARD ERRORS

The 95 percent "plus or minus" confidence interval around each nation's score is two times the standard error.

	MATHEMATICS		SCIENCE	
NATION	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
(AUSTRALIA)	546	3.1	562	2.9
(AUSTRIA)	559	3.1	565	3.3
CANADA	532	3.3	549	3.0
CYPRUS	502	3.1	475	3.3
CZECH REPUBLIC	567	3.3	557	3.1
ENGLAND	513	3.2	551	3.3
GREECE	492	4.4	497	4.1
HONG KONG	587	4.3	533	3.7
(HUNGARY)	548	3.7	532	3.4
ICELAND	474	2.7	505	3.3
IRAN, ISLAMIC REP.	429	4.0	416	3.9
IRELAND	550	3.4	539	3.3
(ISRAEL)	531	3.5	505	3.6
JAPAN	597	2.1	574	1.8
KOREA	611	2.1	597	1.9
(KUWAIT)	400	2.8	401	3.1
(LATVIA (LSS))	525	4.8	512	4.9
(NETHERLANDS)	577	3.4	557	3.1
NEW ZEALAND	499	4.3	531	4.9
NORWAY	502	3.0	530	3.6
PORTUGAL	475	3.5	480	4.0
SCOTLAND	520	3.9	536	4.2
SINGAPORE	625	5.3	547	5.0
(SLOVENIA)	552	3.2	546	3.3
(THAILAND)	490	4.7	473	4.9
UNITED STATES	545	3.0	565	3.1

MATHEMATICS INTERNATIONAL AVERAGE = 529

SCIENCE INTERNATIONAL AVERAGE = 524

Note: Nations not meeting international guidelines are shown in parentheses.

Source: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA.

APPENDIX 4

SUMMARY OF NATIONAL DEVIATIONS FROM INTERNATIONAL STUDY GUIDELINES

Eleven of the 26 TIMSS countries experienced a more or less serious deviation from international guidelines for execution of the study. In 9 countries, the TIMSS International Study Center considered the deviations to be sufficiently serious to raise questions about the confidence to be placed in their scores. These 9 nations with major difficulties are noted with an asterisk.

***Australia**—Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 69 percent after replacements for refusals were substituted.

***Austria**—Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. The initial participation rate was 49 percent for schools before replacement. Participation rate was 69 percent after replacements for refusals were substituted.

England—More than the international criterion of ten percent of schools and students were excused from the test for various reasons, with resulting coverage of 88 percent of the desired population. Participation rate of 83 percent of schools and students combined was achieved only after replacements for refusals were substituted.

***Hungary**—International guidelines for sampling procedures at the classroom level were not followed.

***Israel**—International guidelines for sampling procedures at the classroom level were not followed. The test was administered only in the Hebrew-speaking public school system. Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. Israel tested only the fourth grade, in contrast to other nations that tested the two adjacent grades containing the most 9-year olds. Participation rate was 38 percent both before and after replacements for refusals were substituted.

***Kuwait**—International guidelines for sampling procedures at the classroom level were not followed. In contrast to other nations that tested two adjacent grades, Kuwait tested the fifth grade, which contained relatively few 9-year olds.

***Latvia** (LSS)—Test administered only in Latvian-speaking schools, with resulting coverage of 60 percent of the desired population. Because coverage fell below the international 65 percent population-coverage criterion, Latvia is designated (LSS) for Latvian-speaking schools.

***Netherlands**—Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. The initial participation rate before replacement was 29 percent. Participation rate was 59 percent after replacements for refusals were substituted.

Scotland—Participation rate of 76 percent of schools and students combined was achieved only after replacements for refusals were substituted.

*__Slovenia__—Students tested were older than those in other countries because Slovenia did not test the two grades with the most 9-year olds.

*__Thailand__—International guidelines for sampling procedures at the classroom level were not followed. The sample included a high percentage of older students.

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OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT
U.S. DEPARTMENT OF EDUCATION

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ATTAINING
EXCELLENCE

TIMSS AS A STARTING POINT TO EXAMINE U.S. EDUCATION

DISCUSSION GUIDE FOR "A VIDEO PRESENTATION OF *PURSUING EXCELLENCE*"

U.S. DEPARTMENT OF EDUCATION
OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT

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Media and Information Services
Cynthia Hearn Dorfman
Director

September 1997

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The Widmeyer-Baker Group

Contents

TIMSS Overview and Key Findings from *Pursuing Excellence*

With information on a half-million students worldwide, including more than 33,000 U.S. youth in more than 500 U.S. public and private schools, the Third International Mathematics and Science Study (TIMSS) conducted in 1995 is the largest, most comprehensive, and most rigorous international study of schools and students ever conducted. Students from 41 nations, including our country's major trading partners, were tested at three different grade levels (fourth, eighth, and upon completion of secondary school) to compare their mathematics and science achievement.

TIMSS researchers conducted intensive studies of students, teachers, schools, curricula, instruction, lessons, textbooks, and policy issues to understand the educational context in which mathematics and science learning take place. By combining multiple methodologies and scientific sampling procedures that go beyond simple student test score comparisons and questionnaires, TIMSS created a complete and accurate portrait of how U.S. mathematics and science education differs from that of other nations.

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context was the first TIMSS report released by the Office of Educational Research and Improvement, U.S. Department of Education, in November 1996. Key findings include the following:

- U.S. eighth graders score below average in mathematics achievement and above average in science achievement, compared to the overall average of the 41 nations in the TIMSS assessment.
- In mathematics, our eighth-grade students' international standing is stronger in Algebra and Fractions than in Geometry and Measurement.
- In science, our eighth graders' international standing is stronger in Earth Science, Life Science, and Environmental Science and the Nature of Science than in Chemistry and Physics.
- The United States is one of 11 TIMSS nations in which there is no significant gender gap in eighth-grade mathematics and science achievement.
- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.
- Most U.S. mathematics teachers report familiarity with reform recommendations, although only a few apply the key points in their classrooms.
- Evidence suggests that U.S. teachers do not receive as much practical training and daily support as their Japanese and German colleagues.

No single factor can be considered to influence student performance in isolation from other factors. There are no simple answers to complex questions.

(continued on reverse)

The fourth-grade report, *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, was released by the Office of Educational Research and Improvement, U.S. Department of Education, in June 1997. Key findings include the following:

- U.S. fourth graders score above average in both mathematics and science, compared to the 26 nations in the assessment. In science, only Korea outperforms the United States.
- U.S. students' international standing is stronger at the fourth-grade level than it is at the eighth-grade level in both mathematics and science.
- U.S. students' international standing is stronger in science than it is in mathematics at both the fourth- and eighth-grade levels.
- In mathematics, 9 percent of U.S. fourth graders would rank among the world's top 10 percent. In science, 16 percent of U.S. fourth graders would rank among the world's top 10 percent.
- In mathematics content areas, our fourth graders' performance exceeds the international average in Whole Numbers, Fractions, Data Representation, Geometry, and Patterns. Our students are below the international average in Measurement.
- In science content areas, our fourth graders' performance exceeds the international average in all four of the areas assessed: Earth Science, Life Science, Physical Science, and Environmental Issues and the Nature of Science.
- There is no significant gender gap in fourth-grade mathematics achievement. However, in some content areas of fourth-grade science, U.S. boys outperform U.S. girls.
- Differences between the U.S. average and the international average for most factors which might influence achievement are relatively small. Many factors in which the U.S. average exceeds the international average at the fourth-grade level are not shared by the countries that outperform us.
- Many factors in the United States are similar at both fourth- and eighth-grade levels. Because many of the differences between the grades in the United States also characterize many other TIMSS countries, they cannot account for differences in our students' relative performance at these grade levels.

TIMSS provides a lens through which we can see our nation's education in comparative perspective and identify aspects of education that deserve our attention.

TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and by the National Science Foundation.

For more information on TIMSS, or to download TIMSS reports, visit the World Wide Web site at http://www.ed.gov/NCES/timss. Or, call the TIMSS Customer Service Line at (202) 219-1333. Or, write to Lois Peak, TIMSS Project Officer, National Center for Education Statistics, U.S. Department of Education, 555 New Jersey Avenue, NW, Washington, DC 20208-5574.

How to Use This Guide

The rich body of data gathered through the Third International Mathematics and Science Study (TIMSS) is a virtual treasure trove to be mined by those interested in understanding more about the strengths and needs of the U.S. education system.

This guide is designed to help individuals and groups effectively view and discuss the implications of *A Video Presentation of Pursuing Excellence: U.S. Eighth-Grade Findings from TIMSS.* The videotape provides a brief introduction to the first set of TIMSS findings, the largest, most comprehensive, and most rigorous examination of students and schools in 41 countries. The guide also includes a variety of suggestions to help a discussion moderator plan, promote, and lead an effective group exploration of TIMSS data.

Given the enormous value of TIMSS data, there may be many opportunities to organize a group discussion—whether you are a PTA leader, a school board member, a teacher's union representative, a concerned business leader, or a member of the community at large interested in hosting a public forum aimed at improving teaching and learning in your state or locale. Feel free to draw upon the enclosed materials, or adapt them to meet your needs, to set the context for further action on school improvement efforts in your community.

Reviewing the video with this accompanying guide will provide individual viewers or those assembled for group discussion with an opportunity to:

- Examine how well young people and our schools compare to others internationally.
- Dispel some commonly held myths.
- Consider what the TIMSS findings mean for the future of our young people, communities, and the nation.
- Recognize the value of using TIMSS in ongoing education reform.
- Think about ways to continue assessing student achievement across the country.
- Explore the next steps your community can take.

Specifically, you will learn about what our eighth graders—and their counterparts in other countries—know and don't know. You will consider what factors may have influenced the results and reflect on ways to use the TIMSS information in education improvement efforts underway in your state, local community, or school.

The video and this video guide are part of the set of materials developed by the U.S. Department of Education to help educators and the public better understand and use the rich reservoir of TIMSS information. The National Center for Education Statistics, which is part of the U.S. Department of Education, will release additional reports on TIMSS findings during 1998.

Why You Can Count on TIMSS Information

TIMSS is a fair and accurate comparative study, employing careful quality-control procedures. To enrich its findings, the study employed five different types of inquiry—assessment of student achievement, questionnaires, curriculum analysis, videotapes of classroom instruction, and case studies of policy topics.

TIMSS does not compare all U.S. students with the best and brightest from other countries—a charge that has been leveled against previous international comparisons. Instead, it compares all of our students with all of the students tested in TIMSS countries. The study also marks a milestone in the history of educational assessment.

It moves beyond just comparing academic proficiency to providing analyses of the factors that relate to proficiency—curricula and textbooks used in various countries, what and how teachers teach, and ways in which teachers and students spend their time on academic matters both inside and outside the classroom.

TIMSS information helps us answer the following questions about U.S. mathematics and science learning:

- Are U.S. curricula and expectations for student learning as demanding as those of other nations?
- How does U.S. mathematics instruction compare with that in other countries?
- Do U.S. teachers receive as much support in their efforts to teach students as do their colleagues in other countries?
- Are U.S. students as focused on their studies as are their peers in other countries?

TIMSS is also a valuable resource for local communities and states seeking ways to improve their schools. Through TIMSS, communities can:

- Compare students' achievement with that of peers in other countries.
- Examine similarities and differences among science and mathematics curricula in various countries.
- Explore how teaching styles in the United States compare to those in other countries.
- Recognize the importance of raising local standards and achievement for all.

In short, TIMSS is a rich source of information—combining quantitative data on how students perform on tests with qualitative research into the teaching and learning processes. TIMSS offers important insights to researchers, educators, policymakers, parents, and others concerned with the quality of education in the United States.

Mathematics and Science— Critical Knowledge for Today and Tomorrow

In the not-so-distant past, many people could get by without a first-rate education. But today, low-skilled jobs are disappearing, and the manual labor jobs that remain increasingly require technological understanding. Now, auto mechanics need to understand the computers built into cars.

Spare-time scuba divers, gardeners, home-repair do-it-yourselfers, and mountain climbers use complex concepts and strategies of physics, life sciences, and environmental safety without thinking twice. Everyone, from new high school graduates to retirees, needs to be able to apply advanced mathematics skills to comparison shop, budget, and invest, using the newest financial technologies. Today, mathematics and science are important to career advancement and community life.

Are You Concerned with Questions Like These?

As a parent, do you wonder...

- How do I know if my child is doing challenging mathematics?
- How can I evaluate his or her performance effectively?
- How can I help him or her gain needed mathematics and science skills for the world of work?

As an employer, do you wish you could...

- Find workers with needed mathematics and science skills?
- Show more support for mathematics and science education?

As a concerned citizen, do you want to know...

- How to determine if the schools are doing a good job?
- What information is available?
- Where to invest public dollars wisely?

As a committed educator, do you know...

- What our schools and communities can do to improve excellence in mathematics and science education?
- Why students are not achieving as they might?
- How we gather and analyze data about educational performance?

If so, TIMSS Should Matter to You!

THE BUSINESS PERSPECTIVE— EYE-OPENING FACTS FOR EMPLOYERS AND JOB SEEKERS

Fundamental economic and technological changes in this country over the past decade have made high levels of mathematics and science performance necessary for success in college and the job market, as various reports and studies conducted over the past few years indicate.

Recent research from a variety of sources suggests:

- High school algebra and geometry serve as the gatekeepers to college and high-level careers.
- The college attendance gap between minority and Caucasian students vanishes among minority students who take advanced mathematics.
- African Americans who have not taken college preparatory mathematics have only one chance in 40 of graduating from college.
- Over half of the chief executive officers (CEOs) in the fastest growing companies in the United States say that the lack of skilled workers poses a barrier to business growth.
- One out of every three job applicants (33 percent), tested by 961 U.S. companies, lacked the reading or mathematics skills required for the job.

A 1997 study by the National Center for Education Statistics showed that:

- As much as 20 percent of the increase in worker productivity is due to increases in workers' education.

High levels of mathematics proficiency are required for entry-level jobs, for example:

- Current standards in manufacturing call for workers to be able to perform sophisticated mathematical tasks.
- The chemical industry asks workers to use differential calculus to determine various rates.
- An industry-adopted skill standard for automobile technicians requires them to solve circuit parameter calculations using formulas such as Ohm's Law.
- Intel, the electronics giant, requires entry-level workers to have one year of high school or college chemistry, physics, and electronics and a "firm grasp of basic science."

Questions to Consider

Before viewing the video, take a few minutes to consider and discuss the following questions:

- With which countries should we be concerned about comparing ourselves?
- What can we learn from studying schools in other countries?

After viewing the video, reflect upon these and other general and specific questions—comparing what you learned to what you thought you knew. You may want to jot down your own thoughts and highlights from the group's discussion.

- Were there any surprises in the video? Did you learn something you did not expect to learn?
- What challenges do we face in this community in terms of mathematics and science achievement? Curriculum and teaching?
- What are we going to do about it? What ideas do you have to meet these challenges?

Specific Issues of Concern

While you may not have time today to consider many of the questions the video raised in your mind, it is important to note them for future discussion and action. They suggest that good, accurate information matters—if you and other local leaders, concerned citizens, and parents want to build a secure economic future and a healthy, satisfying lifestyle for your children and communities. Let's look at some of the issues that should be considered in district-wide school and classroom education improvement efforts.

- All German and Japanese students study algebra in the eighth grade. In the United States, only a small number of students enroll in eighth-grade Algebra.

What percentage of eighth-grade students in your school district take Algebra?

How should we expand this percentage?

- Germany sorts students into academic, vocational, and general schools at the middle and high school levels. Japan has no tracking at all in the eighth grade, but conducts competitive entrance exams for different high schools between ninth and tenth grades. In both Germany and Japan, all students study generally the same mathematics. The United States has both informal and formal tracks in middle school, and the different groups study quite different mathematical content.

What is the profile of your school district?

What are the advantages and disadvantages of these systems?

Are all of our students getting the opportunity to take the mathematics and science they need for satisfying careers?

- TIMSS reports that our schools' eighth-grade mathematics curricula include more topics than the international average. In Japan, a lesson could devote a whole period to just two problems.

How can our schools achieve the best balance of depth and breadth?

- Germany's curricula are determined by state governments, Japan's by the national government.

Who controls U.S. curricula?

What is the role of test makers, textbook publishers, teacher groups, and so on?

What is the role of state or voluntary national standards for teaching and learning?

Are we asking enough of students in our district?

- The TIMSS video analysis of classrooms found that our teachers usually concentrate on having the students learn how to do something (how to use the Pythagorean theorem to find the length of the third side of a triangle when the lengths of two are known), while Japanese lessons focus on having the students understand something (why the square of the third side of a triangle equals the sum of the squares of the other two sides).

  What is the general practice in our schools?

  What impact does this have on the knowledge and skills of our students?

- In the United States, we like to think that our lessons encourage problem solving and develop creative-thinking skills. The TIMSS videotape study of actual classroom teaching found that U.S. teachers usually state concepts, rather than allowing students to develop the concepts themselves.

  What are we doing in our classrooms?

  Why do you think we do this?

  What do you think should change?

- TIMSS illustrates the value of good data for making informed decisions. Valid, reliable information helps us to make needed education reforms and can guide development of coherent district policies and effective teaching/learning practices.

  What percentage of our students take advanced mathematics and science?

  How do we know if our schools are doing a good job in mathematics instruction?

  How do our district schools stack up internationally?

  What information is available?

  What information should be available?

- In the United States, we have a decentralized public school system. Each of our states has its own policies and practices for licensing and credentialing teachers.

  What do teachers in your state need to know about mathematics and/or science content and the process of teaching those subjects in middle and junior high schools?

  What are we doing to make sure they stay up-to-date?

  What does our district look for in a teacher?

  How concerned are we with teachers' mathematics and/or science knowledge?

  How do we measure what a teacher knows and can do?

  How do we measure high-quality teaching? Faculty turnover?

- Thoughtful consideration leads to well-founded action. In thinking through what can be gained from the TIMSS information, we may wish to shift to more practical questions about what our community can and should do.

  Are any of these issues important enough to seek answers now?

  How should we proceed?

Next Steps

TIMSS helps clarify the status of U.S. education by holding up a mirror to what we do and by comparing the results with those from other countries. International comparisons provide a way of ranking and judging performance. They also allow us to have greater insight into our own methods of education. Such a comparison exposes assumptions that have been taken for granted and reveals long-neglected alternatives.

The purpose of international studies is not to suggest that any given practice be copied directly from a different country, but that we can make our own unique processes of education more effective by gaining additional information through comparisons with other nations and other systems.

Improving local schools and districts is the responsibility of every parent, businessperson, educator, and citizen. We can use TIMSS as a resource to educate and motivate each other. The TIMSS video, this *Discussion Guide*, and other resources can be used by communities to reflect on their own schools and determine the best ways to improve them.

However, not all information leads to action or even changed opinions. In general, improvement does not take place unless people are committed to an issue and have sufficient information and a solid consensus on the right strategy to pursue. Therefore, as you consider how to best use TIMSS to improve mathematics and science education in your district, remember that people must take gradual steps in making and acting on informed judgments.

Special Notes for Discussion Moderators

Thank you for taking responsibility for organizing a special event aimed at helping people in your community learn more about TIMSS—the Third International Mathematics and Science Study. This section of the guide contains useful information that will help you to plan and conduct a successful group discussion on TIMSS. Additional resources that you can use to facilitate a discussion are available in a series of publications included in *Attaining Excellence: A TIMSS Resource Kit.* Specifically, you may wish to draw upon the booklet *Introduction to TIMSS: The Third International Mathematics and Science Study*, which contains presentation overheads and talking points on TIMSS findings. Another publication in the kit, *Benchmarking to International Achievement*, provides sample problems from the TIMSS eighth-grade mathematics test.

Successful Community Meetings

Convening a community meeting to discuss TIMSS and its implications is an important way to facilitate the process of learning from TIMSS to improve education in your schools. The discussion will allow you to start the conversation about what your community needs from its education system so that students have world-class proficiency in science and in mathematics. The opportunity to talk about the current condition of your community's science and mathematics programs and where they should be headed can give everyone a better understanding of the changes that are needed.

Below are some ideas to consider as you plan your community discussion meeting about the video.

- *The effort should not be in isolation from other education improvement initiatives under way in your community.* Instead, look for ways during the meeting for the group to recognize that the effort should be part of a larger direction being taken—whatever the stage of effort.
- *The meeting should include a broad range of people who can contribute their unique perspectives to the discussions* and should be held in a location and at a time that attracts as many participants as possible. If you find that more than 20 to 50 people indicate interest or RSVP their attendance, you can easily arrange for smaller groups of 10 to 15 to sit in separate circles, or around different tables, to facilitate giving everyone a chance to participate in the discussion exercises.
- *Please be sure to identify participants ahead of time.* It may be useful to invite leaders from key organizations to act as spokespersons or lead smaller discussion groups. Invite representatives from any existing coalitions of individuals and organizations that are currently involved in education reform. Be sure to include among your invitees those who are parents, teachers, school administrators, representatives of the teaching profession/unions, religious leaders, local government officials, the local newspaper editor, TV and radio talk

show hosts, business leaders, and representatives of local service and volunteer groups. And, if you really want an interesting discussion, try to include a good representation of students.

- *Advertise.* Everybody needs to know about the community meeting. Pertinent details include when and where it will be held, what will be discussed, and why it is important to attend. The more people understand, the fewer surprises there will be down the road.
- *Develop an agenda.* If you were to conduct a meeting using all of the questions in this guide, it would most likely take an entire evening or afternoon. If you have only an hour or two as part of another meeting to spend on the discussion, feel free to use what you need from this guide—carefully picking and choosing from the exercises to arrive at an agenda that does what you want it to. Remember, if your meeting has punch and relevance, no matter how short it is, interested participants will likely return for a follow-up discussion or planning meeting.
- *Choose a facilitator wisely, and be sure to have helpers to assist with smaller group discussions if your participant list grows.* An organized discussion about mathematics and science education reform is not likely to happen spontaneously. It will be necessary to have a facilitator to help direct and keep the discussion focused. The facilitator must be adept at encouraging audience participation. He or she will need to ensure that no single person monopolizes the discussion and that shy people are encouraged to speak. The facilitator will bring the discussion to a close and guide the audience to decisions about actions and/or follow-up steps that need to be taken. Above all, the facilitator should have a good working knowledge of your community, its goals for education, and reform efforts already in progress, as well as the dynamics within your school district and community.
- *Develop and disseminate materials.* In addition to the flyers, posters, and news releases; meeting sign-in sheets; and other materials that you will have prepared, make sufficient copies of a meeting agenda, this guide, and any handouts so that you have enough to distribute to all who attend the meeting. You may find it useful to prepare a separate facilitator's guide and a small-group moderator's guide as well. They can be created from selected contents of this publication.

Tips for Stimulating a Good Group Discussion

Experienced group facilitators find that they can stimulate healthy, productive discussion in many ways. They literally look into the eyes of a participant and ask an opinion, then move on to another person the same way. They often ask people to think about what they want to contribute to a particular part of the session by putting their thoughts on paper, using a worksheet.

Tip 1—To Focus on a Discussion Topic, Try to "Define, Personalize, and Challenge."

To introduce exercises or just to focus discussion on a new topic or question to the group, you may want to use the following tried-and-true techniques: Define the topic for discussion, ease into it and "try it on" for the group by offering a personal response, and then challenge the group to add their comments to yours. Here is some advice about using this technique effectively.

- *Introduce the exercise with clarity and purpose.* You should be able to explain what you will be doing and why in a few sentences.
- *Personalize the charge to the group by offering an example,* preferably one that reveals something about you as an individual.
- *Challenge the group.* Ask them to carry out the purpose of the exercise and provide them with clear directions to do so.

Tip 2—Try Asking Open-Ended Questions to Stimulate Lively, Creative Thinking.

Some of the "Questions to Consider" included in this *Guide* are open ended. They stimulate discussion because they elicit many right answers from participants. If they are thought through, most answers to open-ended questions are equally acceptable and will truly cause the discussion to take off. In fact, you may have to work at keeping the discussion focused on the topic, not the novelty of the individual answers!

Tip 3—Always Provide Answers for Factual Questions You Pose, After You Ask Them.

If you choose to focus the discussion on findings from the TIMSS study, discuss the correct answers thoroughly. This will reinforce the link in participants' minds between the questions posed by the exercise and the factual answers derived from TIMSS findings and conclusions.

If, however, you want to focus on drawing out implications of the TIMSS findings, review the answers quickly and spend more time with the group considering the impact of myths that have been dispelled, conclusions that can be made, and what might be done about the issue at the local level.

Tip 4—Establish and Honor a Structure and Time Frame for the Discussion.

Nothing is worse than taking part in a discussion that drags, being forced to spend time on some intrusive tangent, or lingering on a topic long after it has been exhausted. Make sure to honor your prepared agenda and best time "guesstimates."

- *Be flexible.* If it looks like something is not working, quickly bring the discussion to a close. Pick up the pace and move on.
- *Introduce each major discussion segment with a time note.* Let the group know the time allotted to the topic or how long you think the group will take to complete the exercise. It also helps to give folks some warning that the time limit is approaching. "We've got five more minutes for you to trade ideas with your partner before convening the large group to share them," or, "Let's hear these last two comments before we move on."

Tip 5—For Successful Closure, Reemphasize Major TIMSS Findings.

Even if the discussion has moved the group to consider follow-up steps to the meeting, the initial community discussion must still be brought to closure. One good approach for ending the session is to indicate that the discussion has been fruitful and to ask several participants to volunteer something each has learned as a result of attending.

You may also want to distribute copies of the handout titled "TIMSS Overview and Key Findings from *Pursuing Excellence,*" featured at the beginning of this guide. The handout summarizes the eighth-grade and fourth-grade TIMSS reports in the *Pursuing Excellence* series. Participants can use the handout in many ways—as a quick reference in talking about the community discussion with others or for redistribution within their respective organizations.

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LEARNING FROM TIMSS: HOW DOES U.S. EDUCATION COMPARE INTERNATIONALLY?

Curious about how math and science education in the United States compares with that of 40 other countries?

The Third International Mathematics and Science Study (TIMSS)—the largest, most comprehensive international comparison of mathematics and science education—provides a lens through which educators can see themselves in international perspective.

Attaining Excellence: A TIMSS Resource Kit uses the information learned from TIMSS to help educators, practitioners, policymakers, and concerned citizens reflect deeply upon their own local practices. The TIMSS Resource Kit will help you find out:

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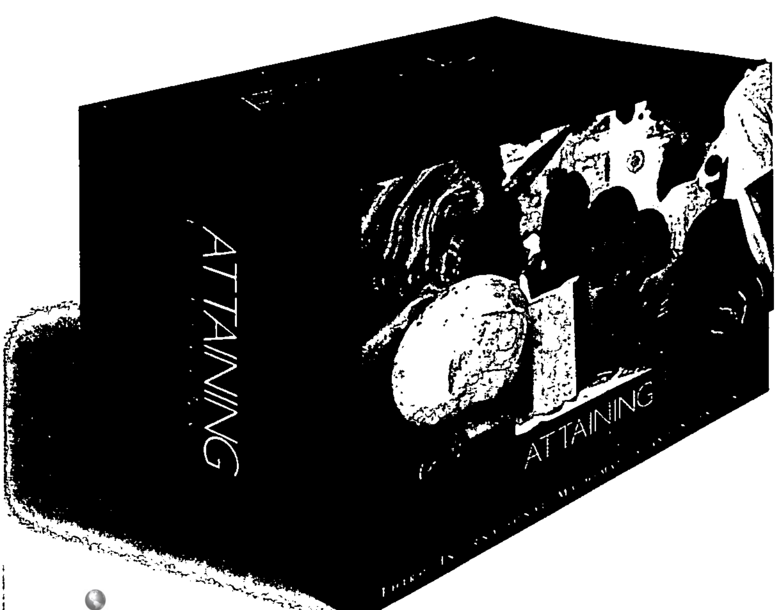

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The Resource Kit contains a guide to the kit and four modules: U.S. Education, Student Achievement, Teaching, and Curricula. The contents of each module are described to the right. Please note that the modules and most individual items may also be purchased separately.

U.S. Education Module

Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education
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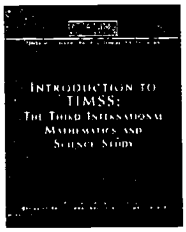

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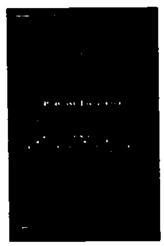

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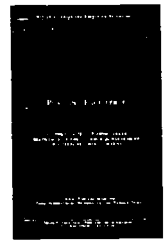

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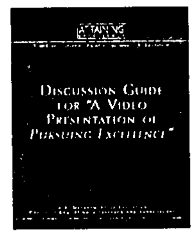

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This module, designed for individual or small-group use, features the following publications and makes the TIMSS findings relevant to local decision makers, educators, and parents:

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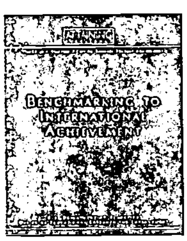

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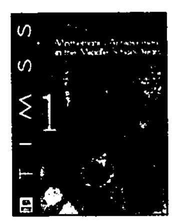

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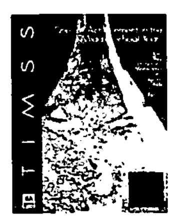

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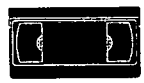

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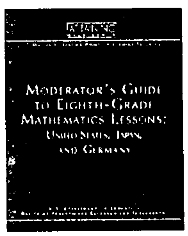

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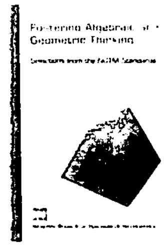

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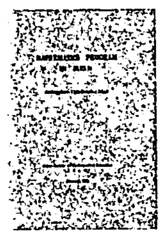

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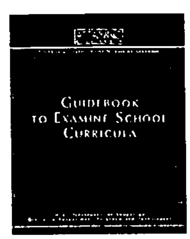

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The kit—based on the world's largest, most comprehensive, and most rigorous international comparison of mathematics and science education—will help state and local policymakers, educators, and citizens compare their education systems with those of other countries. This represents the most comprehensive effort to date by the U.S. Department of Education to assemble significant research findings and present them in a format that can be used by educators for discussion.

TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and the National Science Foundation. The study tested the mathematics and science knowledge of students in 41 countries during the 1995 school year.

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September 1997

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Contents

Introduction

The reports of the Third International Mathematics and Science Study (TIMSS) provide a starting point to examine U.S. student achievement in an international context. *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study* and *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study* summarize mathematics and science achievement for seventh and eighth graders in 41 countries around the world. They are included in this module of the TIMSS Resource Kit. Another report that focuses primarily on U.S. findings for the middle school years, *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context,* is also available in the first module of this Resource Kit, *Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education.*

The TIMSS reports containing results for seventh and eighth graders represent the first in a series. Ordering information for the two corresponding publications presenting the mathematics and science results for third and fourth graders can be found on the last page of this booklet. TIMSS results for students in the final year of secondary school will be available in spring 1998.

The data in these international reports provide a wealth of information about achievement and instructional practices in the United States as compared with other countries. For example, overall national performance is examined in light of students' responses to individual test questions. The reports also include information about selected curriculum, teacher, classroom, and home factors.

This booklet illustrates how the different types of information found in the international reports can provide a crucial springboard for in-depth reflection about the strengths and weaknesses of education efforts in the United States, at the national, state, and local levels.

By highlighting some of the eighth-grade findings from TIMSS, this booklet aims to help readers better understand how TIMSS can serve as a tool for education reform. Policymakers and educators can compare the findings of TIMSS with local student performance and educational practices in order to facilitate reform initiatives.

TIMSS

About TIMSS...

TIMSS is the largest and most ambitious study of comparative educational achievement ever undertaken. In total, TIMSS achievement testing in mathematics and science involved:

- more than 40 countries;
- 5 grade levels (3rd, 4th, 7th, 8th, and 12th);
- more than a half-million students;
- testing in more than 30 languages;
- more than 15,000 participating schools;
- millions of written responses to open-ended questions;
- performance assessment; and
- student, teacher, and school questionnaires about the contexts for schooling.

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality-control observers monitored testing sessions. The procedures for sampling the students tested in each country were scrutinized according to rigorous standards designed to maximize inclusion, prevent bias, and ensure comparability.

TIMSS is the most recent in a series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). The IEA has been providing comparative information about educational achievement and learning contexts to policymakers, educators, researchers, and practitioners since 1959. The International Study Center for TIMSS is located at Boston College. International activities are funded by the National Center for Education Statistics (NCES) of the U.S. Department of Education and the U.S. National Science Foundation (NSF). Each country provides its own funding for the national implementation of TIMSS. In the United States, TIMSS was also funded by NCES and NSF.

U.S. Achievement in International Context

The technological and economic contexts of our world are undergoing rapid changes. Because education is central in preparing individuals and nations to take the best advantage of these changes, information about excellence in academic achievement has become increasingly important. International comparative studies provide empirical data about the quality of a nation's educational system as viewed from the perspective of the global community.

For example, recent results from the National Assessment of Educational Progress (NAEP) show improvements since 1990 in mathematics achievement at all three grades tested: 4, 8, and 12. This is good news indeed. One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. The TIMSS results for fourth-grade students show promise toward reaching this goal. In science, students in only one country outperform U.S. fourth graders—Korea. In mathematics, U.S. fourth graders score above the international average; but students in seven countries—Singapore, Korea, Japan, Hong Kong, Netherlands, Czech Republic, and Austria—outperform U.S. fourth graders.

Despite these encouraging signs for education in the United States, the TIMSS results for eighth graders show that we have a long way to go to fully reach our goal (see Table 1). Compared to the other countries participating in TIMSS, the relative performance of U.S. eighth graders was well below that of U.S. fourth graders. Even though the average achievement of U.S. eighth graders resembles that of other major industrialized nations like Canada, England, and Germany, by and large, the international performance standards in middle school mathematics and science are being set by Singapore, Japan, and Korea. The TIMSS achievement results provide several interesting perspectives from which to view the overall performance of U.S. eighth graders compared with those of the top-performing countries.

- Besides top-performing Singapore, Korea, and Japan, Hong Kong also performs well in mathematics, as does Belgium (Flemish) and Czech Republic. In contrast, U.S. eighth graders score below the international average of the 41 TIMSS countries. In no other

Table 1

Eighth-Grade Achievement in Mathematics and Science: Nations' Average Performance Compared to the United States*

MATHEMATICS

NATION	AVERAGE
NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
SINGAPORE	643
KOREA	607
JAPAN	605
HONG KONG	588
BELGIUM-FLEMISH	565
CZECH REPUBLIC	564
SLOVAK REPUBLIC	547
SWITZERLAND	545
(NETHERLANDS)	541
(SLOVENIA)	541
(BULGARIA)	540
(AUSTRIA)	539
FRANCE	538
HUNGARY	537
RUSSIAN FEDERATION	535
(AUSTRALIA)	530
IRELAND	527
CANADA	527
(BELGIUM-FRENCH)	526
SWEDEN	519
NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
(THAILAND)	522
(ISRAEL)	522
(GERMANY)	509
NEW ZEALAND	508
ENGLAND	506
NORWAY	503
(DENMARK)	502
UNITED STATES	**500**
(SCOTLAND)	498
LATVIA (LSS)	493
SPAIN	487
ICELAND	487
(GREECE)	484
(ROMANIA)	482
NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.	
LITHUANIA	477
CYPRUS	474
PORTUGAL	454
IRAN, ISLAMIC REPUBLIC	428
(KUWAIT)	392
(COLOMBIA)	385
(SOUTH AFRICA)	354

INTERNATIONAL AVERAGE = 513

SCIENCE

NATION	AVERAGE
NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
SINGAPORE	607
CZECH REPUBLIC	574
JAPAN	571
KOREA	565
(BULGARIA)	565
(NETHERLANDS)	560
(SLOVENIA)	560
(AUSTRIA)	558
(HUNGARY)	554
NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
ENGLAND	552
BELGIUM-FLEMISH	550
(AUSTRALIA)	545
SLOVAK REPUBLIC	544
RUSSIAN FEDERATION	538
IRELAND	538
SWEDEN	535
UNITED STATES	**534**
(GERMANY)	531
CANADA	531
NORWAY	527
NEW ZEALAND	525
(THAILAND)	525
(ISRAEL)	524
HONG KONG	522
SWITZERLAND	522
(SCOTLAND)	517
NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.	
SPAIN	517
FRANCE	498
(GREECE)	497
ICELAND	494
(ROMANIA)	486
LATVIA (LSS)	485
PORTUGAL	480
(DENMARK)	478
LITHUANIA	476
BELGIUM-FRENCH	471
IRAN, ISLAMIC REPUBLIC	470
CYPRUS	463
(KUWAIT)	430
(COLOMBIA)	411
(SOUTH AFRICA)	326

INTERNATIONAL AVERAGE = 516

Source:

IEA Third International Mathematics and Science Study (TIMSS), 1994-1995

*Eighth grade in most nations.
Nations shown in parentheses did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures.
Latvia is annotated LSS for Latvian-Speaking Schools only.
The TIMSS international reports present standard errors for all survey estimates.

TIMSS country did mathematics performance drop from above average in the fourth grade to below average in the eighth grade.

- Eighth graders in Singapore, Korea, and Japan outperform those in the United States by more than 100 points on the TIMSS mathematics scale. This is a substantial difference, especially considering that the difference in performance between grades seven and eight is only 26 points in the United States.
- In science, U.S. eighth graders scored above the international average of the 41 TIMSS countries. Yet, in contrast to grade four, the United States is not one of the top-performing countries. Singapore is the top-performing country in this subject. Czech Republic, Japan, and Korea also perform among the best in the world.
- Singaporean eighth graders outscored those in the United States by 73 scale points in science. The U.S. increase between grades seven and eight was 47 scale points.
- If the top 10 percent of all eighth-grade students in the 41 TIMSS countries were to be considered as a group, 5 percent of the U.S. eighth-grade students would be included in mathematics. In science, 13 percent would be included. The corresponding figures for Singapore would be 45 percent in mathematics and 31 percent in science.

Although the TIMSS results are useful for monitoring our national goal in mathematics and science achievement, they go beyond the purpose of providing international standings. TIMSS also can provide valuable information about strengths and weaknesses within subject area achievement. At the eighth-grade level, TIMSS measures achievement in six content areas in mathematics and five areas in science.

- Compared to their overall performance in mathematics, nearly all countries do relatively better in several content areas than they do in others. The relative strengths of U.S. eighth graders are in Algebra; Fractions and Number Sense; and Data Representation, Analysis, and Probability. Relative weaknesses are in Geometry, Measurement, and Proportionality.
- Compared to their overall performance in science, eighth graders in the United States do better in Earth Science, Life Science, and Environmental Issues and the Nature of Science. The relative weaknesses are in Chemistry and Physics.

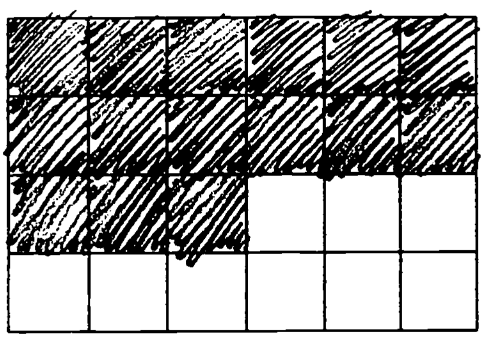
Considering the TIMSS results for clusters of individual test questions provides even more refined indications of needed emphases in classroom instruction. If students in the United States are to challenge those in the highest performing countries, then parents, teachers, administrators, school board members, and other policymakers must be well informed regarding what children know and can do in school mathematics and science, so that they can use this information to improve mathematics and science education.

HOW DO U.S. EIGHTH-GRADE STUDENTS COMPARE TO THE INTERNATIONAL AVERAGE IN...?

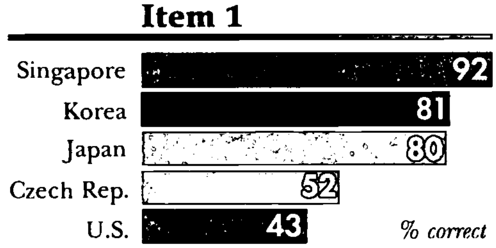
MATHEMATICS CONTENT AREAS:		SCIENCE CONTENT AREAS:	
DATA REPRESENTATION, ANALYSIS, AND PROBABILITY	ABOVE	EARTH SCIENCE	ABOVE
FRACTIONS AND NUMBER SENSE	SAME	LIFE SCIENCE	ABOVE
ALGEBRA	SAME	ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE	ABOVE
GEOMETRY	BELOW	CHEMISTRY	SAME
MEASUREMENT	BELOW	PHYSICS	SAME
PROPORTIONALITY	BELOW		

1

Shade in $^5/_8$ of the unit squares in the grid.



Item 1



International Average - 52

2

A car has a fuel tank that holds 35 L of fuel. The car consumes 7.5 L of fuel for each 100 km driven. A trip of 250 km was started with a full tank of fuel. How much fuel remained in the tank at the end of the trip?

(A) 16.25 L

B. 17.65 L

C. 18.75 L

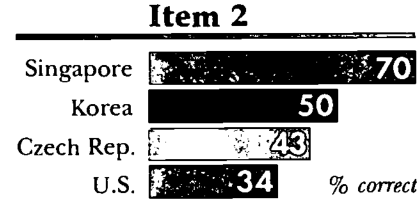
D. 23.75 L

Improving Thoughtful Problem Solving in Mathematics

In this age of information and technology, society's expanding use of data makes it imperative for all citizens to have the facility to reason using quantities. It is in this area of reasoning that U.S. eighth graders often fall behind their counterparts in top-performing countries, in particular, Singapore, Korea, Japan, and Czech Republic.

U.S. students tend to solve multi-step problems as though they involved single-step procedures. For example, in Item 1, about one-fourth of the U.S. eighth graders shaded in 5 squares, presumably because they did not account for the fact that the grid had 24 rather than 8 squares. In Item 2, the most prevalent mistake—made by one-third of the U.S. students—was to select the amount of fuel used on the trip (option C) rather than the amount of fuel remaining in the tank.

Item 2



(data not available for Japan)
International Average - 39

Item 3 was difficult for students in all of the countries. Still, nearly half of the U.S. eighth graders selected the distance traveled by the ball if it only traveled downward, but did not travel back up into the air between bounces (option A).

It is unclear why U.S. students seem to use single-step strategies to solve such problems. This could be due to a less-than-thoughtful approach to solving the problems, an inability to deal with more than one condition in a context, or poorly developed reading skills. The tendency was present in items across all content areas.

3

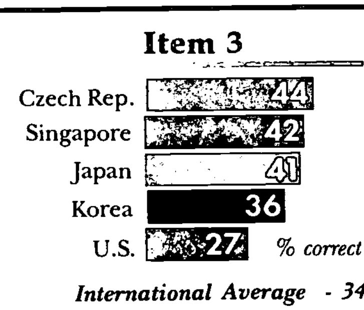
A rubber ball rebounds to half the height it drops. If the ball is dropped from a rooftop 18 m above the ground, what is the total distance traveled by the time it hits the ground the third time?

A. 31.5 m

B. 40.5 m

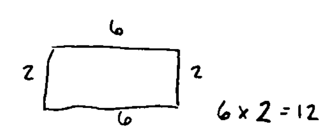
(C.) 45 m

D. 63 m

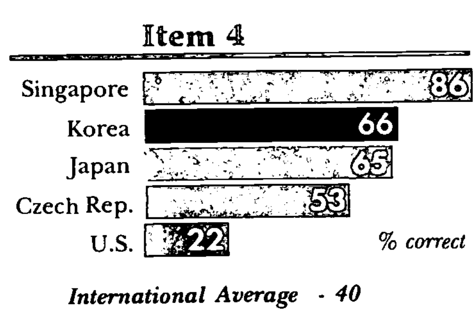


4

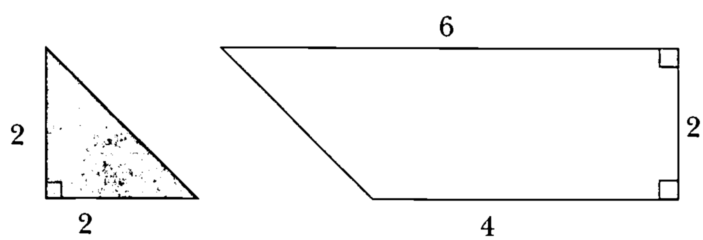
The length of a rectangle is 6 cm, and its perimeter is 16 cm. What is the area of the rectangle in square centimeters?



Answer: 12



5



How many triangles of the shape and size of the shaded triangle can the trapezoid above be divided into?

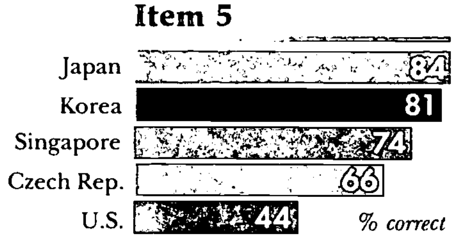
A. Three

B. Four

C. Five

D. Six

Item 5



International Average - 53

TIMSS found that the content of U.S. mathematics classes is not as advanced as in the top-performing countries, and this is reinforced by the achievement results. When the concepts were more specialized, such as in Measurement and Geometry, U.S. eighth-grade students had particular difficulty. For example, Items 4 and 5 required understanding of important concepts in perimeter and area and of the properties of rectangles and triangles. Item 6 indicates that students also may have insufficient understanding of some concepts in Analytic Geometry.

6

A straight line on a graph passes through the points (3,2) and (4,4). Which of these points also lies on the line?

A. (1,1)

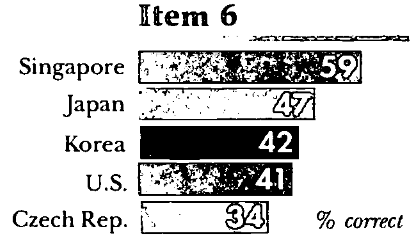
B. (2,4)

C. (5,6)

D. (6,3)

E. (6,5)

Item 6



International Average - 41

The importance of extending and creating patterns is stressed in the NCTM *Curriculum and Evaluation Standards for School Mathematics*[1] (see *TIMSS as a Starting Point to Examine Teaching* for excerpts from the NCTM standards). The results on several TIMSS items, including Item 7, suggest that U.S. eighth graders could use more emphasis in this area.

Students also had difficulty with more traditional algebra items, such as those that required simplifying, evaluating, and writing expressions. For example, about half of the U.S. students were not successful in identifying the correct expression to represent the number of Clarissa's hats (Item 8).

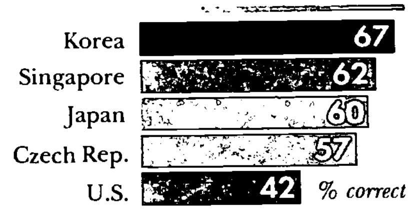
7.

The numbers in the sequence 2, 7, 12, 17, 22, ... increase by fives. The numbers in the sequence 3, 10, 17, 24, 31, ... increase by sevens. The number 17 occurs in both sequences. If the two sequences are continued, what is the next number that will be seen in both sequences?

27, 32, 37, 42, 47, 52
38, 45, 52

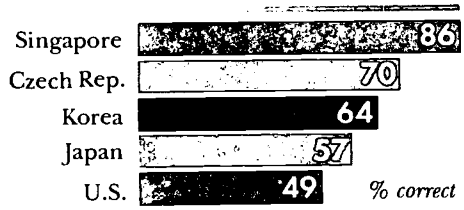
Answer: 52

Item 7



***International Average* - 45**

Item 8



***International Average* - 47**

8.

Juan has 5 fewer hats than Maria, and Clarissa has 3 times as many hats as Juan. If Maria has n hats, which of these represents the number of hats that Clarissa has?

A. $5 - 3n$

B. $3n$

C. $n - 5$

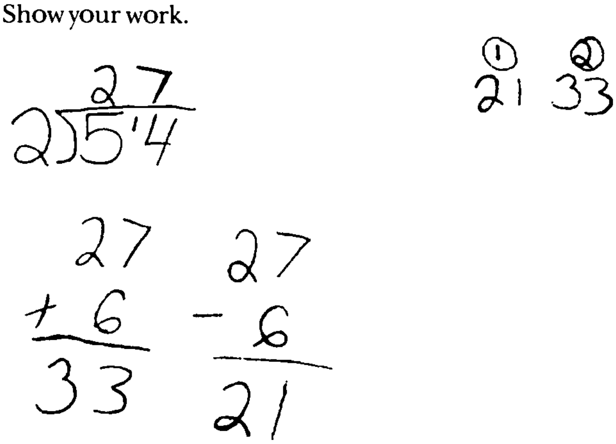
D. $3n - 5$

(E.) $3(n-5)$

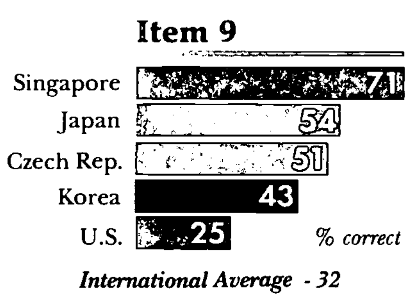
[1] National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: National Council of Teachers of Mathematics, 1989.

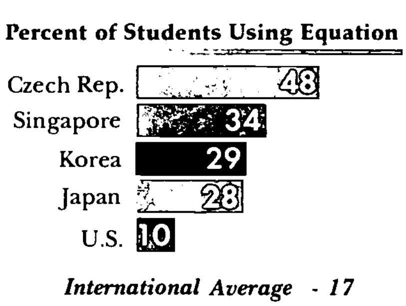
9

There are 54 kilograms of apples in two boxes. The second box of apples weighs 12 kilograms more than the first. How many kilograms of apples are in each box? Show your work.



An algebraic equation with an unknown variable could have been used to solve Item 9, although only about 10 percent of the U.S. eighth graders used this approach compared to nearly one-half of the eight graders in Czech Republic. Most of the U.S. students used basic operations but were unsuccessful in providing a correct solution. Regardless of the approach used, just 25 percent of the U.S. eighth graders answered this item correctly compared with 71 percent of those in Singapore.





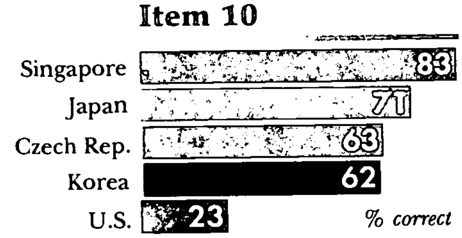
Items 10, 11, and 12 illustrate a range of TIMSS items involving proportionality. All were very difficult for U.S. eighth graders, highlighting the need for further work on this important kind of mathematical reasoning.

10

Peter bought 70 items and Sue bought 90 items. Each item cost the same and the items cost $800 altogether. How much did Sue pay?

Answer: Sue paid 450

Item 10



International Average - 38

11

The table shows the values of x and y, where x is proportional to y.

x	3	6	P
y	7	Q	35

What are the values of P and Q?

A. $P = 14$ and $Q = 31$

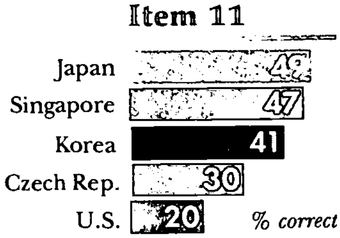
B. $P = 10$ and $Q = 14$

C. $P = 10$ and $Q = 31$

D. $P = 14$ and $Q = 15$

(E.) $P = 15$ and $Q = 14$

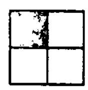
Item 11

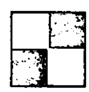


International Average - 25

12

Two boxes of square-shaped cardboard pieces are available to make a larger pattern. There are 4 small squares in each piece.

All pieces in Box 1 look like 

All pieces in Box 2 look like 

In the required pattern, for every piece from Box 2 there are 2 pieces from Box 1.

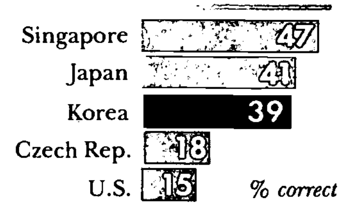
(a) If 60 pieces from Box 2 are used in the required pattern, how many pieces will be needed altogether?

Answer: 180

(b) What fraction of the small squares in the required pattern will be black?

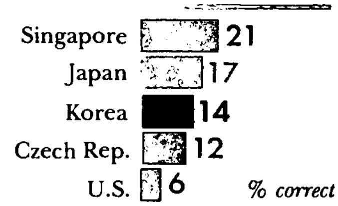
Answer: 1/3

Item 12-a



International Average - 23

Item 12-b



International Average - 8

Taken separately and together, the TIMSS items can reveal considerable information about students' understanding of mathematics and their ability to engage in mathematical reasoning across various content areas. How would students in your classroom, school, district, and state perform on these items?

Improving Scientific Understanding

The overall science achievement of U.S. eighth graders, while above the international average, is still far from being the best in the world. This is particularly true in the physical sciences, where U.S. students perform well below their counterparts in Singapore, Japan, Korea, and Czech Republic.

For example, the majority of U.S. eighth graders did not demonstrate a basic understanding of chemical properties or the classification of matter. Item 13 shows that only 27 percent of U.S. students identified oxygen as the gas required for combustion, with 39 percent of the students indicating nitrogen instead. About half of the U.S. students did not distinguish between solutions and separable heterogeneous mixtures as shown in Item 14.

13

Which gas could cause a glowing splint to burst into flame?

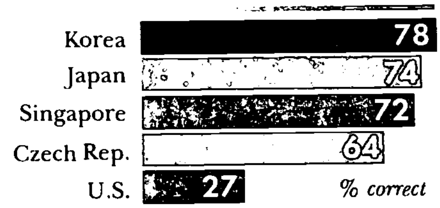
A. Neon

(B.) Oxygen

C. Nitrogen

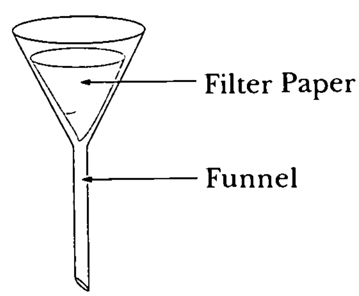
D. Carbon dioxide

Item 13



International Average - *51*

14



Filtration using the equipment shown can be used to separate which materials?

A. A solution of copper sulfate and water

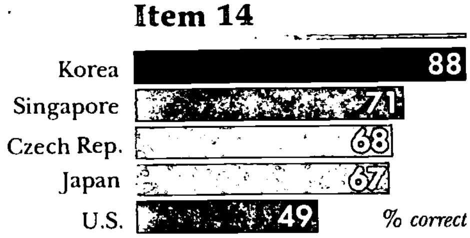
B. A solution of sodium chloride and water

C. A mixture of alcohol and water

(D.) A mixture of mud and water

E. A mixture of sand and sawdust

Item 14



International Average - *53*

15

Which is NOT an example of a chemical change?

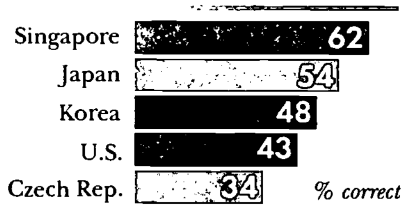
(A.) Boiling water

B. Rusting iron

C. Burning wood

D. Baking bread

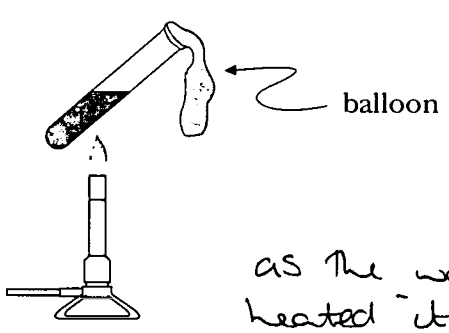
Item 15



International Average - 31

16

The water in a tube is heated, as shown in the diagram. As the water is heated, the balloon increases in size. Explain why.



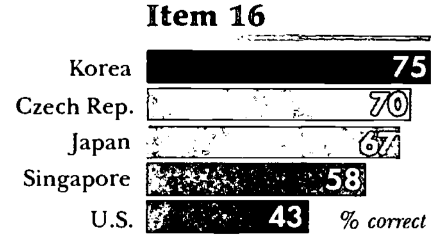
as the water is heated it will evaporate and the steam will go up into the ballon making it raise

The distinction between chemical and physical transformations is also a difficult concept for many U.S. students to grasp (see Item 15).

By the eighth grade, students in the top-performing countries in science are developing a grasp of physics concepts and are able to apply these to solve problems and provide explanations. While the majority of U.S. students demonstrate a basic understanding of many physics concepts, fewer students are able to apply these scientific principles to solve the more complicated TIMSS science problems. In general, this is true across all areas of physics covered by the TIMSS test, including physical properties and transformations, forces and motion, and energy concepts.

Fewer than half of U.S. students could apply concepts of evaporation and vapor pressure in Item 16.

Item 16

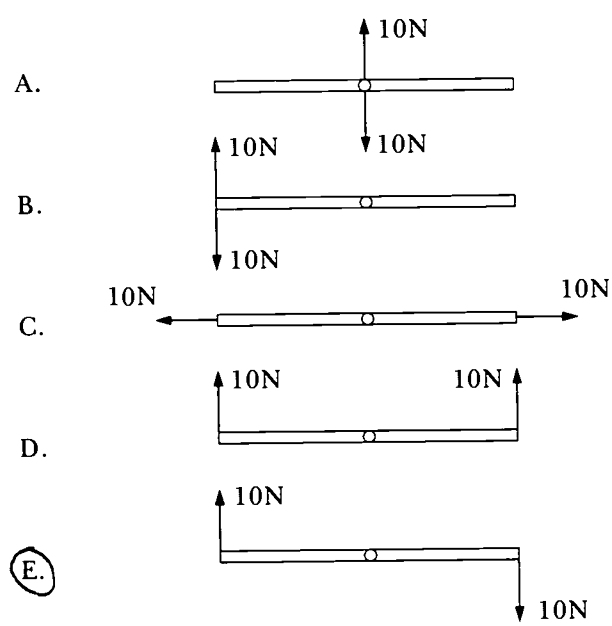


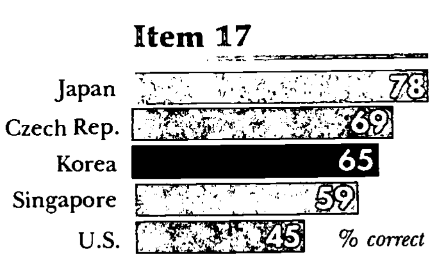
International Average - 58

U.S. students also had difficulty applying knowledge of mechanical forces in Item 17, with nearly half indicating a lack of understanding of balanced forces by selecting options in which no movement of the rod would occur (A, B, and C). For Item 18, fewer than half of the U.S. students demonstrated this knowledge of the nature of visible light and its interaction with matter to produce colors.

17

A uniform rod is pivoted at its center. It is acted on by two forces in the same plane. Each force has the same size, equal to 10 N (newtons). In which case is there a turning effect?





International Average - 49

18

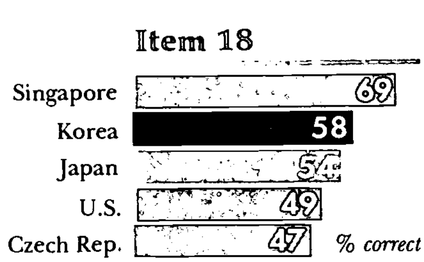
When white light shines on Peter's shirt, the shirt looks blue. Why does the shirt look blue?

A. It absorbs all the white light and turns most of it into blue light.

(B.) It reflects the blue part of the light and absorbs most of the rest.

C. It absorbs only the blue part of the light.

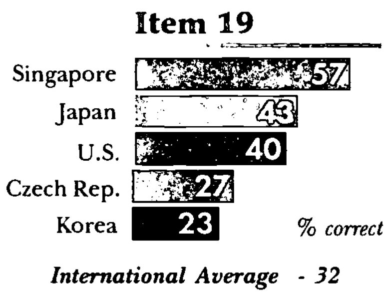
D. It gives off its own blue light.



International Average - 40

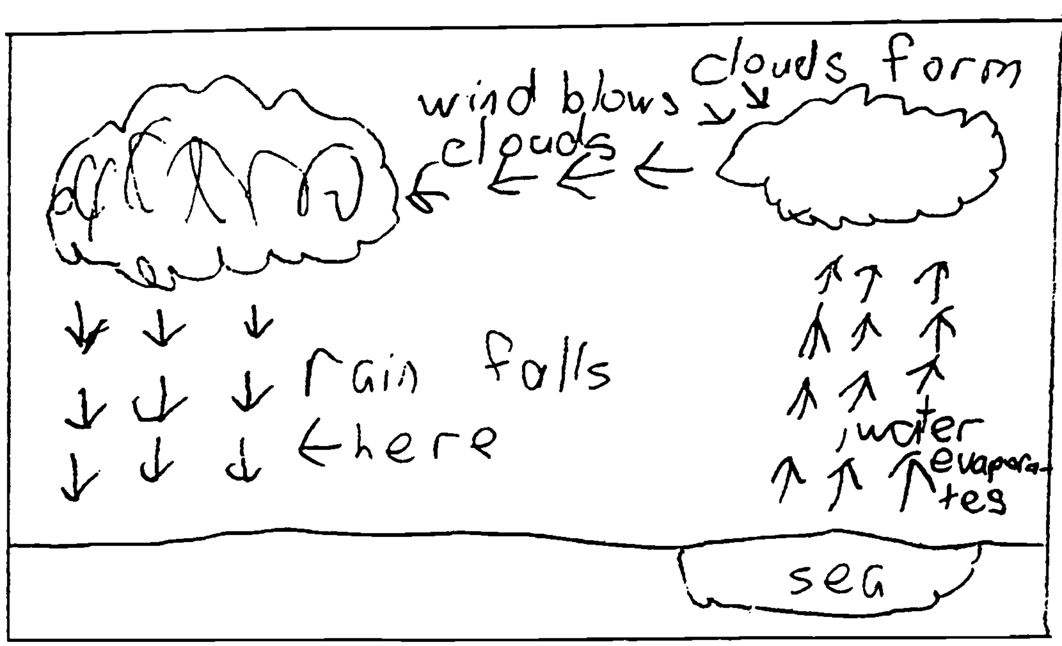
While U.S. performance compares more favorably with that of top-performing countries in the Earth, Life, and Environmental Sciences than it does in Physics and Chemistry, there is still room for improvement in some areas.

Some items which required knowledge of earth features and processes were quite challenging for U.S. students. In Item 19, two-fifths of the eighth graders in the United States, compared with the nearly three-fifths in Singapore, indicated all three steps in the water cycle—evaporation, transportation, and precipitation.



19

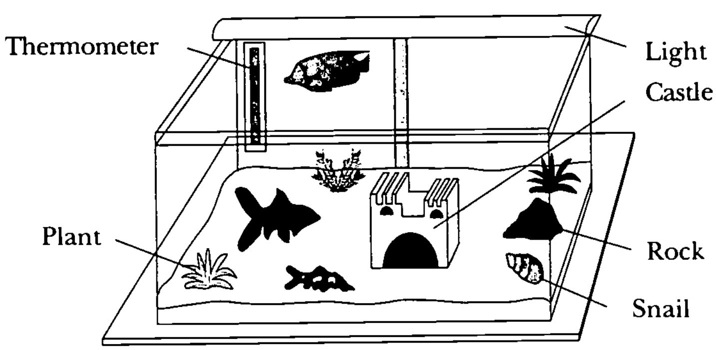
Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.



U.S. students did relatively well on items involving basic knowledge of human biology. Yet, lower performance on items covering the diversity, organization, structure, and interaction of other plant and animal life forms suggests more focus is needed in these areas in U.S. science classes. Even though more than 60 percent of the U.S. students could explain the importance of plants in aquarium ecosystems (Item 20a), nearly all students in Singapore could do so. Only 26 percent of the U.S. students could explain the importance of light. Of these, fewer than 10 percent mentioned energy or photosynthesis, compared with more than 70 percent in Singapore (Item 20b).

20

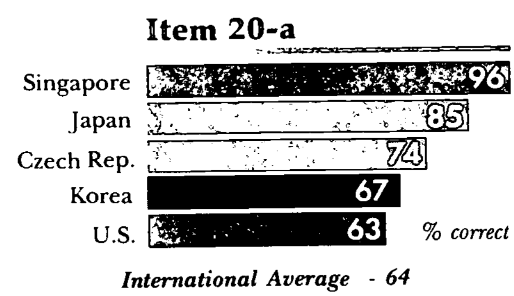
In the picture of an aquarium, six items are labeled.

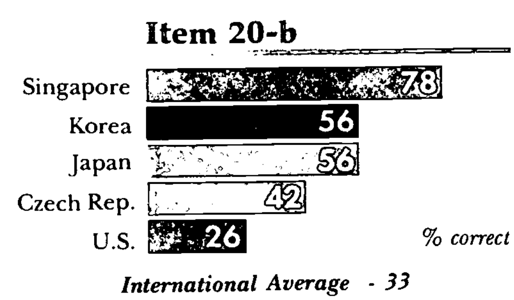


Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant to give off oxegn and take in carbon dioxide which the animals breath out

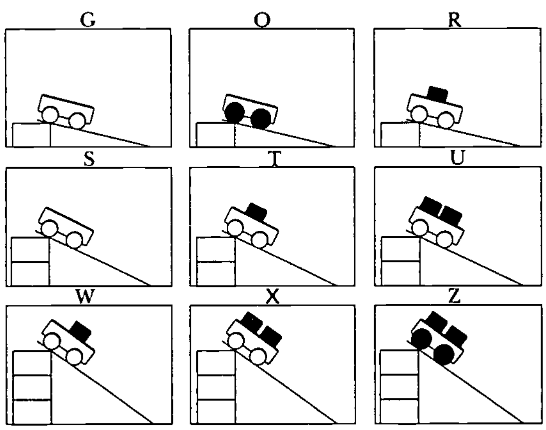
(b) the light to help the plant make photosynthesis and make its own food





21

The diagrams show different trials Abdul carried out with carts having different-sized wheels. He started them from different heights, and the blocks he put in them were of equal mass.



He wants to test this idea: The heavier a cart is, the greater its speed at the bottom of a ramp. Which three trials should he compare ?

A. G, T, and X

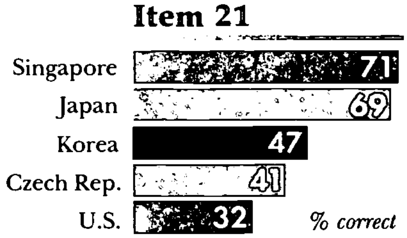
B. O, T, and Z

C. R, U, and Z

(D) S, T, and U

E. S, W, and X

Item 21



International Average - 37

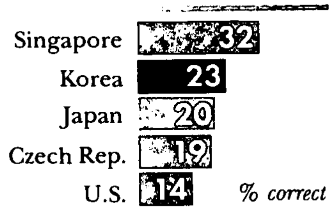
As emphasized by the American Association for the Advancement of Science (AAAS) in *Benchmarks for Science Literacy*[2] and the National Academy of Sciences' *National Science Education Standards*[3] students should be actively engaged in scientific inquiry by designing and conducting investigations. Several of the TIMSS science items reveal that students in the United States need more emphasis on the skills required in this area. In Item 21, only 32 percent of the U.S. students recognized the need to control other variables when conducting an experiment investigating the effect of mass.

[2] American Association for the Advancement of Science. *Benchmarks for Science Literacy: Project 2061.* New York: Oxford University Press, 1993.

[3] National Academy of Sciences. National Science Education Standards. Washington, DC: National Academy Press, 1995.

Designing and communicating an investigation of the effect of exercise on heart rate (Item 22) was quite difficult for students in most countries. Nevertheless, nearly one-third of the students in Singapore, compared with only 14 percent in the United States, describe a procedure that included using a timer to make measurements of pulse before and after exercise.

Item 22



International Average - 14

22

Suppose you want to investigate how the human heart rate changes with changes in activity. What materials would you use, and what procedures would you follow?

materials: stopwatch

procedures: I would have a person sit and then take their pulse.

I would have the person walk, then take their pulse again.

Finally, I would ~~to~~ have the person run and take their pulse.

Each time I took their pulse I would time how many ~~beats~~ times per minute their heart was beating

Because advances in science and technology will form the basis for success in the global community of the 21st century, performance by U.S. students that is just above average may not be good enough to ensure the economic health of our nation. How would students in your classroom, school, district, or state perform on these or similar TIMSS items?

School Contexts for Learning

The TIMSS questionnaire data collected in conjunction with the testing provide another lens through which to view the achievement results. Each TIMSS student completed a questionnaire about his or her attitudes toward mathematics and science, parental expectations, out-of-school experiences, and classroom activities. The mathematics and science teachers of each TIMSS student also completed a questionnaire especially geared toward the teaching of mathematics and science. The teacher questionnaire asked about teachers' preparation, instructional practices, and textbook usage, and their views on current issues in mathematics and science education. The school principal of each school in TIMSS completed a questionnaire regarding school characteristics, resources, course offerings, and the community. Countries also provided extensive information about their educational systems, with a specific focus on mathematics and science education, curricula, textbooks, and assessment. This information has been analyzed and published in a compendium titled *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*[3] available from the University of British Columbia, Faculty of Education.

The data collected from students, teachers, and school principals, as well as the system-level information collected from the participating countries, provide an abundance of information about similarities and differences in educational practices between the United States and other countries. Initial findings based on these data are available in the following publications found in this module of the TIMSS Resource Kit: *Mathematics Achievement in the Middle School Years, Science Achievement in the Middle School Years,* and *Pursuing Excellence: A Study of Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* For example:

- Similar to the United States, most countries report that four years of post-secondary education and practice in

[3] Robitaille, D.F. (Ed.). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, Canada: Pacific Educational Press, 1997.

teaching are required for teacher certification. However, in contrast to the United States, most countries report that some form of examination also is required.

- Different from the United States, the curriculum in most of the TIMSS countries is determined by national authorities. Consequently, textbooks are prepared in accordance with the course of study, and classes are conducted using these textbooks.
- U.S. eighth graders spend more hours in mathematics and science classes than their counterparts in many countries, so the lack of sufficient class time is not the reason why U.S. students perform below the levels achieved by the top-performing countries.
- Eighth graders in most countries typically report studying mathematics for roughly an hour each day outside of school and science for somewhat less than that. However, in comparison with most countries, students in the United States spend more in-class time working on their homework.
- In mathematics, all (or nearly all) students in five of the six top-performing countries follow the same course of study through the eighth grade. In Singapore, there are two courses of study. Thus, in general, all students are expected to achieve the same curriculum. In the United States principals report from two to six courses of study, with the average being three.
- In almost half of the TIMSS countries, eighth-grade science is taught not as an integrated subject, but as individual science subjects (Biology, Chemistry, etc.). In these countries, there are two, three, or even four different science courses available for eighth graders.
- Interestingly, teenagers appear to be much the same around the world. Eighth graders in all countries reported spending a fair amount of out-of-school time on non-academic activities. Most frequently, students reported watching one or two hours of television each day, as well as spending several hours playing or talking with friends, and nearly two hours playing sports. (Of course, for teenagers, these activities often occur simultaneously, such as watching television and talking with friends on the telephone.)

Because there are various pathways to academic excellence, it is informative to consider the contexts for learning in other countries, and how various factors can interact. No single factor in isolation from others should be regarded as the answer to improving students' achievement in a particular state, district, school, or classroom, but the TIMSS results do provide a way for states and districts to examine their own educational policies and practices from an international perspective.

Just as achievement information can provide information vital to improving curricula and teaching emphases, information about teachers' preparation, the activities they use in their classrooms, and the resources they rely upon in their teaching can provide insights into the best ways to improve instructional practices. Similarly, information about students' background and attitudes can suggest ways of stimulating students' willingness to study and learn.

Effective education is key to improving the situations of both individuals and societies, and it is very important to examine the implications of alternative approaches to learning. The TIMSS results provide an "educational laboratory" within which the strengths and weaknesses of educational practices can be assessed.

Conclusion

International studies of educational achievement and its contexts better equip policymakers to study their own approaches to education. For example, the overall achievement standings for the United States on TIMSS indicate that our nation needs to improve our education system if we want our children to achieve on par with the best in the world. Looking at performance on individual test questions reveals strengths, but also a number of weaknesses, regarding U.S. students' understanding of particular concepts in mathematics and science.

Learning that other countries have higher levels of educational achievement than the United States can show what is possible and serve as an impetus to making necessary changes. In his recent State of the Union address, President Clinton challenged every community and state to adopt national standards of excellence in education. He called for voluntary administration of individual-level national tests in reading at grade 4 and mathematics at grade 8 to monitor progress toward these standards. Beginning in 1999, the tests will provide an annual indication of a student's overall proficiency that can be reported to parents and teachers. The reading and mathematics tests will be comparable to the NAEP assessments in those subjects, and at the eighth-grade level, the national test also will be comparable to the mathematics section of TIMSS. For more information about the new national tests, contact the U.S. Department of Education at (202) 219-2042, or visit the test's Web site at http://www.ed.gov/nationaltests.

Studying the various approaches to education used in the different countries also provides important grist for the mill of systemic reform. TIMSS data are a measure against which states and districts can examine current pedagogy, curriculum, and assessment practices. For example, the data can raise issues about the following areas:

- the content and rigor of the curriculum;
- the expectations for high academic achievement for all students;
- the preparation of teachers and the quality of the support they receive;
- the adequacy of instructional materials and resources;
- the quality of classroom instruction;
- the amount of time students spend studying mathematics and science;
- the types of academic support students receive outside of school; and
- the consistency between assessment approaches and the goals of improving students' achievement.

Because they can support or challenge existing notions, insights about educational practices in other countries can fuel the debate about needed improvements and how best to go about implementing them. The TIMSS results indicate many pathways to excellence, and the alternatives represented by the participating countries can serve to stimulate an examination of what approaches are likely to be most effective in your particular classroom, school, district, or state.

Ordering the TIMSS Reports for Third- and Fourth-Grade Students

Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study, $20.00 (prepaid).

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These two reports provide international comparative results in mathematics and science achievement, respectively, for third and fourth graders in 26 countries. The information corresponds to that presented in the middle school reports. Because the 26 countries included in the primary school reports represent a subset of the countries that participated at the seventh- and eighth-grade levels, comparisons across grades are possible.

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TIMSS

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Mathematics Achievement in the Middle School Years

IEA's Third International Mathematcs and Science Study

Albert E. Beaton
Ina V.S. Mullis
Michael O. Martin
Eugenio J. Gonzalez
Dana L. Kelly
Teresa A. Smith

International Association for the Evaluation of Educational Achievement

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November 1996

TIMSS International Study Center
Boston College
Chestnut Hill, MA, USA

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Contents

Executive Summary

Mathematics

Since its inception in 1959, the International Association for the Evaluation of Educational Achievement (IEA) has conducted a series of international comparative studies designed to provide policy makers, educators, researchers, and practitioners with information about educational achievement and learning contexts. The Third International Mathematics and Science Study (TIMSS) is the largest and most ambitious of these studies ever undertaken.

The scope and complexity of TIMSS is enormous. Forty-five countries collected data in more than 30 different languages. Five grade levels were tested in the two subject areas, totaling more than half a million students tested around the world. The success of TIMSS depended on a collaborative effort between the research centers in each country responsible for implementing the steps of the project and the network of centers responsible for managing the across-country tasks such as training country representatives in standardized procedures, selecting comparable samples of schools and students, and conducting the various steps required for data processing and analysis. Including the administrators in the approximately 15,000 schools involved, many thousands of individuals around the world were involved in the data collection effort. Most countries collected their data in May and June of 1995, although those countries on a southern hemisphere schedule tested in late 1994, which was the end of their school year.

Six content dimensions were covered in the TIMSS mathematics tests given to the middle-school students: fractions and number sense; measurement; proportionality; data representation, analysis, and probability; geometry; and algebra. About one-fourth of the questions were in the free-responses format requiring students to generate and write their answers. These types of questions, some of which required extended responses, were allotted approximately one-third of the testing time. Chapter 3 of this report contains 33 example items illustrating the range of mathematics concepts and processes addressed by the TIMSS test.

Because the home, school, and national contexts within which education takes place can play important roles in how students learn mathematics, TIMSS collected extensive information about such background factors. The students who participated in TIMSS completed questionnaires about their home and school experiences related to learning mathematics. Also, teachers and school administrators completed questionnaires about instructional practices. System-level information was provided by each participating country.

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed specifically to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality control monitors observed testing sessions, and sent reports back to the TIMSS International Study Center at Boston College. The samples of students selected for testing were scrutinized according to rigorous standards designed to prevent bias and ensure comparability. In this publication, the countries are grouped for reporting of achievement according to their compliance with the sampling guidelines and the level of their participation rates. Prior to analysis, the data from each country were subjected to exhaustive checks for adherence to the international formats as well as for within-country consistency and comparability across countries.

The results provided in this report describe students' mathematics achievement at both the seventh and eighth grades. For most, but not all TIMSS countries, the two grades tested at the middle-school level represented the seventh and eighth years of formal schooling. Special emphasis is placed on the eighth-grade results, including selected information about students' background experiences and teachers' classroom practices in mathematics. Results are reported for the 41 countries that completed all of the steps on the schedule necessary to appear in this report. The results for students in the third and fourth grades, and for those in their final year of secondary school will appear in subsequent reports.

The following sections summarize the major findings described in this report.

Students' Mathematics Achievement

- Singapore was the top-performing country at both the eighth and seventh grades. Korea, Japan, and Hong Kong also performed very well at both grades as did Flemish-speaking Belgium and the Czech Republic. Lower-performing countries included Colombia, Kuwait, and South Africa (see Tables 1.1 and 1.2; Figures 1.1 and 1.2).

- Perhaps the most striking finding was the large difference in average achievement between the top-performing and bottom-performing countries. Despite this large difference, when countries were ordered by average achievement there were only small or negligible differences in achievement between one country and the one with the next-lowest average achievement. In some sense, at both grades, the results provide a chain of overlapping performances, where most countries had average achievement similar to a cluster of other countries, but from the beginning to the end of the chain there were substantial differences. For example, at both grades, average achievement in top-performing Singapore was comparable to or even exceeded performance for 95% of the students in the lowest-performing countries.

- For most countries, gender differences in mathematics achievement were small or essentially non-existent. However, the direction of the gender differences that did exist favored boys rather than girls. Similarly, within the mathematics content areas, there were few differences in performance between boys and girls. Again, the few differences that did occur favored boys (except in algebra, where, if anything, the differences favored girls).

- Compared to their overall performance in mathematics, nearly all countries did relatively better in several content areas than they did in others. Consistent with the idea of countries having different emphases in curriculum, those that performed relatively better in fractions and number sense tended to be different from those that performed relatively better in geometry and algebra.

- Even though students in the top-performing countries had very high achievement on many of the test questions, both seventh and eighth graders, in most countries, had difficulty with multi-step problem solving and applications. For example, students were asked to actually draw a new rectangle whose length was one and one-half times the length of a given rectangle and whose width was half the width of that rectangle. In only two countries (Korea and Austria) did at least half the eighth-grade students correctly draw the new rectangle.

- Students also found the proportionality items difficult. For example, one of the least difficult problems in this area asked about adding 5 girls and 5 boys to a class that was three-fifths girls. On average, fewer than two-thirds of the students across countries correctly answered that there would still be more girls than boys in the class.

- In algebra, 58% of the eighth-grade students across countries, on average, identified $4m$ as being equivalent to $m + m + m + m$. There was however, a very large range in performance from country to country. Seventy-five percent or more of the eighth graders answered this question correctly in the Czech Republic, Hong Kong, Japan, the Russian Federation, Singapore, the Slovak Republic, and Slovenia.

Students' Attitudes Towards Mathematics

- Within nearly every country, a clear positive relationship was observed between a stronger liking of mathematics and higher achievement. Even though the majority of eighth graders in nearly every country indicated they liked mathematics to some degree, clearly not all students feel positive about this subject area. In Austria, the Czech Republic, Germany, Hungary, Japan, Korea, Lithuania, and the Netherlands, more than 40% of the students reported disliking mathematics.

- In no country, did eighth-grade girls report a stronger liking of mathematics than did boys. However, boys reported liking mathematics better than girls did in several countries, including Austria, France, Germany, Hong Kong, Japan, Norway, and Switzerland.

- In all except four countries, the majority of students agreed or strongly agreed that they did well in mathematics – a perception that did not always coincide with the comparisons in achievement across countries on the TIMSS test. Interestingly, the exceptions included three of the highest performing countries – Hong Kong, Japan, and Korea – where more than 50% of the students disagreed or strongly disagreed about doing well (the fourth was Lithuania). It should be noted, however, that within nearly all countries there was a clear relationship between perception and performance, with those students reporting higher self-perceptions of doing well in mathematics also having higher average achievement.

- Internationally, the most frequently cited reason for needing to do well in mathematics was to get into students' desired secondary school or university.

Home Environment

Home factors were strongly related to mathematics achievement in every country that participated in TIMSS.

- In every country, eighth-grade students who reported having more educational resources in the home had higher mathematics achievement than those who reported little access to such resources. Strong positive relationships were found between mathematics achievement and having study aids in the home, including a dictionary, a computer, and a study desk/table for the student's own use.

- The number of books in the home can be an indicator of a home environment that values and provides general academic support. In most TIMSS countries, the more books students reported in the home, the higher their mathematics achievement.

- In every country, the pattern was for the eighth-grade students whose parents had more education to also have higher achievement in mathematics.

- Beyond the one to two hours of daily television viewing reported by close to the majority of eighth graders in all participating countries, the amount of television students watched was negatively associated with mathematics achievement.

- In most countries, eighth graders reported spending as much out-of-school time each day in non-academic activities as they did in academic activities. Besides watching television, students reported spending several hours, on average, each day playing or talking with friends, and nearly two hours playing sports. (It should be noted, however, the time spent in these activities is not additive because students can talk with their friends at sporting events or while watching TV, for example.)

Instructional Contexts and Practices

In comparison to the positive relationships observed between mathematics achievement and home factors, the relationships were less clear between achievement and various instructional variables, both within and across countries. Obviously, educational policies and practices such as tracking and streaming serve to systematically confound these relationships. Also, the interaction among instructional variables can be extremely complex and merits further study.

- The qualifications required for teaching certification were relatively uniform across countries. Most countries reported that four years of post-secondary education were required, even though there was a range from two to six years. Almost all countries reported that teaching practice was a requirement, as was an examination or evaluation.

- Teachers in most countries reported that mathematics classes typically meet for at least two hours a week, but less than three and one-half hours. Weekly instructional time of from three and one-half hours up to five hours also was common for a number of countries. The data, however, revealed no clear pattern between the number of in-class instructional hours and mathematics achievement.

- There was considerable variation in class size. In a number of countries, nearly all students (90% or more) were in classes of fewer than 30 students. At the other end of the spectrum, 93% of the students in Korea were in classes with more than 40 students. The TIMSS data showed different patterns of mathematics achievement in relation to class size for different countries.

- Small-group work was used less frequently than other instructional approaches. Across countries, mathematics teachers reported that working together as a class with the teacher teaching the whole class, and having students work individually with assistance from the teacher were the most frequently used instructional approaches.

- In most participating countries, teachers reported using a textbook in teaching mathematics for 95% or more of the students. Relatively uniformly, the majority of students were asked both to practice computation and do some type of reasoning tasks in most or every lesson.

- Regarding the use of technology, teachers in many countries reported three-fourths or more of the eighth graders used calculators almost every day in their mathematics classes, often for checking answers, routine computation, and solving complex problems. An exception was Korea, where it was reported that calculators were seldom used. Teachers and students agreed that the computer was almost never used in most students' mathematics lessons.

- Eighth graders in about half the countries reported doing an average of two to three hours per day of homework, with those in many countries reporting studying mathematics for roughly an hour each day. There was a range from half an hour to two hours per day spent on mathematics homework and about two to five hours overall, but the relationship between amount of homework done and level of mathematics achievement was inconsistent.

- Eighth-grade students reported substantial variation in the frequency of testing in mathematics classes. In a number of countries, the majority of the eighth-grade students reported having quizzes and tests only once in while or never. In contrast, one-third or more of the students reported almost always having quizzes or tests in Colombia, Hong Kong, Kuwait, Romania, Spain, and the United States.

Introduction

MATHEMATICS

As the 21st century approaches, technology is having more and more impact on the daily lives of individuals throughout the world. It influences our receipt of news and information, how we spend our leisure time, and where we work. At an ever-increasing pace, technology also is becoming a major factor in determining the economic health of countries. To ensure their economic well-being, countries will need citizens prepared to participate in "brain-power" industries such as micro-electronics, computers, and telecommunications. The young adolescents of today will be seeking jobs in a global economy requiring levels of technical competence and flexible thinking that were required by only a few workers in the past. To make sensible decisions and participate effectively in a world transformed by the ability to exchange all types of information almost instantly, these students will need to be well educated in a number of core areas, especially mathematics and science.

The fact that skills in mathematics and science are so critical to economic progress in a technologically-based society has led countries to seek information about what their school-age populations know and can do in mathematics and science. There is interest in what concepts students understand, how well they can apply their knowledge to problem-solving situations, and whether they can communicate their understandings. Even more vital, countries are desirous of furthering their knowledge about what can be done to improve students' understanding of mathematical concepts, their ability to solve problems, and their attitudes toward learning.

The Third International Mathematics and Science Study (TIMSS) provided countries with a vehicle for investigating these issues while expanding their perspectives of what is possible beyond the confines of their national borders. It is the most ambitious and complex comparative education study in a series of such undertakings conducted during the past 37 years by the International Association for the Evaluation of Educational Achievement (IEA).[1] The main purpose of TIMSS was to focus on educational policies, practices, and outcomes in order to enhance mathematics and science learning within and across systems of education.

With its wealth of information covering more than half a million students at five grade levels in 15,000 schools and more than 40 countries around the world, TIMSS offers an unprecedented opportunity to examine similarities and differences in how mathematics and science education works and how well it works. The study used innovative testing approaches and collected extensive information about the contexts within which students learn mathematics and science.

[1] The previous IEA mathematics studies were conducted in 1964 and 1980-82, and the science studies in 1970-71 and 1983-84. For information about TIMSS procedures, see Appendix A.

The present report focuses on the mathematics achievement of students in the two grades with the largest proportion of 13-year-olds – the seventh and eighth grades in most countries. Special emphasis is placed on the eighth-grade results, including selected information about students' background and classroom practices in teaching mathematics.

All countries that participated in TIMSS were to test students in the two grades with the largest proportion of 13-year-olds in both mathematics and science. A companion report, *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*,[2] presents corresponding results about students' science achievement.

Many TIMSS countries also tested the mathematics and science achievement of students in the two grades with the largest proportion of 9-year-olds (third and fourth grades in most countries) and of students in their final year of secondary education. Subsets of students, except the final-year students, also had the opportunity to participate in a "hands-on" performance assessment where they designed experiments and tested hypotheses. The results of these components of TIMSS will be presented in forthcoming reports.

Together with the achievement tests, TIMSS administered a broad array of background questionnaires. The data collected from students, teachers, and school principals, as well as the system-level information collected from the participating countries, provide an abundance of information for further study and research. TIMSS data make it possible to examine differences in current levels of performance in relation to a wide variety of variables associated with classroom, school, and national contexts within which education takes place.

Which Countries Participated?

TIMSS was very much a collaborative process among countries. Table 1 shows the 45 participating countries. Each participant designated a national center to conduct the activities of the study and a National Research Coordinator (NRC) to assume responsibility for the successful completion of these tasks.[3] For the sake of comparability, all testing was conducted at the end of the school year. The four countries on a Southern Hemisphere school schedule (Australia, Korea, New Zealand, and Singapore) tested in September through November of 1994, which was the end of the school year in the Southern Hemisphere. The remaining countries tested the mathematics and science achievement of their students at the end of the 1994-95 school year, most often in May and June of 1995. Because Argentina, Italy, and Indonesia were unable to complete the steps necessary to appear in this report, the tables throughout the report do not include data for these three countries. Results also are not presented for Mexico, which chose not to release its seventh- and eighth-grade results in the international reports.

[2] Beaton, A.E., Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1996). *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[3] Appendix F lists the National Research Coordinators as well as the members of the TIMSS advisory committees.

Table 1

Countries Participating in TIMSS[1]

- Argentina
- Australia
- Austria
- Belgium *
- Bulgaria
- Canada
- Colombia
- Cyprus
- Czech Republic
- Denmark
- England
- France
- Germany
- Greece
- Hong Kong
- Hungary
- Iceland
- Indonesia
- Iran, Islamic Republic
- Ireland
- Israel
- Italy
- Japan
- Korea, Republic of
- Kuwait
- Latvia
- Lithuania
- Mexico
- Netherlands
- New Zealand
- Norway
- Philippines
- Portugal
- Romania
- Russian Federation
- Scotland
- Singapore
- Slovak Republic
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Thailand
- United States

* The Flemish and French educational systems in Belgium participated separately.

1 Argentina, Italy, and Indonesia were unable to complete the steps necessary for their data to appear in this report. Because the characteristics of its school sample are not completely known, achievement results for the Philippines are presented in Appendix C. Mexico participated in the testing portion of TIMSS, but chose not to release its results at grades 7 and 8 in the international report.

Table 2 shows information about the lower and upper grades tested in each country, including the country names for those two grades and the years of formal schooling students in those grades had completed when they were tested for TIMSS. Table 2 reveals that for most, but not all, countries, the two grades tested represented the seventh and eighth years of formal schooling. Thus, solely for convenience, the report often refers to the upper grade tested as the eighth grade and the lower grade tested as the seventh grade. As a point of interest, a system-split (where the lower grade was in upper primary and the upper grade was in lower secondary) occurred in six countries: New Zealand, Norway, the Philippines, South Africa, Sweden, and Switzerland. Two countries, Israel and Kuwait, tested only at the upper grade.

Having valid and efficient samples in each country is crucial to the quality and success of any international comparative study. The accuracy of the survey results depends on the quality of sampling information available, and particularly on the quality of the samples. TIMSS developed procedures and guidelines to ensure that the national samples were of the highest quality possible. Standards for coverage of the target population, participation rates, and the age of students were established, as were clearly documented procedures on how to obtain the national samples. For the most part, the national samples were drawn in accordance with the TIMSS standards, and achievement results can be compared with confidence. However, despite efforts to meet the TIMSS specifications, some countries did not do so. These countries are specially annotated and/or shown in separate sections of the tables in this report.[4]

[4] The TIMSS sampling requirements and the outcomes of the sampling procedures are described in Appendix A.

Table 2

Information About the Grades Tested

Country	Lower Grade: Country's Name for Lower Grade	Lower Grade: Years of Formal Schooling Including Lower Grade[1]	Upper Grade: Country's Name for Upper Grade	Upper Grade: Years of Formal Schooling Including Upper Grade[1]
[2] Australia	7 or 8	7 or 8	8 or 9	8 or 9
Austria	3. Klasse	7	4. Klasse	8
Belgium (Fl)	1A	7	2A & 2P	8
Belgium (Fr)	1A	7	2A & 2P	8
Bulgaria	7	7	8	8
Canada	7	7	8	8
Colombia	7	7	8	8
Cyprus	7	7	8	8
Czech Republic	7	7	8	8
Denmark	6	6	7	7
England	Year 8	8	Year 9	9
France	5ème	7	4ème (90%) or 4ème Technologique (10%)	8
Germany	7	7	8	8
Greece	Secondary 1	7	Secondary 2	8
Hong Kong	Secondary 1	7	Secondary 2	8
Hungary	7	7	8	8
Iceland	7	7	8	8
Iran, Islamic Rep.	7	7	8	8
Ireland	1st Year	7	2nd Year	8
Israel	–	–	8	8
Japan	1st Grade Lower Secondary	7	2nd Grade Lower Secondary	8
Korea, Republic of	1st Grade Middle School	7	2nd Grade Middle School	8
Kuwait	–	–	9	9
Latvia	7	7	8	8
Lithuania	7	7	8	8
Netherlands	Secondary 1	7	Secondary 2	8
[3,4] New Zealand	Form 2	7.5 - 8.5	Form 3	8.5 - 9.5
[3] Norway	6	6	7	7
[3] Philippines	Grade 6 Elementary	6	1st Year High School	7
Portugal	Grade 7	7	Grade 8	8
Romania	7	7	8	8
[5] Russian Federation	7	6 or 7	8	7 or 8
Scotland	Secondary 1	8	Secondary 2	9
Singapore	Secondary 1	7	Secondary 2	8
Slovak Republic	7	7	8	8
Slovenia	7	7	8	8
Spain	7 EGB	7	8 EGB	8
[3] South Africa	Standard 5	7	Standard 6	8
[3] Sweden	6	6	7	7
[3] Switzerland				
(German)	6	6	7	7
(French and Italian)	7	7	8	8
Thailand	Secondary 1	7	Secondary 2	8
United States	7	7	8	8

[1] Years of schooling based on the number of years children in the grade level have been in formal schooling, beginning with primary education (International Standard Classification of Education Level 1). Does not include preprimary education.

[2] Australia: Each state/territory has its own policy regarding age of entry to primary school. In 4 of the 8 states/territories students were sampled from grades 7 and 8; in the other four states/territories students were sampled from grades 8 and 9.

[3] Indicates that there is a system-split between the lower and upper grades. In Switzerland there is a system-split in 14 of 26 cantons.

[4] New Zealand: The majority of students begin primary school on or near their 5th birthday so the "years of formal schooling" vary.

[5] Russian Federation: 70% of students in the seventh grade have had 6 years of formal schooling; 70% in the eighth grade have had 7 years of formal schooling.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

What Was the Nature of the Mathematics Test?

Together with the quality of the samples, the quality of the test also receives considerable scrutiny in any comparative study. All participants wish to ensure that the achievement items are appropriate for their students and reflect their current curriculum. Developing the TIMSS tests was a cooperative venture involving all of the NRCs during the entire process. Through a series of efforts, countries submitted items that were reviewed by mathematics subject-matter specialists, and additional items were written to ensure that the desired mathematics topics were covered adequately. Items were piloted, the results reviewed, and new items were written and piloted. The resulting TIMSS mathematics test contained 151 items representing a range of mathematics topics and skills.

The TIMSS curriculum frameworks described the content dimensions for the TIMSS tests as well as performance expectations (behaviors that might be expected of students in school mathematics).[5] Six content areas are covered in the mathematics test taken by seventh- and eighth-grade students. These areas and the percentage of the test items devoted to each include: fractions and number sense (34%); measurement (12%); proportionality (7%); data representation, analysis, and probability (14%); geometry (15%); and algebra (18%). The performance expectations include: knowing (22%); performing routine procedures (25%); using complex procedures (21%); and solving problems (32%).

About one-fourth of the questions were in the free-response format, requiring students to generate and write their answers. These questions, some of which required extended responses, were allotted approximately one-third of the testing time. Responses to the free-response questions were evaluated to capture diagnostic information, and some were scored using procedures that permitted partial credit.[6] Chapter 3 of this report contains 33 example items illustrating the range of mathematics concepts and processes addressed by the TIMSS test.

The TIMSS tests were prepared in English and translated into 30 additional languages using explicit guidelines and procedures. A series of verification checks were conducted to ensure the comparability of the translations.[7]

The tests were given so that no one student took all of the items, which would have required more than three hours. Instead, the test was assembled in eight booklets, each requiring 90 minutes to complete. Each student took only one booklet, and the items were rotated through the booklets so that each one was answered by a representative sample of students.

[5] Robitaille, D.F., McKnight, C.C., Schmidt, W.H., Britton, E.D., Raizen, S.A., and Nicol, C. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science.* Vancouver, B.C.: Pacific Educational Press.

[6] TIMSS scoring reliability studies within and across countries indicate that the percent of exact agreement for correctness scores averaged well above 90%. For more details, see Appendix A.

[7] See Appendix A for more information about the translation procedures.

TIMSS conducted a Test-Curriculum Matching Analysis whereby countries examined the TIMSS test to identify items measuring topics not addressed in their curricula. The analysis showed that omitting such items for each country had little effect on the overall pattern of achievement results across all countries.[8]

How Do Country Characteristics Differ?

International studies of student achievement provide valuable comparative information about student performance and instructional practices. Along with the benefits of international studies, though, are challenges associated with comparing achievement across countries, cultures, and languages. In TIMSS, extensive efforts were made to attend to these issues through careful planning and documentation, cooperation among the participating countries, standardized procedures, and rigorous attention to quality control throughout.[9]

Beyond the integrity of the study procedures, the results of comparative studies such as TIMSS also need to be considered in light of the larger contexts in which students are educated and the kinds of system-wide factors that might influence students' opportunity to learn. A number of these factors are more fully described in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*;[10] however, some selected demographic characteristics of the TIMSS countries are presented in Table 3. Table 4 contains information about public expenditure on education. The information in these two tables shows that some of the TIMSS countries are densely populated and others are more rural, some are large and some small, and some expend considerably more resources on education than others. Although these factors do not necessarily determine high or low performance in mathematics, they do provide a context for considering the difficulty of the educational task from country to country.

Describing students' educational opportunities also includes understanding the knowledge and skills that students are supposed to master. To help complete the picture of educational practices in the TIMSS countries, mathematics and curriculum specialists within each country provided detailed categorizations of their curriculum guides, textbooks, and curricular materials. The initial results from this effort can be found in two reports, entitled *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science*.[11]

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[8] Results of the Test-Curriculum Matching Analysis are presented in Appendix B.

[9] Appendix A contains an overview of the procedures used and cites a number of references providing details about TIMSS methodology.

[10] Robitaille D.F. (in press). *National Contexts for Mathematics and Science Education: An Encylopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

[11] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.* Dordrecht, the Netherlands: Kluwer Academic Publishers. Schmidt, W.H., Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G., (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Table 3

Selected Demographic Characteristics of TIMSS Countries

Country	Population Size (1,000)[1]	Area of Country (1000 Square Kilometers)[2]	Density (Population per Square Kilometer)[3]	Percentage of Population Living in Urban Areas	Life Expectancy[4]	Percent in Secondary School[5]
Australia	17843	7713	2.29	84.8	77	84
Austria	8028	84	95.28	55.5	77	107
Belgium	10116	31	330.40	96.9	76	103
Bulgaria	8435	111	76.39	70.1	71	68
Canada	29248	9976	2.90	76.7	78	88
Colombia	36330	1139	31.33	72.2	70	62
Cyprus	726	9	77.62	53.6	77	95
Czech Republic	10333	79	130.99	65.3	73	86
Denmark	5205	43	120.42	85.1	75	114
[6] England	48533	130	373.33	–	77	–
France	57928	552	104.56	72.8	78	106
Germany	81516	357	227.39	86.3	76	101
Greece	10426	132	78.63	64.7	78	99
[7] Hong Kong	6061	1	5691.35	94.8	78	98
Hungary	10261	93	110.03	64.2	70	81
Iceland	266	103	2.56	91.4	79	103
Iran	62550	1648	36.98	58.5	68	66
Ireland	3571	70	50.70	57.4	76	105
Israel	5383	21	252.14	90.5	77	87
Japan	124961	378	329.63	77.5	79	96
Korea, Republic of	44453	99	444.92	79.8	71	93
Kuwait	1620	18	80.42	96.8	76	60
Latvia	2547	65	40.09	72.6	68	87
Lithuania	3721	65	57.21	71.4	69	78
Netherlands	15381	37	409.30	88.9	78	93
New Zealand	3493	271	12.78	85.8	76	104
Norway	4337	324	13.31	73.0	78	116
Philippines	67038	300	218.83	53.1	65	79
Portugal	9902	92	106.95	35.2	75	81
Romania	22731	238	95.81	55.0	70	82
Russian Federation	148350	17075	8.70	73.2	64	88
[8] Scotland	5132	79	65.15	–	75	–
Singapore	2930	1	4635.48	100.0	75	84
Slovak Republic	5347	49	108.61	58.3	72	89
Slovenia	1989	20	97.14	62.7	74	85
South Africa	40539	1221	32.46	50.5	64	77
Spain	39143	505	77.43	76.3	77	113
Sweden	8781	450	19.38	83.1	78	99
Switzerland	6994	41	168.03	60.6	78	91
Thailand	58024	513	111.76	31.9	69	37
United States	260650	9809	27.56	76.0	77	97

[1] Estimates for 1994 based, in most cases, on a de facto definition. Refugees not permanently settled in the country of asylum are generally considered to be part of their country of origin.
[2] Area is the total surface area in square kilometers, comprising all land area and inland waters.
[3] Density is population per square kilometer of total surface area.
[4] Number of years a newborn infant would live if prevailing patterns of mortality at its birth were to stay the same throughout its life.
[5] Gross enrollment of all ages at the secondary level as a percentage of school-age children as defined by each country. This may be reported in excess of 100% if some pupils are younger or older than the country's standard range of secondary school age.
[6] Annual Abstract of Statistics1995, and Office of National Statistics. All data are for 1993.
[7] Number for Secondary Enrollment is from Education Department (1985) Education Indicators for the Hong Kong Education System (unpublished document).
[8] Registrar General for Scotland Annual Report 1995 and Scottish Abstract of Statistics 1993.
(–) A dash indicates the data were unavailable.
SOURCE: The World Bank, Social Indicators of Development, 1996.

Table 4

Public Expenditure on Education at Primary and Secondary Levels[1] in TIMSS Countries

Country	Gross National Product per Capita (US Dollars)[2]	Gross National Product per Capita (Intl. Dollars)[3]	Public Expenditure on Education (Levels 1 & 2) as % of Gross National Product[4]	Public Expenditure on Education (Intl. Dollars per Capita)[5]
Australia	17980	19000	3.69	701
Austria	24950	20230	4.24	858
Belgium	22920	20450	3.70	757
Bulgaria	1160	4230	3.06	129
Canada	19570	21230	4.62	981
Colombia	1620	5970	2.83	169
[6] Cyprus	10380	–	3.60	–
Czech Republic	3210	7910	3.75	297
Denmark	28110	20800	4.80	998
[7] England	18410	18170	3.57	649
France	23470	19820	3.61	716
Germany	25580	19890	2.43	483
Greece	7710	11400	2.27	259
[8] Hong Kong	21650	23080	1.34	309
Hungary	3840	6310	4.31	272
Iceland	24590	18900	4.77	902
Iran	–	4650	3.93	183
Ireland	13630	14550	4.21	613
Israel	14410	15690	3.72	584
Japan	34360	21350	2.82	602
Korea, Republic of	8220	10540	3.43	362
Kuwait	19040	24500	3.46	848
Latvia	2290	5170	2.85	147
Lithuania	1350	3240	2.18	71
Netherlands	21970	18080	3.30	597
New Zealand	13190	16780	3.15	529
Norway	26480	21120	5.26	1111
Philippines	960	2800	1.78	50
Portugal	9370	12400	2.98	370
Romania	1230	2920	1.89	55
Russian Federation	2650	5260	–	–
[7] Scotland	18410	18170	3.57	649
Singapore	23360	21430	3.38	724
Slovak Republic	2230	6660	2.69	179
Slovenia	7140	–	4.20	–
South Africa	3010	–	5.12	–
Spain	13280	14040	3.17	445
Sweden	23630	17850	4.92	878
Switzerland	37180	24390	3.72	907
Thailand	2210	6870	3.00	206
United States	25860	25860	4.02	1040

[1] The levels of education are based on the International Standard Classification of Education. The duration of Primary (level 1) and Secondary (level 2) vary depending on the country.

[2] SOURCE: The World Bank Atlas, 1996. Estimates for 1994 at current market prices in U.S. dollars, calculated by the conversion method used for the World Bank Atlas.

[3] SOURCE: The World Bank Atlas, 1996. Converted at purchasing power parity (PPP). PPP is defined as number of units of a country's currency required to buy same amounts of goods and services in domestic market as one dollar would buy in the United States.

[4] SOURCE: UNESCO Statistical Yearbook, 1995. Calculated by multiplying the Public Expenditure on Education as a % of GNP by the percentage of public education expenditure on the first and second levels of education. Figures represent the most recent figures released.

[5] Calculated by multiplying the GNP per Capita (Intl. Dollars) column by Public Expenditure on Education.

[6] GNP per capita figure for Cyprus is for 1993.

[7] The figures for England and Scotland are for the United Kingdom.

[8] Calculated using Education Department (1985) Education Indicators for the Hong Kong Education System (unpublished document).

(–) A dash indicates the data were unavailable.

Depending on the educational system, students' learning goals are commonly set at one of three main levels: the national or regional level, the school level, or the classroom level. Some countries are highly centralized, with the ministry of education (or highest authority in the system) having exclusive responsibility for making the major decisions governing the direction of education. In others, such decisions are made regionally or locally. Each approach has its strengths and weaknesses. Centralized decision making can add coherence in curriculum coverage, but may constrain a school or teacher's flexibility in tailoring instruction to the different needs of students.

Figures 1, 2, and 3 show the degree of centralization in the TIMSS countries regarding decision-making about curriculum syllabi, textbooks, and examinations. Thirty of the TIMSS participants reported nationally-centralized decision-making about curriculum. Fewer countries reported nationally-centralized decision-making about textbooks, although 16 participants were in this category. Thirteen countries reported nationally-centralized decision-making about examinations. Regional decision-making about these three aspects of education does not appear very common among the TIMSS countries, with only a few countries reporting this level of decision-making for curriculum syllabi and textbooks, and none reporting it for examinations.

Most countries reported having centralized decision-making for one or two of the areas and "not centralized" decision-making for one or two of the areas. However, six countries – Bulgaria, Hong Kong, Lithuania, the Philippines, Romania, and Singapore – reported nationally-centralized decision-making for all three areas: curriculum syllabi, textbooks, and examinations. Six countries – Australia, Hungary, Iceland, Latvia, Scotland, and the United States – reported that decision-making is not centralized for any of these areas.

Figure 1

Centralization of Decision-Making Regarding Curriculum Syllabi

Criteria

Countries are in the "Nationally Centralized" category regarding curriculum if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the syllabi for courses of study. If curriculum syllabi are determined at the regional level (e.g., state, province, territory), a country is in the "Regionally Centralized" Category. If syllabi for courses of study are not determined nationally or regionally, a country is in the "Not Centralized" category.

Nationally Centralized

Austria
Belgium (Fl)[1]
Belgium (Fr)[1]
Bulgaria
Colombia
Cyprus
Czech Republic
England
France
Greece
Hong Kong
Iran, Islamic Rep.
Ireland
Israel
Japan
Korea
Kuwait
Lithuania
New Zealand
Norway[2]
Philippines
Portugal
Romania
Singapore
Slovak Republic
Slovenia
South Africa
Spain[3]
Sweden[4]
Thailand

Regionally Centralized

Canada
Germany
Switzerland[5]

Not Centralized

Australia[6]
Denmark[7]
Hungary[8]
Iceland
Latvia
Netherlands[9]
Russian Federation
Scotland
United States

[1]Belgium: In Belgium, decision-making is centralized separately for the two educational systems.

[2]Norway: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

[3]Spain: Spain is now reforming to a regionally centralized system with high responsibility at the school level.

[4]Sweden: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

[5]Switzerland: Decision-making regarding curricula in upper secondary varies across cantons and types of education.

[6]Australia: Students tested in TIMSS were educated under a decentralized system. Reforms beginning in 1994 are introducing regionally centralized (state-determined) curriculum guidelines.

[7]Denmark: The Danish Parliament makes decisions governing the overall aim of education, and the Minister of Education sets the target, the central knowledge, and proficiency for each subject and the grades for teaching the subject. The local school administration can implement the subjects from guidelines from the Ministry; however, these are recommendations and are not mandatory.

[8]Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

[9]Netherlands: The Ministry of Education sets core objectives (for subjects in primary education and in 'basic education' at lower secondary level) and goals/objectives (for subjects in the four student ability tracks in secondary education) which schools are required to work towards. Schools have the freedom, though, to decide how to reach these objectives.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Figure 2

Centralization of Decision-Making Regarding Textbooks

Criteria

Countries are in the "Nationally Centralized" category regarding textbooks if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for determining the approved textbooks. If textbooks are selected from a regionally approved list (e.g., state, province, territory), a country is in the "Regionally Centralized" Category. If that decision-making body has less than exclusive repsonsibility for determining the approved textbooks, a country is in the "Not Centralized" category.

Nationally Centralized	Regionally Centralized	Not Centralized
Austria	Canada	Australia
Bulgaria	Germany	Belgium (Fl)
Cyprus	Japan	Belgium (Fr)
Greece	South Africa	Colombia
Hong Kong	Switzerland[2]	Czech Republic
Iran, Islamic Rep.		Denmark
Korea		England
Kuwait		France
Lithuania		Hungary[3]
Norway		Iceland
Philippines		Ireland
Romania		Israel
Singapore		Latvia
Slovenia		Netherlands
Spain[1]		New Zealand
Thailand		Portugal
		Russian Federation
		Scotland
		Slovak Republic
		Sweden
		United States

[1]Spain: Spain is now reforming to a regionally centralized system with high responsibility at the school level.
[2]Switzerland: Decision-making regarding textbooks in upper secondary varies across the cantons and the types of education.
[3]Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Figure 3

Centralization of Decision-Making Regarding Examinations

Criteria

Countries are in the "Nationally Centralized" category regarding examinations if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the content of examinations. The notes explain during which school years the examinations are administered. If that decision-making body has less than exclusive responsibility for or final approval of the examination content, the country is in the "Not Centralized" category.

Nationally Centralized

Bulgaria
Denmark[1]
England[2]
Hong Kong[3]
Ireland[4]
Lithuania
Netherlands[5]
New Zealand[6]
Philippines[7]
Romania
Russian Federation[8]
Singapore[9]
South Africa

Not Centralized

Australia[10]
Austria
Belgium (Fl)
Belgium (Fr)
Canada
Colombia
Cyprus
Czech Republic
France
Germany[11]
Greece
Hungary
Iceland
Iran, Islamic Rep.
Israel[12]
Japan
Korea
Kuwait
Latvia[13]
Norway
Portugal
Scotland
Singapore
Slovak Republic
Slovenia[14]
Spain
Sweden[15]
Switzerland
Thailand
United States

[1]Denmark: Written examinations are set and marked centrally. The Ministry of Education sets the rules and framework for oral examinations. However, oral examinations are conducted by the pupil's own teacher, together with a teacher from another local school or an external (ministry-appointed) examiner.

[2]England: Centralized national curriculum assessments taken at Years 2, 6 and 9. Regionally centralized examinations taken at Years 11 and 13.

[3]Hong Kong: Centralized examination taken at Year 11.

[4]Ireland: Centralized examinations taken at Grade 9 and Grade 12.

[5]Netherlands: School-leaving examinations consisting of a centralized part and a school-bound part are taken in the final grades of the four student ability tracks in secondary education.

[6]New Zealand: Centralized examinations taken at Years 11, 12 and 13. Centralized national monitoring at Years 4 and 8.

[7]Philippines: Centralized examinations taken at Grade 6 and Year 10 (4th year high school).

[8]Russian Federation: Centralized examinations taken in Grades 9 and 11 in mathematics and Russian/literature.

[9]Singapore: Centralized examinations taken at Grades 6,10, and 12.

[10]Australia: Not centralized as a country, but low-stakes statewide population assessments are undertaken in most states at one or more of Grades 3, 5, 6 and 10. In most states, centralized examinations are taken at Grade 12.

[11]Germany: Not centralized as a country, but is centralized within 6 (of 16) federal states.

[12]Israel: Centralized examinations taken at the end of secondary school that affect opportunities for further education.

[13]Latvia: Centralized examinations taken at Grade 9 and Grade 12.

[14]Slovenia: Two-subject national examination taken after Grade 8 (end of compulsory education); five-subject externally-assessed baccalaureat after Grade 12 for everyone entering university.

[15]Sweden: There are no examinations in Sweden.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Chapter 1

International Student Achievement in Mathematics

What Are the Overall Differences in Mathematics Achievement?

Chapter 1 summarizes achievement on the TIMSS mathematics test for each of the participating countries. Comparisons are provided overall and by gender for the upper grade tested (often the eighth grade) and the lower grade tested (often the seventh grade), as well as for 13-year-olds.

Table 1.1 presents the mean (or average) achievement for 41 countries at the eighth grade.[1] The 25 countries shown by decreasing order of mean achievement in the upper part of the table were judged to have met the TIMSS requirements for testing a representative sample of students. Although all countries tried very hard to meet the TIMSS sampling requirements, several encountered resistance from schools and teachers and did not have participation rates of 85% or higher as specified in the TIMSS guidelines (i.e., Australia, Austria, Belgium (French), Bulgaria, the Netherlands, and Scotland). To provide a better curricular match, four countries (i.e., Colombia, Germany, Romania, and Slovenia) elected to test their seventh- and eighth-grade students even though that meant not testing the two grades with the most 13-year-olds and led to their students being somewhat older than those in the other countries. The countries in the remaining two categories encountered various degrees of difficulty in implementing the prescribed methods for sampling classrooms within schools. Because the Philippines did not document clearly its procedures for sampling schools, its achievement results are presented in Appendix C. A full discussion of the sampling procedures and outcomes for each country can be found in Appendix A.

To aid in interpretation, the table also contains the years of formal schooling and average age of the students. Equivalence of chronological age does not necessarily mean that students have received the same number of years of formal schooling or studied the same curriculum. Most notably, students in the three Scandinavian countries, Sweden, Norway, and Denmark, had fewer years of formal schooling than their counterparts in other countries,[2] and those in England, Scotland, New Zealand, and Kuwait had more. Countries with a high percentage of older students may have policies that include retaining students in lower grades.

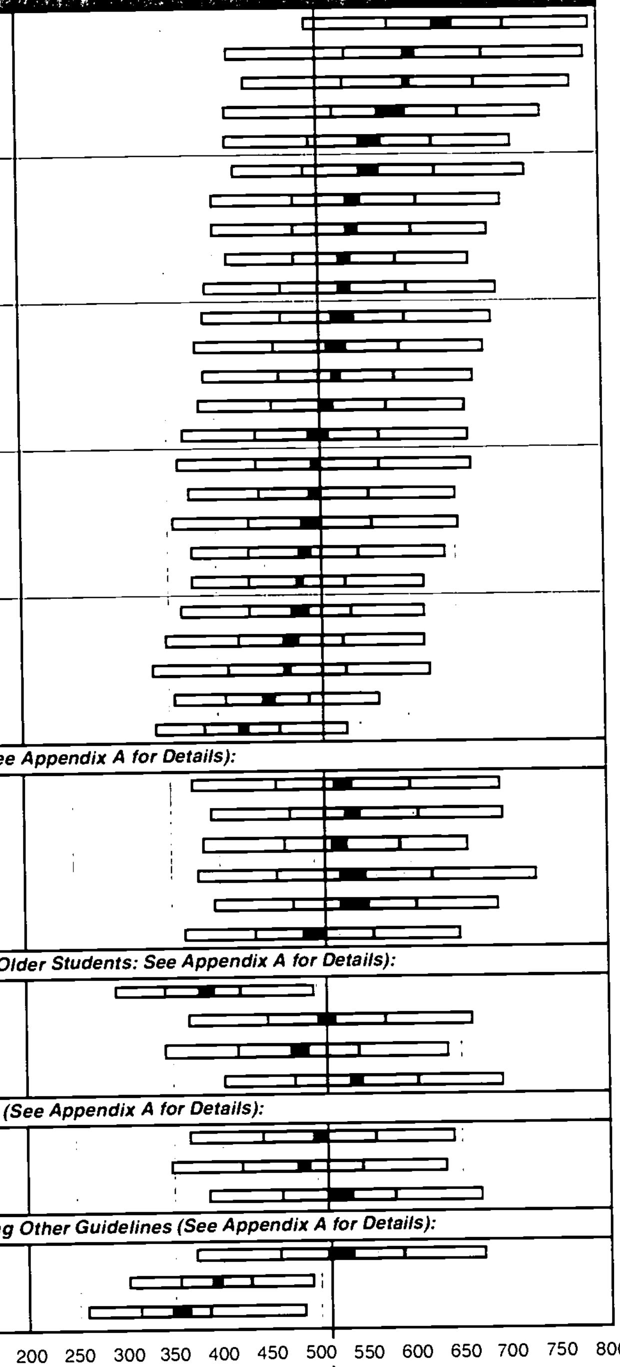
[1] TIMSS used item response theory (IRT) methods to summarize the achievement results for both grades on a scale with a mean of 500 and a standard deviation of 100. Scaling averages students' responses to the subsets of items they took in a way that accounts for differences in the difficulty of those items. It allows students' performance to be summarized on a common metric even though individual students responded to different items in the mathematics test. For more detailed information, see the "IRT Scaling and Data Analysis" section of Appendix A.

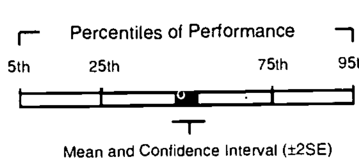
[2] Achievement results for the eighth-grade students in Denmark and Sweden, as well as for the eighth-grade students in German-speaking schools in Switzerland are presented in Appendix D.

Table 1.1

Distributions of Mathematics Achievement - Upper Grade (Eighth Grade*)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	643 (4.9)	8	14.5
Korea	607 (2.4)	8	14.2
Japan	605 (1.9)	8	14.4
Hong Kong	588 (6.5)	8	14.2
† Belgium (Fl)	565 (5.7)	8	14.1
Czech Republic	564 (4.9)	8	14.4
Slovak Republic	547 (3.3)	8	14.3
¹ Switzerland	545 (2.8)	7 or 8	14.2
France	538 (2.9)	8	14.3
Hungary	537 (3.2)	8	14.3
Russian Federation	535 (5.3)	7 or 8	14.0
Ireland	527 (5.1)	8	14.4
Canada	527 (2.4)	8	14.1
Sweden	519 (3.0)	7	13.9
New Zealand	508 (4.5)	8.5 - 9.5	14.0
†² England	506 (2.6)	9	14.0
Norway	503 (2.2)	7	13.9
† United States	500 (4.6)	8	14.2
¹ Latvia (LSS)	493 (3.1)	8	14.3
Spain	487 (2.0)	8	14.3
Iceland	487 (4.5)	8	13.6
¹ Lithuania	477 (3.5)	8	14.3
Cyprus	474 (1.9)	8	13.7
Portugal	454 (2.5)	8	14.5
Iran, Islamic Rep.	428 (2.2)	8	14.6
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	530 (4.0)	8 or 9	14.2
Austria	539 (3.0)	8	14.3
Belgium (Fr)	526 (3.4)	8	14.3
Bulgaria	540 (6.3)	8	14.0
Netherlands	541 (6.7)	8	14.3
Scotland	498 (5.5)	9	13.7
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):			
Colombia	385 (3.4)	8	15.7
†¹ Germany	509 (4.5)	8	14.8
Romania	482 (4.0)	8	14.6
Slovenia	541 (3.1)	8	14.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	502 (2.8)	7	13.9
Greece	484 (3.1)	8	13.6
Thailand	522 (5.7)	8	14.3
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
¹ Israel	522 (6.2)	8	14.1
Kuwait	392 (2.5)	9	15.3
South Africa	354 (4.4)	8	15.4





International Average = 513
(Average of All Country Means)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
¹National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
²National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 1.1

Multiple Comparisons of Mathematics Achievement - Upper Grade (Eighth Grade*)

Instructions: Read *across* the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries. †

Country	Singapore	Korea	Japan	Hong Kong	Belgium (Fl)	Czech Republic	Slovak Republic	Switzerland	*Netherlands*	*Slovenia*	*Bulgaria*	*Austria*	France	Hungary	Russian Fed.	*Australia*	Ireland	Canada	*Belgium (Fr)*	*Thailand*	*Israel*	Sweden	*Germany*	New Zealand	England	Norway	*Denmark*	United States	*Scotland*	Latvia (LSS)	Spain	Iceland	*Greece*	*Romania*	Lithuania	Cyprus	Portugal	Iran, Islamic Rep.	*Kuwait*	*Colombia*	*South Africa*
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●		●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼	▼	▼	●	●		●	▲	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	●	▼	●		●	●	●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	●	●	▲	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Israel	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●		●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		▲	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲
Kuwait	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Statistically significant at .05 level, adjusted for multiple comparisons.
Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

The results reveal substantial differences in average mathematics achievement between the top- and bottom-performing countries, although most countries had achievement somewhere in the middle ranges. To illustrate the broad range of achievement both across and within countries, Table 1.1 also provides a visual representation of the distribution of student performance within each country. Achievement for each country is shown for the 25th and 75th percentiles as well as for the 5th and 95th percentiles.[3] Each percentile point indicates the percentages of students performing below and above that point on the scale. For example, 25% of the eighth-grade students in each country performed below the 25th percentile for that country, and 75% performed above the 25th percentile.

The range between the 25th and 75th percentiles represents performance by the middle half of the students. In contrast, performance at the 5th and 95th percentiles represents the extremes in both lower and higher achievement. The dark boxes at the midpoints of the distributions show the 95% confidence intervals around the average achievement in each country.[4] These intervals can be compared to the international average of 513, which was derived by averaging across the means for each of the 41 participants shown on the table.[5] A number of countries had mean achievement well above the international average of 513, and others had mean achievement well below that level.

Comparisons also can be made across the means and percentiles. For example, average performance in Singapore was comparable to or even exceeded performance at the 95th percentile in the lower-performing countries such as Portugal, Iran, Kuwait, Colombia, and South Africa. Also, the differences between the extremes in performance were very large within most countries.

Figure 1.1 provides a method for making appropriate comparisons in overall mean achievement between countries.[6] This figure shows whether or not the differences in mean achievement between pairs of countries are statistically significant. Selecting a country of interest and reading across the table, a triangle pointing up indicates significantly higher performance than the country listed across the top, a dot indicates no significant difference in performance, and a triangle pointing down indicates significantly lower performance.

At the eighth grade, Singapore, with all triangles pointing up, had significantly higher mean achievement than other participating countries. Korea, Japan, and Hong Kong also performed very well. Korea and Japan performed similarly to each other and better than all of the other participating countries except Singapore. Besides showing no significant difference from Korea and Japan, Hong Kong also performed about the same as Flemish-speaking Belgium and the Czech Republic. Interestingly, from the top-performing countries on down through the list of participants, the differences in

[3] Tables of the percentile values and standard deviations for all countries are presented in Appendix E.

[4] See the "IRT Scaling and Data Analysis" section of Appendix A for more details about calculating standard errors and confidence intervals for the TIMSS statistics.

[5] Because the Flemish and French educational systems in Belgium participated separately, their results are presented separately in the tables in this report.

[6] The significance tests in Figures 1.1 and 1.2 are based on a Bonferroni procedure for multiple comparisons that holds to 5% the probability of erroneously declaring the mean of one country to be different from another country.

performance from one country to the next were often negligible. For example, in addition to performing similarly to each other and Hong Kong, Belgium-Flemish and the Czech Republic also performed similarly to the Slovak Republic, the Netherlands, and Bulgaria. In turn, the Slovak Republic also performed similarly to Switzerland, Slovenia, Austria, France, Hungary, and the Russian Federation.

Despite the small differences from one country to the next, however, spanning across all the participating TIMSS countries, the performance differences from the top-performing to the bottom-performing countries was very large. Because of this large range in performance, the pattern for a number of countries was one of having lower mean achievement than some countries, about the same mean achievement as some countries, and higher mean achievement than other countries. In contrast, Kuwait and Colombia, which performed similarly to each other, had significantly lower means than all other countries except South Africa.

Table 1.2 and Figure 1.2 present corresponding data for the seventh grade.[7] The cluster of the four highest performing countries is the same as at the eighth grade. Seventh-grade students in Singapore had significantly higher mean achievement than other participating countries, with Korea, Japan, and Hong Kong also performing very well and similarly to each other. For the remaining countries, performance rankings tended to be similar, but not identical, to those found at the eighth grade. For example, at the seventh grade, Flemish-speaking Belgium had higher achievement than the Czech Republic. Flemish-speaking Belgium performed as well as Hong Kong but not as well as Korea and Japan. The Czech Republic, the Netherlands, Bulgaria, Austria, the Slovak Republic, and French-speaking Belgium all performed at about the same level.

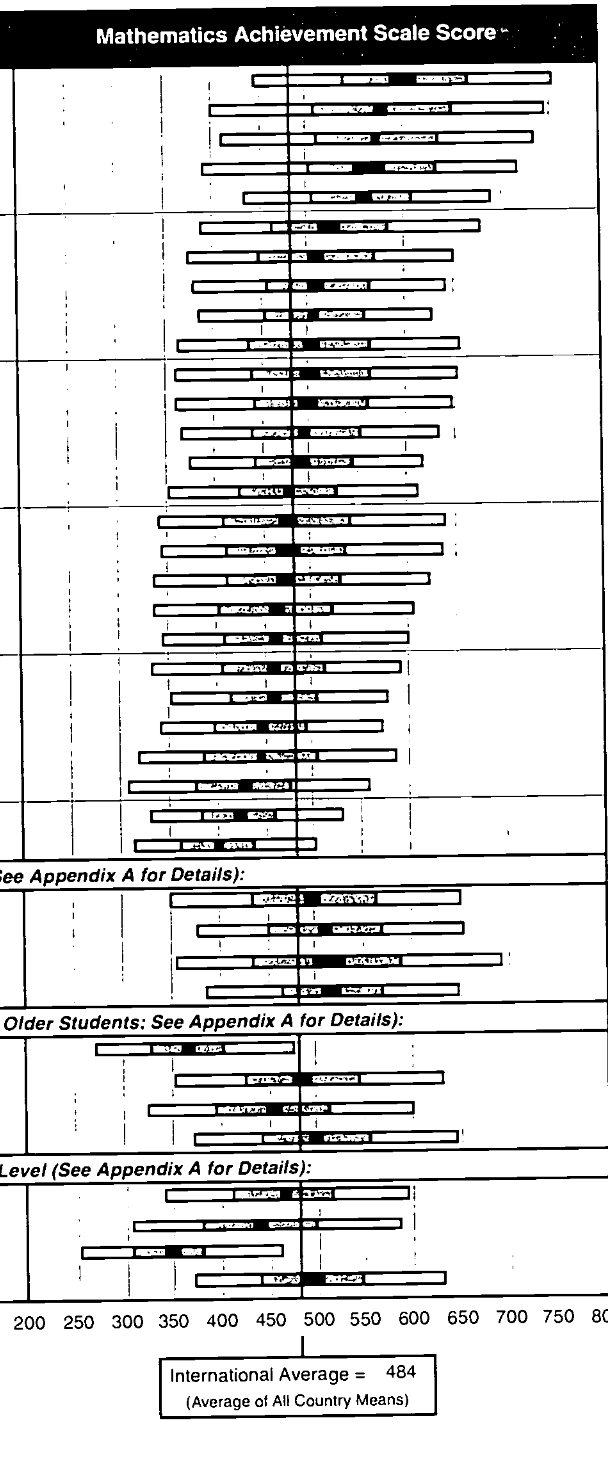
It can be noted that the international average at the eighth grade (513) was nearly 30 points higher than the international average of 484 shown at the seventh grade. Even though equivalent achievement increases cannot be assumed from grade to grade throughout schooling, this 30-point difference does provide a rough indication of grade-by-grade increases in mathematics achievement during the middle school years. By this gauge, the achievement differences across countries at both grades reflect several grade levels in learning between the higher- and lower-performing countries. A similarly large range in performance can be noted within most countries. There needs to be a further note of caution, however, in using growth from grade to grade as an indicator of achievement. The TIMSS scale measures achievement in mathematics judged to be appropriate for seventh- and eighth-grade students around the world. Thus, higher performance does not mean students can do advanced secondary-school mathematics, only that they are more proficient at middle-school mathematics.

[7] Results are presented for 27 countries in the top portion of Table 1.2 because French-speaking Belgium and Scotland met the sampling requirements at this grade. Thirty-nine countries are presented in total because Kuwait and Israel tested only the eighth grade.

Table 1.2

Distributions of Mathematics Achievement - Lower Grade (Seventh Grade*)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	601 (6.3)	7	13.3
Korea	577 (2.5)	7	13.2
Japan	571 (1.9)	7	13.4
Hong Kong	564 (7.8)	7	13.2
† Belgium (Fl)	558 (3.5)	7	13.0
Czech Republic	523 (4.9)	7	13.4
Slovak Republic	508 (3.4)	7	13.3
† Belgium (Fr)	507 (3.5)	7	13.2
[1] Switzerland	506 (2.3)	6 or 7	13.1
Hungary	502 (3.7)	7	13.4
Russian Federation	501 (4.0)	6 or 7	13.0
Ireland	500 (4.1)	7	13.4
Canada	494 (2.2)	7	13.1
France	492 (3.1)	7	13.3
Sweden	477 (2.5)	6	12.9
†[2] England	476 (3.7)	8	13.1
† United States	476 (5.5)	7	13.2
New Zealand	472 (3.8)	7.5 - 8.5	13.0
† Scotland	463 (3.7)	8	12.7
[1] Latvia (LSS)	462 (2.8)	7	13.3
Norway	461 (2.8)	6	12.9
Iceland	459 (2.6)	7	12.6
Spain	448 (2.2)	7	13.2
Cyprus	446 (1.9)	7	12.8
[1] Lithuania	428 (3.2)	7	13.4
Portugal	423 (2.2)	7	13.4
Iran, Islamic Rep.	401 (2.0)	7	13.6
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	498 (3.8)	7 or 8	13.2
Austria	509 (3.0)	7	13.3
Bulgaria	514 (7.5)	7	13.1
Netherlands	516 (4.1)	7	13.2
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):			
Colombia	369 (2.7)	7	14.5
†[1] Germany	484 (4.1)	7	13.8
Romania	454 (3.4)	7	13.7
Slovenia	498 (3.0)	7	13.8
Countries With Unapproved Sampling Procedures At The Classroom Level (See Appendix A for Details):			
Denmark	465 (2.1)	6	12.9
Greece	440 (2.8)	7	12.6
† South Africa	348 (3.8)	7	13.9
Thailand	495 (4.8)	7	13.5



*Seventh grade in most countries: see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 1.2

Multiple Comparisons of Mathematics Achievement - Lower Grade (Seventh Grade*)

Instructions: Read *across* the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.[†]

Country	Singapore	Korea	Japan	Hong Kong	Belgium (Fl)	Czech Republic	*Netherlands*	*Bulgaria*	*Austria*	Slovak Republic	Belgium (Fr)	Switzerland	Hungary	Russian Fed.	Ireland	*Slovenia*	*Australia*	*Thailand*	Canada	France	*Germany*	Sweden	England	United States	New Zealand	*Denmark*	Scotland	Latvia (LSS)	Norway	Iceland	*Romania*	Spain	Cyprus	*Greece*	Lithuania	Portugal	Iran, Islamic Rep.	*Colombia*	*South Africa*
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼	▼	▼	▼	▼		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	▼	▼	▼	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	▼	▼	▼	▼	●	●		●	●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	▼	●	●	●	●	●	●		●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	▼	●	●	●	●	●	●	●		●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	▲	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.

†Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Increases in Achievement Between the Lower and Upper Grades?

Table 1.3 shows the increases in mean achievement between the two grades tested in each TIMSS country. Countries in the upper portion of the table are shown in decreasing order by the amount of this difference. Increases in mean performance between the two grades ranged from a high of 49 points in Lithuania to a low of 8 points in the Flemish-speaking part of Belgium[8] and 7 points in South Africa.[9] This degree of increase can be compared to the difference of nearly 30 points between the international average of 513 at eighth grade and that of 484 at seventh grade. Despite the larger increases in some countries compared to others, there is no obvious relationship between mean seventh-grade performance and the difference between that and mean eighth-grade performance. That is, countries showing the highest performance at the seventh grade did not necessarily show either the largest or smallest increases in achievement at the eighth grade. Still, in general, countries with high mean performance in the seventh grade also had high mean performance in the eighth grade.

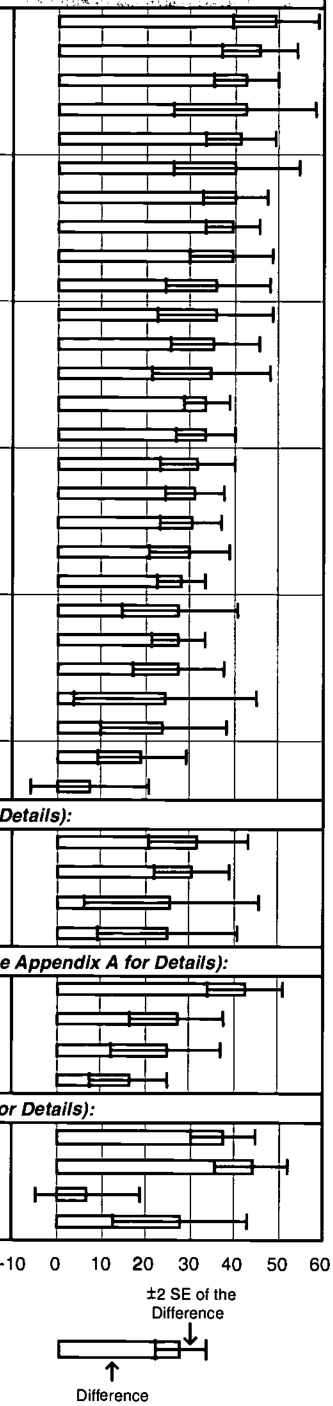
[8] Both the Flemish and French educational systems in Belgium have policies whereby lower-performing sixth-grade students continue their study of the primary school curriculum and then re-enter the system as part of a vocational track in the eighth grade. Since these lower-performing students are not included in the seventh-grade results, but do compose about 10% of the sample at the eighth grade, this contributed to reduced performance differences between the seventh and eighth grades.

[9] In South Africa, there is no structural reason to explain the relatively small difference between seventh- and eighth-grade performance. However, in 1995, its education system was undergoing radical reorganization from 18 racially-divided systems into 9 provincial systems.

Table 1.3

Achievement Differences in Mathematics Between Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Seventh Grade Mean	Eighth Grade Mean	Eighth-Seventh Difference
[1] Lithuania	428 (3.2)	477 (3.5)	49 (4.7)
France	492 (3.1)	538 (2.9)	46 (4.3)
Norway	461 (2.8)	503 (2.2)	43 (3.6)
Singapore	601 (6.3)	643 (4.9)	42 (8.0)
Sweden	477 (2.5)	519 (3.0)	41 (3.9)
Czech Republic	523 (4.9)	564 (4.9)	40 (7.0)
[1] Switzerland	506 (2.3)	545 (2.8)	40 (3.6)
Spain	448 (2.2)	487 (2.0)	39 (3.0)
Slovak Republic	508 (3.4)	547 (3.3)	39 (4.7)
New Zealand	472 (3.8)	508 (4.5)	36 (5.9)
† Scotland	463 (3.7)	498 (5.5)	36 (6.6)
Hungary	502 (3.7)	537 (3.2)	35 (4.9)
Russian Federation	501 (4.0)	535 (5.3)	35 (6.6)
Japan	571 (1.9)	605 (1.9)	34 (2.7)
Canada	494 (2.2)	527 (2.4)	33 (3.3)
[1] Latvia (LSS)	462 (2.8)	493 (3.1)	32 (4.2)
Portugal	423 (2.2)	454 (2.5)	31 (3.3)
Korea	577 (2.5)	607 (2.4)	30 (3.5)
†[2] England	476 (3.7)	506 (2.6)	30 (4.5)
Cyprus	446 (1.9)	474 (1.9)	28 (2.7)
Ireland	500 (4.1)	527 (5.1)	28 (6.6)
Iran, Islamic Rep.	401 (2.0)	428 (2.2)	27 (2.9)
Iceland	459 (2.6)	487 (4.5)	27 (5.2)
Hong Kong	564 (7.8)	588 (6.5)	24 (10.2)
† United States	476 (5.5)	500 (4.6)	24 (7.2)
† Belgium (Fr)	507 (3.5)	526 (3.4)	19 (4.9)
† Belgium (Fl)	558 (3.5)	565 (5.7)	8 (6.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	498 (3.8)	530 (4.0)	32 (5.5)
Austria	509 (3.0)	539 (3.0)	30 (4.3)
Bulgaria	514 (7.5)	540 (6.3)	26 (9.8)
Netherlands	516 (4.1)	541 (6.7)	25 (7.8)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Slovenia	498 (3.0)	541 (3.1)	43 (4.3)
Romania	454 (3.4)	482 (4.0)	27 (5.3)
†[1] Germany	484 (4.1)	509 (4.5)	25 (6.1)
Colombia	369 (2.7)	385 (3.4)	16 (4.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	465 (2.1)	502 (2.8)	37 (3.5)
Greece	440 (2.8)	484 (3.1)	44 (4.2)
South Africa	348 (3.8)	354 (4.4)	7 (5.9)
Thailand	495 (4.8)	522 (5.7)	28 (7.5)



*Seventh and eighth grades in most countries; see Table 2 for infomation about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Differences in Performance Compared to Three Marker Levels of International Mathematics Achievement?

Tables 1.4 and 1.5 portray performance in terms of international levels of achievement for the eighth and seventh grades, respectively. Since the TIMSS achievement tests do not have any pre-specified performance standards, three marker levels were chosen on the basis of the combined performance of all students at a grade level in the study — the Top 10%, the Top Quarter (25%), and the Top Half (50%). For example, Table 1.4 shows that 10% of all eighth graders in countries participating in the TIMSS study achieved at the level of 656 or better. This score point, then, was designated as the marker level for the Top 10%. Similarly, the Top Quarter marker level was determined as 587 and the Top Half marker level as 509. At the seventh grade, the three marker levels are: Top 10% – 619, Top Quarter – 551, and Top Half – 476.

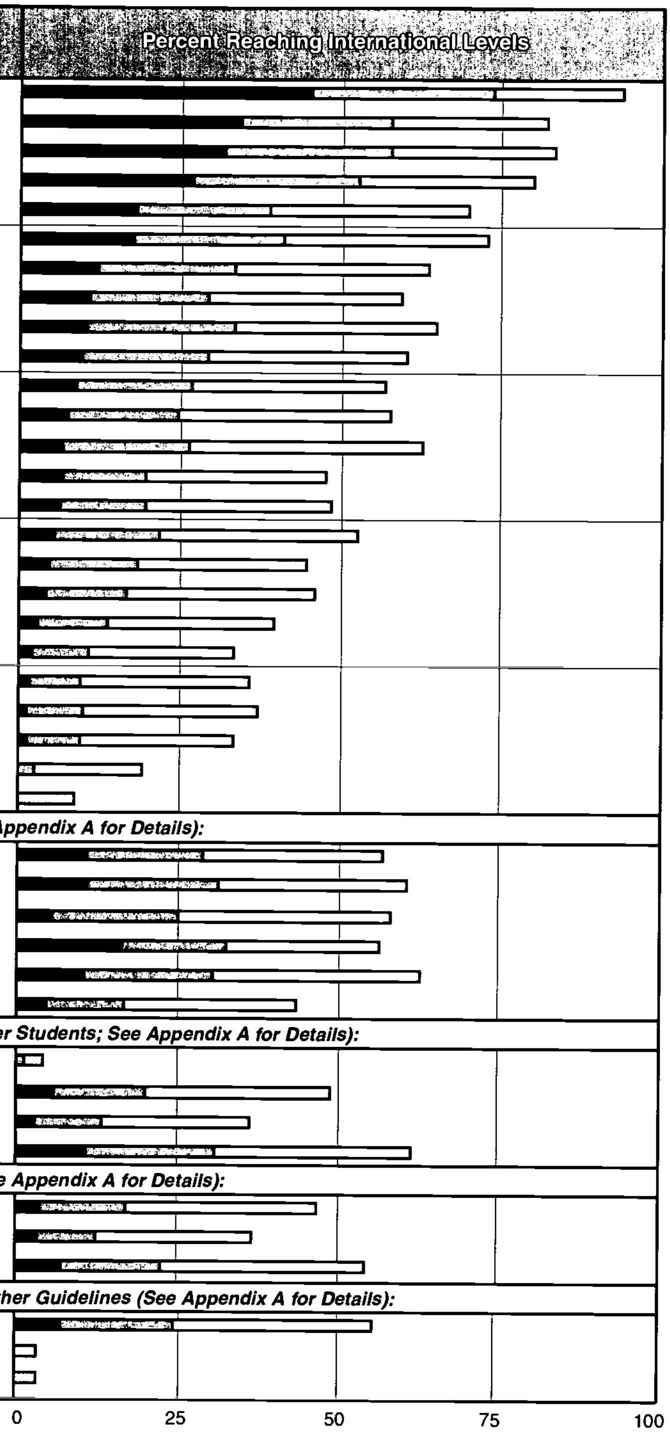
If every country had the same distribution of high-, medium-, and low-performing students, then each country would be expected to have approximately 10% of its students reaching the Top 10% level, 25% reaching the Top Quarter level, and 50% reaching the Top Half level. Although no country achieved exactly this pattern at either grade tested, the data in Tables 1.4 and 1.5 indicate that in both grades Ireland came close to the international norm from the perspective of relative percentages of high-performing students. In contrast, at both grades close to half the students in Singapore (45% at the eighth grade and 44% at the seventh grade) reached the Top 10% level, about three-fourths (74% and 70%) reached the Top Quarter level, and more than 90% performed at or above the Top Half level (94% and 91%).

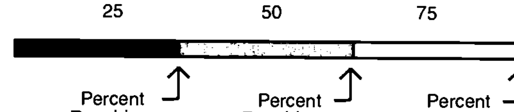
It can be informative to look at performance at each marker level. For example, the results in Table 1.4 show that students in New Zealand did not quite attain the Top 10% or Top Quarter levels for the eighth grade, with 6% and 20% of the students reaching those levels, respectively. However, performance approximated the marker level for the Top Half (48%). Achievement in England was nearly identical to that of New Zealand in this regard. In France, achievement fell somewhat short at the Top 10% level (7%), approximated the Top Quarter level (26%), and exceeded the Top Half level (63%).

Table 1.4

Percentages of Students Achieving International Marker Levels in Mathematics Upper Grade (Eighth Grade*)

Country	Top 10% Level	Top Quarter Level	Top Half Level
Singapore	45 (2.5)	74 (2.1)	94 (0.8)
Korea	34 (1.1)	58 (1.0)	82 (0.8)
Japan	32 (0.8)	58 (0.9)	83 (0.6)
Hong Kong	27 (2.1)	53 (2.6)	80 (2.4)
Czech Republic	18 (1.9)	39 (2.3)	70 (1.9)
† Belgium (Fl)	17 (1.2)	41 (2.3)	73 (2.9)
Slovak Republic	12 (1.0)	33 (1.5)	64 (1.6)
Hungary	11 (0.8)	29 (1.3)	60 (1.6)
[1] Switzerland	11 (0.7)	33 (1.2)	65 (1.4)
Russian Federation	10 (0.7)	29 (2.4)	60 (2.6)
Ireland	9 (1.0)	27 (1.9)	57 (2.4)
Canada	7 (0.7)	25 (1.1)	58 (1.2)
France	7 (0.8)	26 (1.5)	63 (1.5)
†[2] England	7 (0.6)	20 (1.1)	48 (1.4)
New Zealand	6 (0.8)	20 (1.6)	48 (2.2)
Sweden	5 (0.5)	22 (1.2)	53 (1.5)
† United States	5 (0.6)	18 (1.5)	45 (2.3)
Norway	4 (0.4)	17 (0.9)	46 (1.2)
[1] Latvia (LSS)	3 (0.5)	14 (1.2)	40 (1.5)
Cyprus	2 (0.3)	11 (0.6)	34 (1.1)
Spain	2 (0.2)	10 (0.7)	36 (1.2)
Iceland	1 (0.3)	10 (1.3)	37 (2.9)
[1] Lithuania	1 (0.3)	10 (1.0)	34 (1.8)
Portugal	0 (0.1)	2 (0.4)	19 (1.3)
Iran, Islamic Rep.	0 (0.0)	0 (0.2)	9 (0.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	11 (0.9)	29 (1.5)	57 (1.7)
Austria	11 (0.7)	31 (1.3)	61 (1.4)
Belgium (Fr)	6 (0.6)	25 (1.5)	58 (1.7)
Bulgaria	16 (1.9)	33 (2.7)	57 (2.7)
Netherlands	10 (1.6)	30 (2.7)	63 (3.2)
Scotland	5 (0.9)	17 (2.1)	44 (2.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	0 (0.0)	1 (0.3)	4 (0.8)
†[1] Germany	6 (0.7)	20 (1.7)	49 (2.3)
Romania	3 (0.4)	13 (1.1)	36 (2.0)
Slovenia	11 (0.7)	31 (1.4)	61 (1.5)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	4 (0.5)	17 (1.0)	47 (1.6)
Greece	3 (0.4)	13 (0.8)	37 (1.5)
Thailand	7 (1.2)	23 (2.6)	54 (2.7)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
[1] Israel	6 (0.9)	24 (2.5)	56 (2.6)
Kuwait	0 (0.0)	0 (0.1)	3 (0.5)
South Africa	0 (0.0)	0 (0.0)	2 (0.9)





The international levels correspond to the percentiles computed from the combined data from all of the participating countries.

Top 10% Level (90th Percentile) = 656
Top Quarter Level (75th Percentile) = 587
Top Half Level (50th Percentile) = 509

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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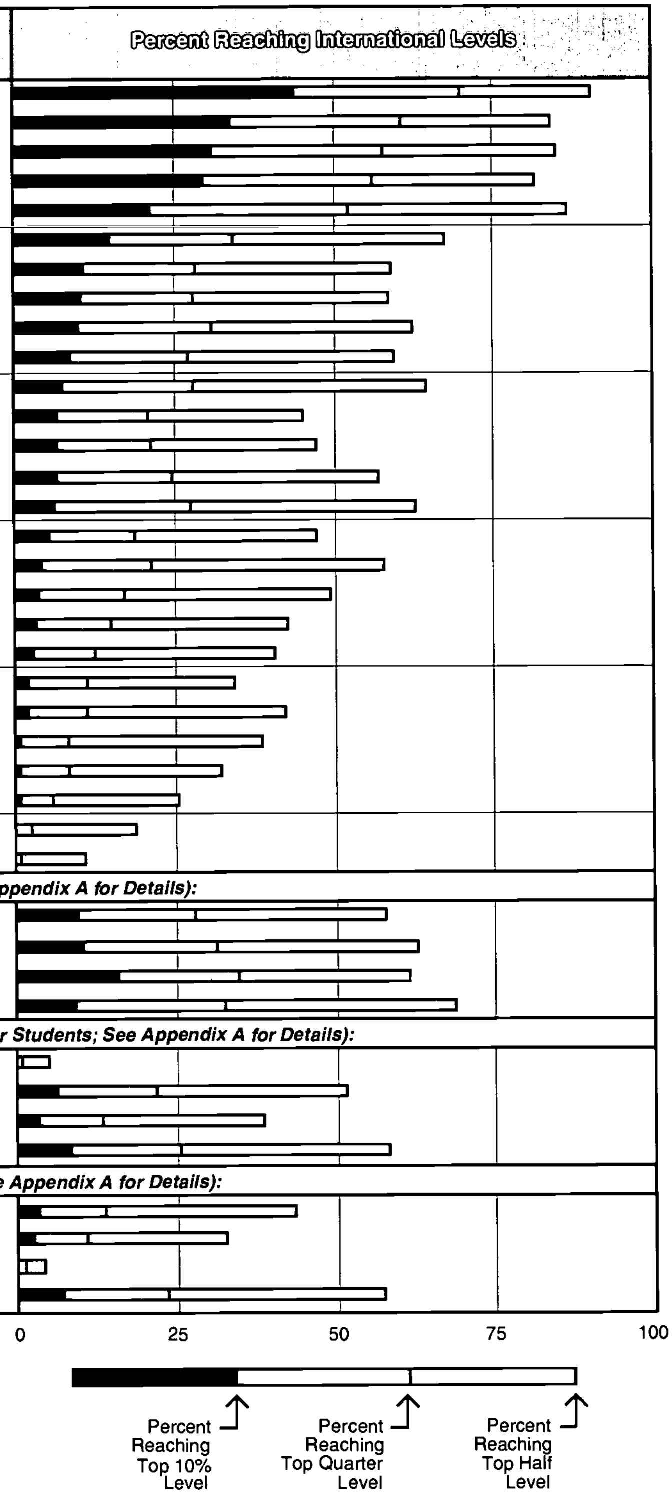
Table 1.5

Percentages of Students Achieving International Marker Levels in Mathematics Lower Grade (Seventh Grade*)

Country	Top 10% Level	Top Quarter Level	Top Half Level
Singapore	44 (3.0)	70 (2.7)	91 (1.4)
Korea	34 (1.1)	61 (1.1)	84 (0.7)
Japan	31 (1.0)	58 (0.9)	85 (0.6)
Hong Kong	30 (2.5)	56 (3.3)	81 (2.8)
† Belgium (Fl)	22 (1.8)	52 (2.0)	86 (1.2)
Czech Republic	15 (1.8)	34 (2.4)	67 (1.9)
Hungary	11 (1.1)	29 (1.5)	59 (1.8)
Russian Federation	11 (1.1)	28 (1.6)	59 (1.8)
Slovak Republic	10 (1.0)	31 (1.4)	62 (1.7)
Ireland	9 (0.9)	27 (1.7)	60 (2.2)
† Belgium (Fr)	7 (0.9)	28 (1.5)	64 (2.0)
† United States	7 (1.2)	21 (2.3)	45 (2.7)
†2 England	7 (0.9)	21 (1.4)	47 (1.7)
Canada	7 (0.5)	25 (1.0)	57 (1.4)
1 Switzerland	6 (0.5)	28 (0.9)	63 (1.3)
New Zealand	5 (0.6)	19 (1.4)	47 (2.0)
France	4 (0.4)	21 (1.3)	58 (1.9)
Sweden	4 (0.4)	17 (0.9)	50 (1.5)
† Scotland	4 (0.5)	15 (1.4)	43 (2.1)
1 Latvia (LSS)	3 (0.4)	12 (0.9)	41 (1.6)
Cyprus	2 (0.3)	11 (0.6)	35 (1.1)
Norway	2 (0.3)	11 (1.0)	42 (1.4)
Iceland	1 (0.3)	8 (0.9)	38 (1.9)
Spain	1 (0.2)	8 (0.7)	32 (1.2)
1 Lithuania	1 (0.2)	6 (0.7)	26 (1.6)
Portugal	0 (0.1)	3 (0.4)	19 (1.3)
Iran, Islamic Rep.	0 (0.0)	1 (0.2)	11 (0.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	10 (1.0)	28 (1.6)	58 (1.7)
Austria	10 (0.7)	31 (1.4)	63 (1.6)
Bulgaria	16 (2.2)	35 (3.1)	62 (2.8)
Netherlands	9 (1.3)	33 (2.4)	69 (2.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	0 (0.0)	1 (0.2)	5 (0.9)
†1 Germany	6 (0.8)	22 (1.8)	52 (2.0)
Romania	3 (0.4)	14 (1.0)	39 (1.7)
Slovenia	8 (0.7)	25 (1.4)	58 (1.6)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	3 (0.4)	14 (0.9)	44 (1.5)
Greece	2 (0.3)	11 (0.9)	32 (1.3)
† South Africa	0 (0.0)	1 (0.6)	4 (1.1)
Thailand	7 (1.2)	23 (2.3)	57 (2.5)



The international levels correspond to the percentiles computed from the combined data from all of the participating countries.

Top 10% Level (90th Percentile) = 619
Top Quarter Level (75th Percentile) = 551
Top Half Level (50th Percentile) = 476

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Gender Differences in Mathematics Achievement?

Tables 1.6 and 1.7, showing the differences in achievement by gender, reveal that, in most countries, girls and boys had approximately the same average mathematics achievement as each other at both grades. However, the differences in achievement that did exist in some countries tended to favor boys rather than girls.

Each of the two tables, the first one for the eighth grade and the second for the seventh grade, presents mean mathematics achievement separately for boys and girls for each country, as well as the difference between the means. The visual representation of the gender difference for each country, shown by a bar, indicates the amount of the difference, whether the direction of the difference favors girls or boys, and whether or not the difference is statistically significant (indicated by a darkened bar). Regardless of their directions, about three-fourths of the differences were not statistically significant, indicating that, for most countries, gender differences in mathematics achievement generally are small or negligible in the middle years of schooling. That is, nearly three-quarters of the differences favoring boys at the eighth grade and more than three-quarters at the seventh grade were not statistically significant. Also, girls had higher mean achievement than boys in nine countries (across both grades), even though those results were not statistically significant either.

From another perspective, however, all the statistically significant differences favored boys rather than girls. At both grades, boys had significantly higher mathematics achievement than girls in Japan, Iran, and Korea. Further, boys outperformed girls at the eighth grade in Spain, Portugal, Denmark, Greece, and Israel, and at the seventh grade in Belgium (French), Switzerland, and England. Also, including those differences that were not statistically significant, the direction at both grades favored boys much more often than girls. A sign test across countries indicates that internationally there is a significant difference in achievement by gender favoring males. The gender differences in mathematics, however, were much less pronounced than those in science. The TIMSS science results for seventh and eighth grades show significant gender differences favoring males to be pervasive across most countries.[10]

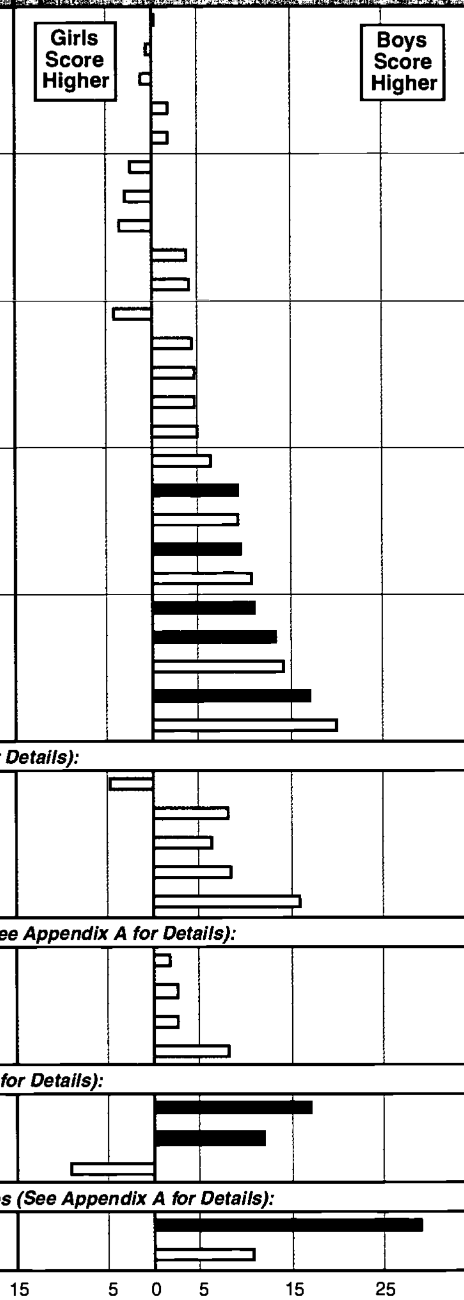
[10] Beaton, A.E., Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1996). *Science Achievement in the Middle School Years: The IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, MA: Boston College.

Table 1.6

Gender Differences in Mathematics Achievement - Upper Grade (Eighth Grade*)

Country	Boys' Mean	Girls' Mean	Difference (Absolute Value)
Hungary	537 (3.6)	537 (3.6)	0 (5.1)
[1] Lithuania	477 (4.0)	478 (4.1)	1 (5.7)
Russian Federation	535 (6.3)	536 (5.0)	1 (8.0)
Iceland	488 (5.5)	486 (5.6)	2 (7.8)
Sweden	520 (3.6)	518 (3.1)	2 (4.7)
Singapore	642 (6.3)	645 (5.4)	2 (8.3)
Cyprus	472 (2.8)	475 (2.5)	3 (3.7)
Canada	526 (3.2)	530 (2.7)	4 (4.2)
Slovak Republic	549 (3.7)	545 (3.6)	4 (5.2)
Norway	505 (2.8)	501 (2.7)	4 (3.9)
† Belgium (Fl)	563 (8.8)	567 (7.4)	4 (11.5)
†2 England	508 (5.1)	504 (3.5)	4 (6.2)
[1] Latvia (LSS)	496 (3.8)	491 (3.5)	4 (5.2)
† United States	502 (5.2)	497 (4.5)	5 (6.9)
[1] Switzerland	548 (3.5)	543 (3.1)	5 (4.7)
France	542 (3.1)	536 (3.8)	6 (4.9)
Japan	609 (2.6)	600 (2.1)	9 (3.3)
New Zealand	512 (5.9)	503 (5.3)	9 (7.9)
Spain	492 (2.5)	483 (2.6)	10 (3.6)
Czech Republic	569 (4.5)	558 (6.3)	11 (7.7)
Portugal	460 (2.8)	449 (2.7)	11 (3.9)
Iran, Islamic Rep.	434 (2.9)	421 (3.3)	13 (4.4)
Ireland	535 (7.2)	520 (6.0)	14 (9.3)
Korea	615 (3.2)	598 (3.4)	17 (4.7)
Hong Kong	597 (7.7)	577 (7.7)	20 (10.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	527 (5.1)	532 (4.6)	5 (6.9)
Austria	544 (3.2)	536 (4.5)	8 (5.6)
Belgium (Fr)	530 (4.7)	524 (3.7)	6 (6.0)
Netherlands	545 (7.8)	536 (6.4)	8 (10.1)
Scotland	506 (6.6)	490 (5.2)	16 (8.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	386 (6.9)	384 (3.6)	2 (7.7)
†1 Germany	512 (5.1)	509 (5.0)	3 (7.1)
Romania	483 (4.8)	480 (4.0)	3 (6.2)
Slovenia	545 (3.8)	537 (3.3)	8 (5.0)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	511 (3.2)	494 (3.4)	17 (4.7)
Greece	490 (3.7)	478 (3.1)	12 (4.8)
Thailand	517 (5.6)	526 (7.0)	9 (9.0)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
[1] Israel	539 (6.6)	509 (6.9)	29 (9.6)
South Africa	360 (6.3)	349 (4.1)	11 (7.5)

Gender Difference



■ Gender difference statistically significant at .05 level.
□ Gender difference not statistically significant.

International Averages		
Boys	Girls	Difference
519	512	8
(Averages of all country means)		

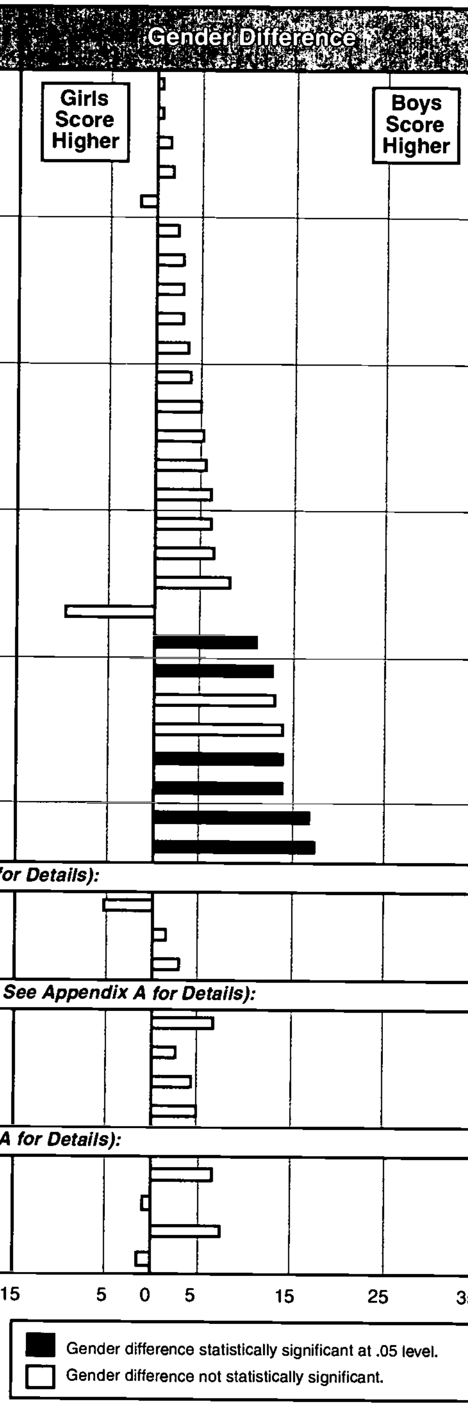
*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 1.7

Gender Differences in Mathematics Achievement - Lower Grade (Seventh Grade*)

Country	Boys' Mean	Girls' Mean	Difference Absolute Value
Cyprus	446 (2.5)	446 (2.6)	0 (3.6)
Singapore	601 (7.1)	601 (8.0)	0 (10.7)
Hungary	503 (3.8)	501 (4.4)	1 (5.8)
Canada	495 (2.7)	493 (2.6)	2 (3.8)
† Belgium (Fl)	557 (4.5)	559 (4.7)	2 (6.5)
Iceland	460 (2.7)	458 (3.2)	2 (4.2)
† Scotland	465 (4.6)	462 (3.8)	3 (5.9)
New Zealand	473 (4.6)	470 (3.8)	3 (5.9)
Russian Federation	502 (5.1)	499 (3.5)	3 (6.1)
Norway	462 (3.3)	459 (3.2)	4 (4.6)
1 Latvia (LSS)	463 (3.5)	460 (3.3)	4 (4.8)
† United States	478 (5.7)	473 (5.7)	5 (8.1)
Sweden	480 (2.8)	475 (3.2)	5 (4.2)
Spain	451 (2.7)	445 (2.7)	5 (3.8)
Slovak Republic	511 (4.4)	505 (3.3)	6 (5.5)
Portugal	426 (2.7)	420 (2.2)	6 (3.5)
Czech Republic	527 (4.8)	520 (5.6)	6 (7.4)
France	497 (3.6)	489 (3.3)	8 (4.9)
1 Lithuania	423 (3.6)	433 (3.5)	10 (5.0)
Japan	576 (2.7)	565 (2.0)	11 (3.4)
† Belgium (Fr)	514 (4.1)	501 (4.2)	13 (5.9)
Ireland	507 (6.0)	494 (4.8)	13 (7.7)
Hong Kong	570 (9.7)	556 (8.3)	14 (12.8)
Iran, Islamic Rep.	407 (2.7)	393 (2.3)	14 (3.5)
1 Switzerland	513 (2.9)	498 (2.6)	14 (3.9)
†2 England	484 (6.2)	467 (4.3)	17 (7.5)
Korea	584 (3.7)	567 (4.4)	17 (5.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	495 (5.2)	500 (4.3)	5 (6.8)
Austria	510 (4.6)	509 (3.3)	1 (5.6)
Netherlands	517 (5.2)	515 (4.3)	3 (6.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	372 (3.8)	365 (3.9)	7 (5.4)
†1 Germany	486 (4.8)	484 (4.5)	2 (6.6)
Romania	457 (3.7)	452 (3.7)	4 (5.2)
Slovenia	501 (3.5)	496 (3.2)	5 (4.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	468 (2.8)	462 (2.9)	7 (4.0)
Greece	440 (3.2)	440 (3.0)	1 (4.4)
South Africa	352 (5.3)	344 (3.3)	8 (6.2)
Thailand	494 (4.8)	495 (5.7)	1 (7.5)



International Averages		
Boys	Girls	Difference
486	481	6
(Averages of all country means)		

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are the Differences in Median Performance at Age 13?

For countries where the grades tested contained at least 75% of the 13-year-olds, TIMSS estimated the median performance for this age group. Table 1.8 provides this estimate as well as presenting estimates of the distribution of 13-year-olds across grades.[11] For many countries, the two grades tested included practically all of their 13-year-olds (nine countries have at least 98%), whereas, for some others, there were substantial percentages outside these grades, mostly in the grade below.[12] For countries included in Table 1.8, Hong Kong, Belgium (French), Hungary, France, Ireland, Latvia (LSS), Spain, Lithuania, Portugal, Austria, Romania, and Thailand had 10% or more of their 13-year-olds below the two grades tested.

The median is the point on the mathematics scale that divides the higher-performing 50% of the students from the lower-performing 50%. Like the mean, the median provides a useful summary statistic on which to compare performance across countries. It is used instead of the mean in this table because it can be reliably estimated even when scores from some members of the population are not available[13] (that is, those 13-year-olds outside the tested grades).

Notwithstanding the additional difficulties in calculating the age-based achievement estimates, the results for 13-year-olds appear quite consistent with those obtained for the two grade levels. The relative performance of countries in mathematics achievement on the basis of median performance of 13-year-olds is quite similar to that based on average eighth-grade and/or seventh-grade performance. Despite some slight differences in relative standings (generally within sampling error), the higher-performing countries in the eighth and seventh grades generally were those with higher-performing 13-year-olds.

[11] For information about the distribution of 13-year-olds in all countries, not just those with 75% coverage, see Table A.3 in Appendix A.

[12] The number of 13-year-olds below the lower grade and above the upper grade tested were extrapolated from the estimated distribution of 13-year-olds in the tested grades.

[13] Because TIMSS sampled students in the two adjacent grades with the most 13-year-olds within a country, it was possible to estimate the median for the 13-year-old students when the two tested grades included at least an estimated 75% of the 13-year-olds in that country. To compute the median, TIMSS assumed that those 13-year-old students in the grades below the tested grades would score below the median and those in the grades above the tested grades would score above the median. The percentages assumed to be above and below the median were added to the tails of the distribution before calculating the median using the modified distribution.

Table 1.8

Median Mathematics Achievement - 13-Year-Old Students
Includes Only Countries Where the Grades Tested Contained at Least 75% of the 13-Year-Olds

Country	Median	Lower Grade	Upper Grade	Estimated Distribution of 13-Year-Olds: Percent Below Lower Grade*	Percentage of 13-Year-Old Students Tested: Percent in Lower Grade	Percentage of 13-Year-Old Students Tested: Percent in Upper Grade	Percent Above Upper Grade*
Singapore	608 (7.1)	Secondary 1	Secondary 2	3.1%	82.2%	14.7%	0.0%
Korea	591 (2.2)	1st Grade Middle School	2nd Grade Middle School	1.5%	69.9%	28.2%	0.4%
Japan	572 (3.7)	1st Grade Lower Secondary	2nd Grade Lower Secondary	0.3%	90.9%	8.8%	0.0%
Hong Kong	570 (7.8)	Secondary 1	Secondary 2	10.0%	44.2%	45.6%	0.2%
† Belgium (Fl)	562 (4.6)	1A	2A & 2P	5.4%	45.6%	48.8%	0.2%
1 Switzerland	519 (2.4)	6 or 7	7 or 8	8.3%	47.6%	43.9%	0.2%
† Belgium (Fr)	516 (3.6)	1A	2A & 2P	13.3%	40.6%	46.0%	0.2%
Czech Republic	514 (5.2)	7	8	9.6%	73.3%	17.1%	0.0%
Russian Federation	511 (4.2)	7	8	4.5%	50.4%	44.3%	0.7%
Slovak Republic	511 (3.9)	7	8	4.7%	73.2%	22.1%	0.0%
Hungary	504 (3.7)	7	8	10.5%	65.1%	24.2%	20.0%
Canada	498 (5.9)	7	8	8.1%	48.4%	42.9%	0.6%
France	498 (3.0)	5ème	4ème (90%) or 4ème Technologique (10%)	20.5%	43.5%	34.7%	1.3%
Sweden	497 (2.4)	6	7	0.8%	44.9%	54.1%	0.1%
Ireland	492 (4.2)	1st Year	2nd Year	14.1%	69.0%	16.8%	0.2%
† Scotland	486 (5.7)	Secondary 1	Secondary 2	0.3%	24.0%	75.3%	0.5%
Norway	483 (2.8)	6	7	0.3%	42.5%	57.0%	0.2%
New Zealand	483 (7.2)	Form 2	Form 3	0.5%	51.7%	47.4%	0.4%
†2 England	482 (4.4)	Year 8	Year 9	0.6%	57.2%	41.7%	0.5%
Iceland	479 (4.5)	7	8	0.2%	16.5%	83.0%	0.4%
† United States	472 (5.4)	7	8	9.0%	57.8%	33.1%	0.2%
Cyprus	460 (2.5)	7	8	1.7%	27.7%	69.9%	0.7%
1 Latvia (LSS)	455 (3.2)	7	8	14.3%	59.5%	26.0%	0.2%
Spain	452 (3.3)	7 EGB	8 EGB	14.9%	45.8%	39.0%	0.3%
1 Lithuania	429 (3.4)	7	8	10.1%	64.1%	25.6%	0.2%
Portugal	416 (1.8)	Grade 7	Grade 8	23.5%	44.1%	32.1%	0.3%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix for Details):							
Australia	499 (4.3)	7 or 8	8 or 9	7.5%	63.6%	28.4%	0.5%
Austria	509 (3.1)	3. Klasse	4. Klasse	10.7%	62.4%	26.9%	0.0%
Bulgaria	516 (6.9)	7	8	3.2%	58.1%	36.9%	1.8%
Netherlands	519 (5.3)	Secondary 1	Secondary 2	9.8%	58.7%	31.2%	0.4%
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix for Details):							
Romania	419 (3.9)	7	8	23.9%	66.6%	9.3%	0.3%
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix for Details):							
Denmark	485 (3.5)	6	7	1.0%	34.6%	63.5%	0.9%
Greece	474 (3.8)	Secondary 1	Secondary 2	3.1%	11.2%	84.5%	1.2%
Thailand	483 (6.9)	Secondary 1	Secondary 2	18.0%	58.4%	19.6%	4.0%

*Data are extrapolated: students below the lower grade and above the upper grade were not included in the sample. Denmark, Sweden and Switzerland tested 3 grades.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Chapter 2

Average Achievement in the Mathematics Content Areas

Recognizing that important curricular differences exist between and within countries is an important aspect of IEA studies, and TIMSS attempted to measure achievement in different areas within mathematics that would be useful in relating achievement to curriculum. After much deliberation, the mathematics test for the seventh and eighth grades was designed to enable reporting by six content areas.[1] These six content areas include:

- fractions and number sense
- geometry
- algebra
- data representation, analysis, and probability
- measurement
- proportionality

Following the discussion in this chapter about differences in average achievement for the TIMSS countries across the content areas, Chapter 3 contains further information about the types of items within each content area, including a range of five or six example items within each content area and the percent of correct responses on those items for each of the TIMSS countries.

How Does Achievement Differ Across Mathematics Content Areas?

As we have seen in Chapter 1, there are substantial differences in achievement among the participating countries on the TIMSS mathematics test. Given that the mathematics test was designed to include items from different curricular areas, it is important to examine whether or not the participating countries have particular strengths and weaknesses in their achievement in these content areas.

This chapter uses an analysis based on the average percent of correct responses to items within each content area to address the question of whether or not countries performed at the same level in each of the content areas as they did on the mathematics test as a whole. Because additional resources and time would have been required to use the more complex IRT scaling methodology that served as the basis for the overall achievement estimates in Chapter 1, TIMSS could not generate scale scores for the six content areas for this report.[2]

[1] Please see the test development section of Appendix A for more information about the process used to develop the TIMSS tests. Appendix B provides an analysis of the match between the test and curriculum in the different TIMSS countries and the effect of this match on the TIMSS results.

[2] TIMSS plans to generate IRT scale scores for the mathematics content areas for future reports.

Tables 2.1 and 2.2 provide the average percent of correct responses to items in the different content areas for the eighth- and seventh-grade students, respectively. The countries are listed in order of their average percent correct across all items in the test. As indicated by the numbers of items overall and in each content area, the overall test contains more fractions and number sense items (34%) and fewer proportionality items (7%). Thus, countries that did well on the items testing fractions and number sense were more likely to have higher overall scores than those that performed better in proportionality.[3]

The results for the average percent correct across all mathematics items are provided for each country primarily to provide a basis of comparison for performance in each of the content areas. For the purpose of comparing overall achievement between countries, it is preferable to use the results presented in Chapter 1.[4] It is interesting to note, however, that even though the relative standings of countries differ somewhat from Tables 1.1 and 1.2, the slight differences are well within the limits expected by sampling error and can be attributed to the differences in the methodologies used.

The data in each column show each country's average percent correct for items in that content area and the international average across all countries for the content area (shown as the last entry in the column). Looking down each of the columns, in turn, two findings become apparent. First, the countries that did well on the overall test generally did well in each of the various content areas, and those that did poorly overall also tended to do so in each of the content areas. There are differences between the relative standing of countries within each of the content areas and their overall standing, but these differences are small when sampling error is considered.

Second, the international averages show that the different content areas in the TIMSS test were not equally difficult for the students taking the test. Data representation, analysis, and probability was the least difficult content area for both grades. On average, the items in this content area were answered correctly by 62% of the eighth-graders and 57% of the seventh-graders across countries. Internationally, the proportionality items (international averages of 45% at eighth grade and 40% at seventh grade) were the most difficult items for the students at both grades.

It is important to keep these differences in average difficulty in mind when reading across the rows of the table. These differences mean that for many countries, students will appear to have higher than average performance in data representation, analysis, and probability and lower than average performance in proportionality. For example, even the eighth-grade students in Singapore, who performed above the international average for the area of proportionality by a substantial margin, still

[3] Table A.1 in Appendix A provides details about the distributions of items across the content areas, by format and score points (taking into account multi-part items and items scored for partial credit).

[4] The IRT scale scores provide better estimates of overall achievement, because they take the difficulty of items into account. This is important in a study such as TIMSS, where different students take overlapping but somewhat different sets of items.

Table 2.1

Average Percent Correct by Mathematics Content Areas
Upper Grade (Eighth Grade*)

Country	Mathematics Overall (151 items)	Fractions & Number Sense (51 items)	Geometry (23 items)	Algebra (27 items)	Data Representation, Analysis & Probability (21 items)	Measurement (18 items)	Proportionality (11 items)
Singapore	79 (0.9)	84 (0.8)	76 (1.0)	76 (1.1)	79 (0.8)	77 (1.0)	75 (1.0)
Japan	73 (0.4)	75 (0.4)	80 (0.4)	72 (0.6)	78 (0.4)	67 (0.5)	61 (0.5)
Korea	72 (0.5)	74 (0.5)	75 (0.6)	69 (0.6)	78 (0.6)	66 (0.7)	62 (0.6)
Hong Kong	70 (1.4)	72 (1.4)	73 (1.5)	70 (1.5)	72 (1.3)	65 (1.7)	62 (1.4)
† Belgium (Fl)	66 (1.4)	71 (1.2)	64 (1.5)	63 (1.7)	73 (1.3)	60 (1.3)	53 (1.8)
Czech Republic	66 (1.1)	69 (1.1)	66 (1.1)	65 (1.3)	68 (0.9)	62 (1.2)	52 (1.3)
Slovak Republic	62 (0.8)	66 (0.8)	63 (0.8)	62 (0.9)	62 (0.7)	60 (0.9)	49 (1.0)
1 Switzerland	62 (0.6)	67 (0.7)	60 (0.8)	53 (0.7)	72 (0.7)	61 (0.8)	52 (0.7)
Hungary	62 (0.7)	65 (0.8)	60 (0.8)	63 (0.9)	66 (0.7)	56 (0.8)	47 (0.9)
France	61 (0.8)	64 (0.8)	66 (0.8)	54 (1.0)	71 (0.8)	57 (0.9)	49 (0.9)
Russian Federation	60 (1.3)	62 (1.2)	63 (1.4)	63 (1.5)	60 (1.2)	56 (1.5)	48 (1.5)
Canada	59 (0.5)	64 (0.6)	58 (0.6)	54 (0.7)	69 (0.5)	51 (0.7)	48 (0.7)
Ireland	59 (1.2)	65 (1.2)	51 (1.3)	53 (1.3)	69 (1.1)	53 (1.3)	51 (1.2)
Sweden	56 (0.7)	62 (0.8)	48 (0.7)	44 (0.9)	70 (0.7)	56 (0.9)	44 (0.9)
New Zealand	54 (1.0)	57 (1.1)	54 (1.1)	49 (1.1)	66 (1.0)	48 (1.2)	42 (1.0)
Norway	54 (0.5)	58 (0.6)	51 (0.6)	45 (0.7)	66 (0.6)	51 (0.6)	40 (0.6)
†2 England	53 (0.7)	54 (0.8)	54 (1.0)	49 (0.9)	66 (0.7)	50 (0.9)	41 (1.1)
† United States	53 (1.1)	59 (1.1)	48 (1.2)	51 (1.2)	65 (1.1)	40 (1.1)	42 (1.1)
1 Latvia (LSS)	51 (0.8)	53 (0.9)	57 (0.8)	51 (0.9)	56 (0.8)	47 (0.9)	39 (0.9)
Spain	51 (0.5)	52 (0.5)	49 (0.6)	54 (0.8)	60 (0.7)	44 (0.7)	40 (0.8)
Iceland	50 (1.1)	54 (1.2)	51 (1.4)	40 (1.3)	63 (1.1)	45 (1.4)	38 (1.4)
1 Lithuania	48 (0.9)	51 (1.0)	53 (1.1)	47 (1.2)	52 (1.0)	43 (0.9)	35 (0.9)
Cyprus	48 (0.5)	50 (0.6)	47 (0.6)	48 (0.7)	53 (0.6)	44 (0.9)	40 (0.7)
Portugal	43 (0.7)	44 (0.7)	44 (0.8)	40 (0.8)	54 (0.7)	39 (0.7)	32 (0.8)
Iran, Islamic Rep.	38 (0.6)	39 (0.6)	43 (0.8)	37 (0.8)	41 (0.6)	29 (1.2)	36 (0.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):							
Australia	58 (0.9)	61 (0.9)	57 (1.0)	55 (1.0)	67 (0.8)	54 (1.0)	47 (0.9)
Austria	62 (0.8)	66 (0.8)	57 (1.0)	59 (0.8)	68 (0.8)	62 (1.0)	49 (0.9)
Belgium (Fr)	59 (0.9)	62 (1.0)	58 (1.0)	53 (1.1)	68 (1.0)	56 (1.0)	48 (0.9)
Bulgaria	60 (1.2)	60 (1.4)	65 (1.3)	62 (1.5)	62 (1.1)	54 (1.6)	47 (1.5)
Netherlands	60 (1.6)	62 (1.6)	59 (1.8)	53 (1.6)	72 (1.7)	57 (1.6)	51 (1.9)
Scotland	52 (1.3)	53 (1.3)	52 (1.4)	46 (1.5)	65 (1.3)	48 (1.6)	40 (1.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):							
Colombia	29 (0.8)	31 (0.9)	29 (0.9)	28 (0.9)	37 (1.0)	25 (1.5)	23 (0.9)
†1 Germany	54 (1.1)	58 (1.1)	51 (1.4)	48 (1.3)	64 (1.2)	51 (1.1)	42 (1.3)
Romania	49 (1.0)	48 (1.0)	52 (0.9)	52 (1.3)	49 (1.0)	48 (1.1)	42 (1.2)
Slovenia	61 (0.7)	63 (0.7)	60 (0.9)	61 (0.8)	66 (0.7)	59 (0.9)	49 (0.8)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):							
Denmark	52 (0.7)	53 (0.9)	54 (0.9)	45 (0.7)	67 (0.9)	49 (1.0)	41 (0.8)
Greece	49 (0.7)	53 (0.8)	51 (0.7)	46 (0.8)	56 (0.8)	43 (0.9)	39 (1.1)
Thailand	57 (1.4)	60 (1.5)	62 (1.3)	53 (1.7)	63 (1.1)	50 (1.4)	51 (1.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):							
1 Israel	57 (1.3)	60 (1.4)	57 (1.4)	61 (1.6)	63 (1.3)	48 (1.6)	43 (1.6)
Kuwait	30 (0.7)	27 (0.8)	38 (1.0)	30 (1.0)	38 (1.0)	23 (1.0)	21 (0.7)
South Africa	24 (1.1)	26 (1.4)	24 (1.0)	23 (1.1)	26 (1.2)	18 (1.1)	21 (0.9)
International Average Percent Correct	55 (0.1)	58 (0.1)	56 (0.1)	52 (0.2)	62 (0.1)	51 (0.1)	45 (0.2)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.2

Average Percent Correct by Mathematics Content Areas
Lower Grade (Seventh Grade*)

Country	Mathematics Overall (151 items)	Fractions & Number Sense (51 items)	Geometry (23 items)	Algebra (27 items)	Data Representation, Analysis & Probability (21 items)	Measurement (18 items)	Proportionality (11 items)
Singapore	73 (1.3)	79 (1.2)	69 (1.4)	68 (1.4)	72 (1.2)	70 (1.5)	71 (1.4)
Japan	67 (0.4)	71 (0.4)	70 (0.4)	64 (0.6)	73 (0.5)	62 (0.6)	55 (0.6)
Korea	67 (0.6)	70 (0.6)	70 (0.7)	64 (0.7)	73 (0.5)	62 (0.8)	55 (0.7)
Hong Kong	65 (1.8)	67 (1.7)	68 (1.9)	66 (2.0)	69 (1.5)	62 (2.0)	55 (1.7)
† Belgium (Fl)	65 (0.8)	72 (0.8)	59 (0.9)	60 (1.0)	73 (0.9)	59 (1.0)	54 (1.0)
Czech Republic	57 (1.2)	61 (1.4)	58 (1.1)	55 (1.2)	61 (1.1)	55 (1.2)	41 (1.3)
† Belgium (Fr)	54 (0.9)	59 (1.0)	55 (1.0)	44 (1.0)	64 (1.0)	53 (1.0)	44 (1.0)
Slovak Republic	54 (0.8)	58 (0.9)	57 (0.8)	50 (1.0)	56 (0.7)	52 (1.0)	41 (1.0)
Hungary	54 (0.8)	59 (0.9)	52 (0.9)	52 (1.1)	60 (0.8)	49 (1.0)	38 (1.0)
Ireland	53 (1.0)	62 (1.1)	43 (0.9)	47 (1.1)	64 (0.9)	46 (1.1)	46 (1.1)
[1] Switzerland	53 (0.5)	60 (0.7)	46 (0.6)	41 (0.6)	65 (0.7)	53 (0.8)	44 (0.7)
Russian Federation	53 (0.9)	56 (1.0)	55 (1.2)	55 (1.0)	55 (1.0)	47 (1.0)	40 (1.1)
Canada	52 (0.5)	58 (0.6)	50 (0.7)	43 (0.7)	63 (0.6)	44 (0.6)	42 (0.7)
France	51 (0.8)	53 (0.8)	58 (0.9)	39 (0.8)	63 (0.8)	49 (1.0)	41 (1.0)
† United States	48 (1.2)	54 (1.4)	44 (1.1)	44 (1.3)	60 (1.2)	36 (1.4)	38 (1.2)
†[2] England	47 (0.9)	48 (1.0)	49 (0.9)	41 (1.0)	62 (0.9)	43 (0.9)	38 (1.0)
Sweden	47 (0.6)	51 (0.8)	43 (0.6)	35 (0.6)	64 (0.9)	47 (0.7)	36 (0.8)
New Zealand	46 (0.9)	50 (0.9)	46 (1.1)	39 (0.9)	59 (1.0)	40 (1.0)	38 (1.0)
† Scotland	44 (0.9)	47 (1.0)	46 (1.1)	36 (0.8)	58 (1.0)	40 (0.9)	34 (0.8)
Norway	44 (0.7)	49 (0.9)	42 (0.7)	32 (0.7)	59 (0.9)	44 (0.9)	34 (0.7)
[1] Latvia (LSS)	44 (0.7)	46 (0.8)	48 (0.8)	43 (1.0)	49 (0.8)	41 (0.8)	33 (1.0)
Iceland	43 (0.7)	49 (1.0)	47 (0.7)	31 (0.6)	56 (0.8)	38 (0.8)	33 (0.7)
Spain	42 (0.6)	43 (0.6)	43 (0.7)	41 (0.7)	52 (0.7)	38 (0.7)	35 (0.7)
Cyprus	42 (0.4)	46 (0.5)	43 (0.6)	39 (0.5)	48 (0.6)	34 (0.5)	36 (0.7)
[1] Lithuania	38 (0.8)	41 (0.9)	38 (1.0)	38 (1.0)	44 (0.9)	32 (0.9)	25 (0.7)
Portugal	37 (0.6)	39 (0.6)	38 (0.8)	31 (0.7)	46 (0.6)	34 (0.7)	25 (0.6)
Iran, Islamic Rep.	32 (0.5)	34 (0.6)	40 (0.9)	28 (0.6)	36 (0.7)	23 (0.7)	30 (0.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):							
Australia	52 (0.8)	56 (0.9)	52 (0.8)	47 (1.0)	63 (0.9)	48 (1.0)	41 (0.9)
Austria	56 (0.7)	61 (0.8)	52 (0.9)	48 (0.8)	63 (0.8)	55 (0.8)	44 (1.0)
Bulgaria	55 (1.7)	56 (1.8)	61 (1.8)	58 (2.2)	56 (1.1)	52 (1.8)	44 (2.1)
Netherlands	55 (1.0)	60 (1.2)	54 (1.1)	42 (1.0)	69 (1.0)	52 (1.2)	51 (1.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):							
Colombia	26 (0.6)	28 (0.7)	26 (0.9)	24 (0.8)	32 (0.8)	22 (0.7)	21 (0.9)
†[1] Germany	49 (1.0)	55 (1.2)	46 (1.1)	39 (1.4)	61 (1.1)	46 (0.9)	37 (1.0)
Romania	43 (0.8)	43 (0.8)	48 (1.0)	46 (1.0)	44 (0.7)	42 (1.1)	35 (0.9)
Slovenia	53 (0.7)	56 (0.7)	52 (0.8)	48 (0.8)	60 (0.7)	50 (0.8)	39 (0.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):							
Denmark	44 (0.5)	45 (0.7)	46 (0.8)	36 (0.7)	59 (0.8)	41 (0.7)	34 (0.7)
Greece	40 (0.6)	47 (0.7)	39 (0.7)	33 (0.7)	46 (0.7)	35 (0.8)	34 (0.7)
† South Africa	23 (0.9)	26 (1.1)	22 (0.9)	20 (0.8)	25 (1.1)	17 (1.0)	20 (0.8)
Thailand	52 (1.2)	56 (1.3)	57 (1.0)	45 (1.3)	57 (1.1)	44 (1.4)	46 (1.3)
International Average Percent Correct	49 (0.1)	53 (0.2)	49 (0.2)	44 (0.2)	57 (0.1)	45 (0.2)	40 (0.2)

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

performed somewhat less well in this area than they did on the test as a whole. That is, simply comparing performance across the rows gives an unclear picture of each country's relative performance across the content areas because the differing difficulty of the items has not been taken into account.

To facilitate more meaningful comparisons across rows, TIMSS has developed profiles of relative performance, which are shown for both grades in Table 2.3. These profiles are designed to show whether participating countries performed better or worse in some content areas than they did on the test as a whole, after adjusting for the differing difficulty of the items in each of the content areas.[5] An up-arrow indicates that a country did significantly better in a content area than it did on the test as a whole, a down-arrow indicates significantly lower performance, and a circle indicates that the country's performance in a content area is not very different from its performance on the test as a whole.[6]

The profiles in Table 2.3 reveal that many countries performed relatively better or worse in several content areas than they did overall. Except in the Netherlands at the seventh grade, each country had at least one content area in which it did relatively better or worse than it did on average. Although countries that did well in one content area tended to do well in others, there were still significant performance differences by content area among countries. For example, countries that performed relatively better in fractions and number sense often were different from those that performed relatively better in geometry and algebra. Also, although there were some differences between the two grades, relative performance tended to be similar at both the seventh and eighth grades.

Singapore, Belgium (Flemish), Hungary, Ireland, Switzerland, Canada, the United States, and Germany all performed relatively better in fractions and number sense than they did on the test as a whole at both grades. The countries performing relatively better in geometry at both grades included Japan, Korea, Hong Kong, the Russian Federation, France, Latvia (LSS), Iran, Romania, and Thailand. In algebra, the countries performing relatively better at both grades were Japan, Hong Kong, the Czech Republic, the Slovak Republic, Hungary, the Russian Federation, Spain, Cyprus, Romania, and South Africa. This is consistent with the existence of differing curricular patterns and

[5] Since the items in the different content areas varied in difficulty, the first step was to adjust the average percents to make all content areas equally difficult so that the comparisons would not reflect the various difficulties of the items in the content areas. The next step was to subtract these adjusted percentages for each content area from a country's average percentage over all six content areas. If the overall percentage of correct items by students in a country was the same as the adjusted average for that country for each of the content areas, then these differences would all be zero. The standard errors for these differences were computed, and then each difference was examined for statistical significance. This approach is similar to testing interaction terms in the analysis of variance. The jackknife method was used to compute the standard error of each interaction term. The significance level was adjusted using the Bonferroni method, assuming 6x41 (content areas by countries) comparisons at the eighth grade and 6x39 at the seventh grade.

[6] The statistics are not independent. That is, a country cannot do better (or worse) than its average on all scales, since a country's differences must add up to zero. However, it is possible for a country to have no statistically significant differences in performance.

approaches among countries as discussed in the curriculum analysis report, *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.*[7] This report indicates that a number of the Pacific Rim and Eastern European countries focus on geometry and algebra during the middle-school years.

[7] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Table 2.3

Profiles of Relative Performance in Mathematics Content Areas - Lower and Upper Grades (Seventh and Eighth Grades*) - Indicators of Statistically Significant Differences from Overall Percent Correct Adjusted for the Difficulty of the Content Areas

Seventh Grade

Country	Fractions & Number Sense	Geometry	Algebra	Data Rep., Analy. & Probability	Measurement	Proportionality
Singapore	▲	▼	●	▼	▲	▲
Japan	●	▲	▲	▼	●	▼
Korea	●	▲	▲	▼	●	▼
Hong Kong	▼	▲	▲	▼	●	●
† Belgium (Fl)	▲	▼	●	●	●	●
Czech Republic	●	●	▲	▼	▲	▼
† Belgium (Fr)	●	●	▼	●	▲	●
Slovak Republic	●	▲	▲	▼	▲	▼
Hungary	▲	●	▲	●	●	▼
Ireland	▲	▼	●	▲	▼	▲
1 Switzerland	▲	▼	▼	▲	▲	●
Russian Federation	●	▲	▲	▼	●	▼
Canada	▲	●	▼	▲	▼	●
France	▼	▲	▼	▲	●	●
† United States	▲	▼	▲	▲	▼	●
†2 England	▼	●	●	▲	●	●
Sweden	●	▼	▼	▲	▲	▼
New Zealand	●	●	▼	▲	▼	●
† Scotland	▼	●	▼	▲	●	●
Norway	●	▼	▼	▲	▲	●
1 Latvia (LSS)	▼	▲	▲	▼	●	▼
Iceland	●	▲	▼	▲	●	●
Spain	▼	●	▲	●	●	▲
Cyprus	●	●	▲	▼	▼	▲
1 Lithuania	●	●	▲	▼	●	▼
Portugal	▼	●	●	▲	●	▼
Iran, Islamic Rep.	▼	▲	●	▼	▼	▲
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	▲	▼	●	●	▲	●
Austria	▼	▲	▲	▼	●	●
Bulgaria	●	▼	▼	▲	●	▲
Netherlands	●	●	●	●	●	●
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	▼	●	▲	▼	●	▲
†1 Germany	▲	▼	▼	▲	▲	▼
Romania	▼	▲	▲	▼	●	●
Slovenia	●	●	●	●	▲	▼
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▼	●	▼	▲	●	●
Greece	▲	●	▼	▼	●	▲
† South Africa	●	▼	▲	▼	▼	▲
Thailand	●	▲	▼	▼	▼	▲
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						

Eighth Grade

Country	Fractions & Number Sense	Geometry	Algebra	Data Rep., Analy. & Probability	Measurement	Proportionality
Singapore	▲	▼	●	▼	▲	▲
Japan	▼	▲	▲	▼	▼	▼
Korea	●	▲	●	●	●	●
Hong Kong	●	▲	▲	▼	●	▲
† Belgium (Fl)	▲	▼	●	●	●	▼
Czech Republic	●	●	▲	▼	▲	▼
Slovak Republic	▲	●	▲	▼	▲	▼
1 Switzerland	▲	▼	▼	▲	▲	●
Hungary	▲	●	▲	▼	●	▼
France	●	▲	▼	▲	●	▼
Russian Federation	●	▲	▲	▼	●	●
Canada	▲	●	▼	▲	▼	●
Ireland	▲	▼	▼	▲	●	▲
Sweden	▲	▼	▼	▲	▲	●
New Zealand	●	●	▼	▲	●	●
Norway	▲	▼	▼	▲	▲	▼
†2 England	▼	●	▼	▲	●	●
† United States	▲	▼	●	▲	▼	●
1 Latvia (LSS)	▼	▲	●	▼	●	▼
Spain	▼	▼	▲	●	▼	●
Iceland	▲	●	▼	▲	●	●
1 Lithuania	●	▲	●	▼	●	▼
Cyprus	●	●	▲	▼	●	●
Portugal	▼	●	●	▲	●	●
Iran, Islamic Rep.	▼	▲	●	▼	▼	▲
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	●	▼	●	▲	●	●
Austria	▲	▼	●	●	▲	▼
Belgium (Fr)	●	●	▼	▲	▲	●
Bulgaria	▼	▲	▲	▼	●	●
Netherlands	●	●	▼	▲	●	●
Scotland	▼	●	▼	▲	●	●
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	●	●	●	●	●	▲
†1 Germany	▲	▼	▼	▲	▲	●
Romania	▼	▲	▲	▼	▲	▲
Slovenia	●	●	▲	▼	▲	●
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▼	●	▼	▲	●	●
Greece	●	●	●	●	▼	●
Thailand	●	▲	▼	▼	▼	▲
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	●	●	▲	●	▼	▼
Kuwait	▼	▲	●	●	▼	●
South Africa	●	●	▲	▼	▼	▲

▲ = Significantly higher than overall average ● = No significant difference from overall average ▼ = Significantly lower than overall average

*Seventh and eighth grades in most countries: see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are the Increases in Achievement Between the Lower and Upper Grades?

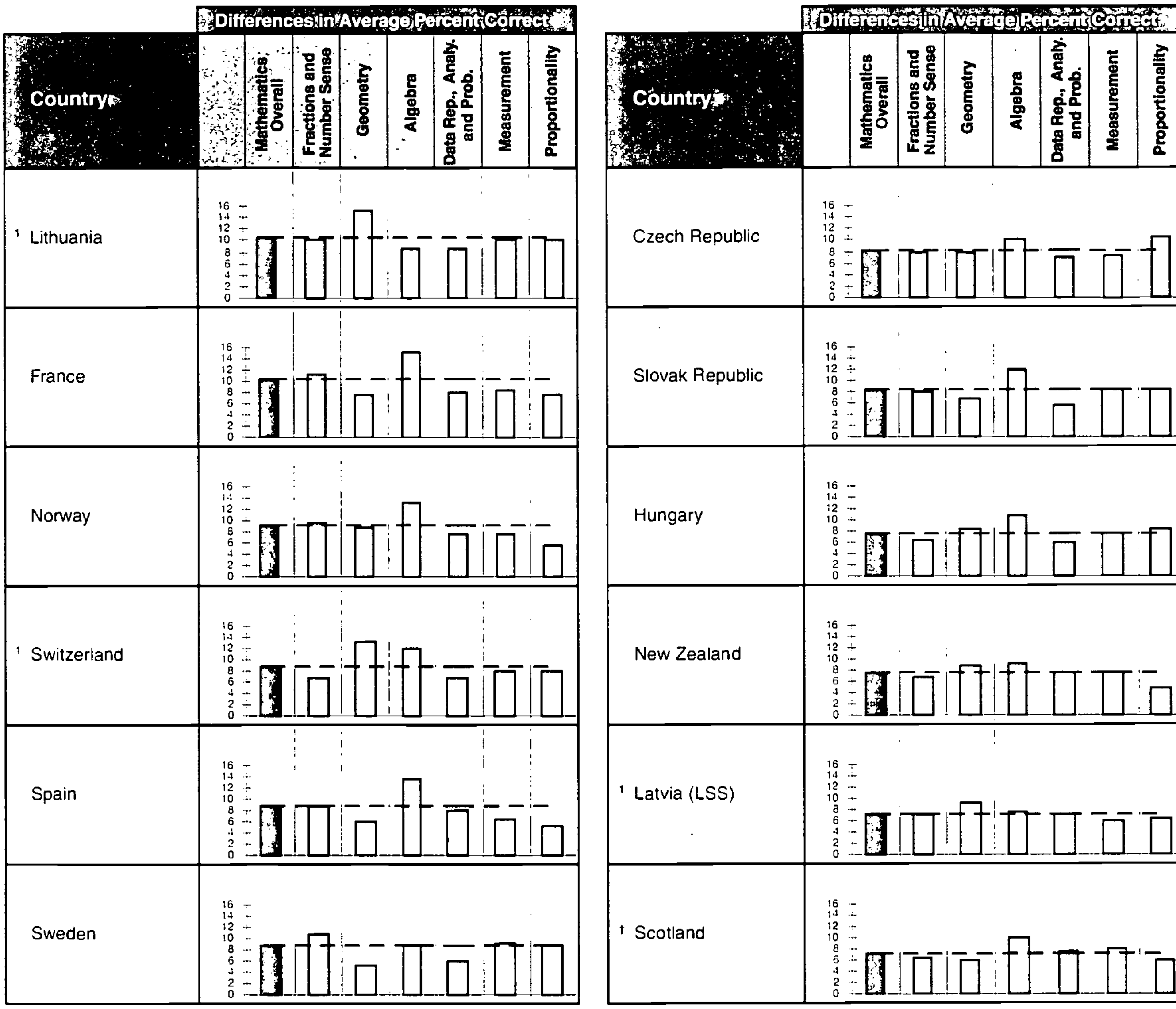
Figure 2.1, which profiles the increases in average percent correct between the seventh and eighth grade for each country across content areas, also reflects these curricular differences. The figure portrays the degree of the increase in mathematics achievement overall as well as the increase in achievement for each of the six content areas. The dashed line indicates the overall increase, for ease in comparing the growth within content areas against the growth in performance overall. The results are presented in descending order by the amount of overall increase between the grades, beginning with Lithuania, France, and Norway, all three of which showed the greatest increases (about 10%).

The results show that the degree of increase across the different content areas was uneven in most countries, generally reflecting a greater emphasis in the curriculum on some areas compared to others during the eighth grade. There were several countries, however, where the increases in the content areas were similar to the overall between-grade increase across most content areas, including Latvia (LSS), the United States, Korea, Hong Kong, and Denmark, for example.

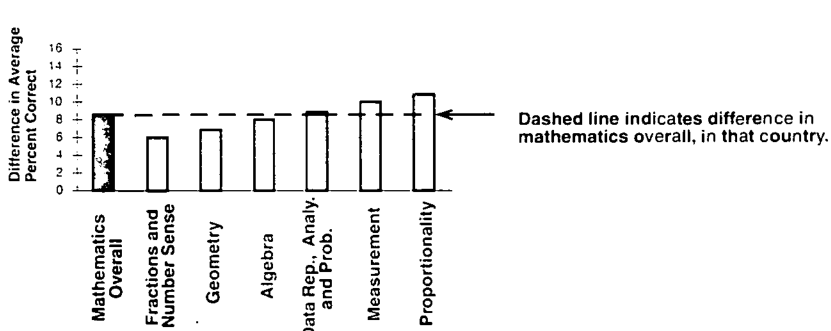
In general, performance in geometry and algebra showed the largest growth between the seventh and eighth grades. This is most noticeable in geometry for Lithuania and Switzerland. France, Norway, Switzerland, Spain, the Slovak Republic, and Hungary were among those countries showing higher-than-average between-grade increases in algebra. In general, the growth in data representation, analysis, and probability was quite similar or somewhat below the average between-grade increase. Fractions and number sense often showed a smaller-than-average increase compared to that overall, presumably because this content area was no longer emphasized in the middle-school curriculum in many countries. The smaller-than-average increases in the area of proportionality most likely reflect a general lack of special emphasis in this area.

Figure 2.1

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Mathematics Content Areas



Legend:

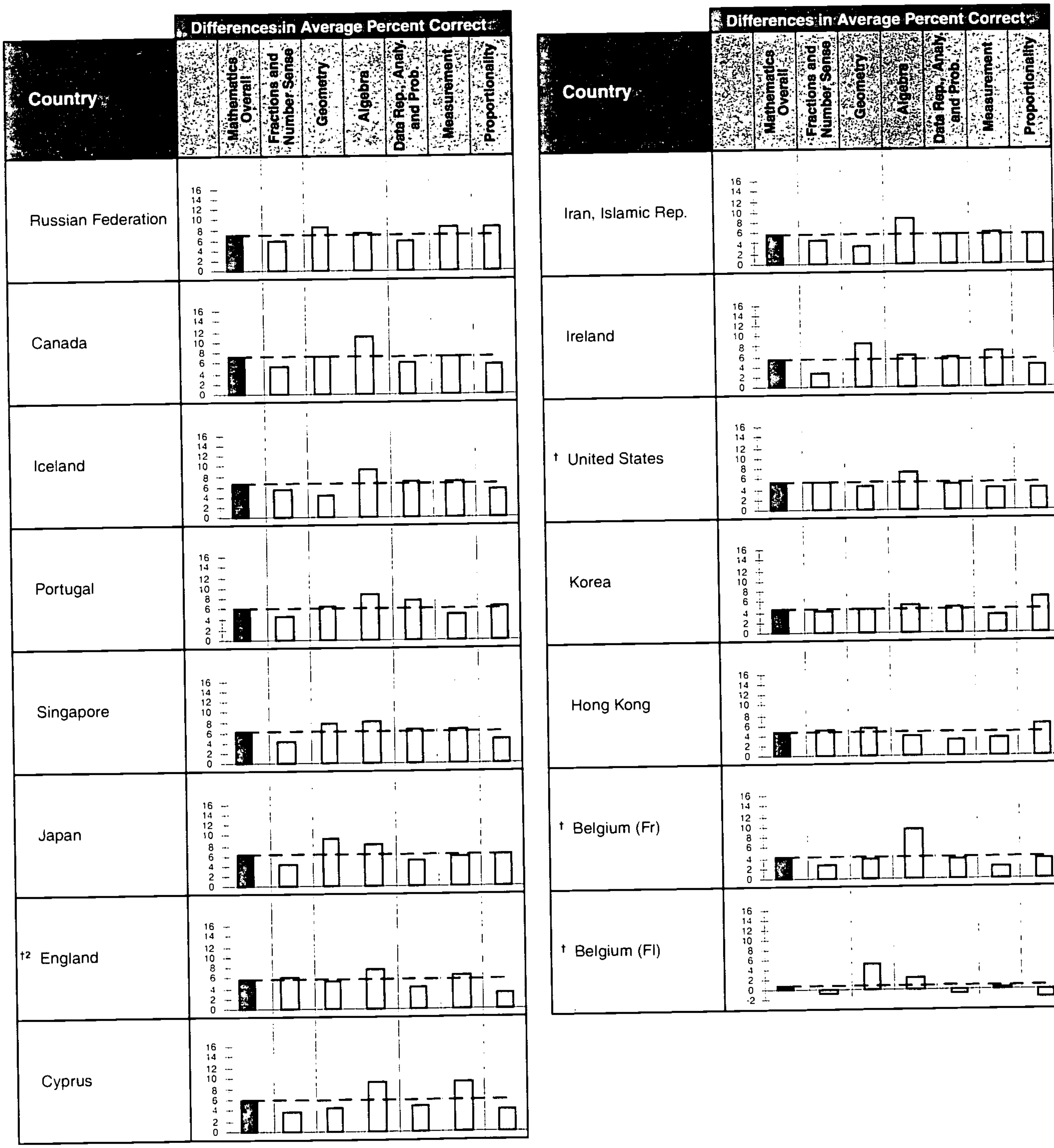


*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
¹Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
²National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
†National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 2.1 (Continued-2)

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Mathematics Content Areas

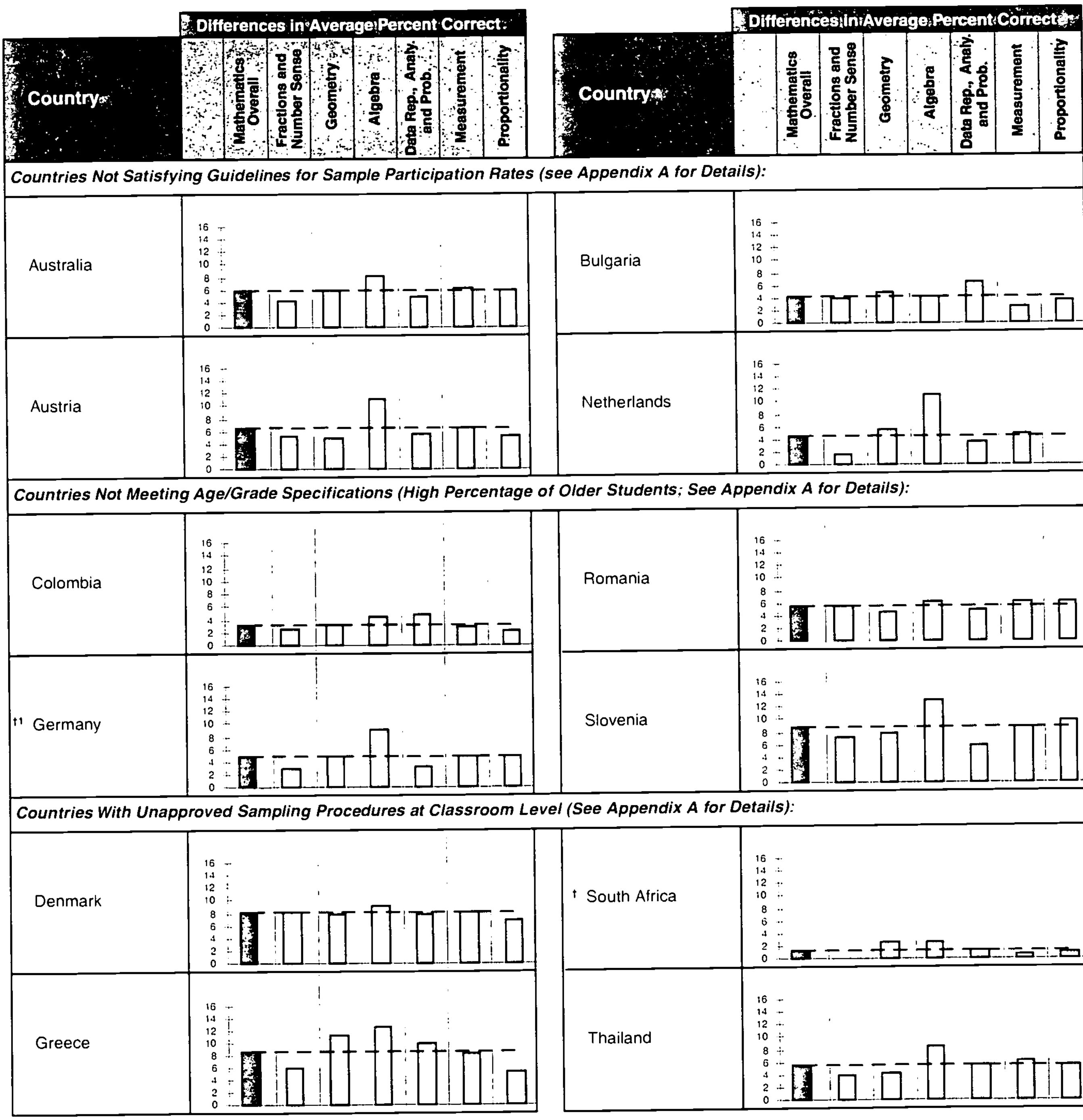


*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 2.1 (Continued-3)

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Mathematics Content Areas



*Seventh and eighth grades in most countries: see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Gender Differences in Achievement for the Content Areas?

Tables 2.4 and 2.5 indicate few statistically significant gender differences in achievement by content areas. However, the reduced number of gender differences in performance overall compared to the differences in scale scores discussed in Chapter 1 reinforces the idea of less precision in the percent-correct metric. Still, the findings are consistent — few gender differences, but the differences that do exist tended to favor boys. The exception from the pattern occurred in algebra, where, if anything, girls tended to have the advantage.

In fractions and number sense, the gender differences at both grades were minimal in all countries except Korea, where the eighth-grade boys showed a significant advantage. Similarly, boys and girls performed about the same in the content area of geometry at both grades. The exception was Greece, where the eighth-grade boys performed significantly better than the girls did.

In algebra, no gender differences were statistically significant at the eighth grade, but the results appeared to be more diverse, with girls having slightly higher averages (3 percentage points or more) than boys in a dozen or so countries. At the seventh grade, the pattern was similar, and girls performed significantly better than boys in Canada and Lithuania.

Boys and girls performed similarly on the items in the content area of data representation, analysis, and probability, except in a few countries where boys appeared to outperform girls. The only significant differences were in Korea, where the boys outperformed the girls at both grades.

The most differences in performance by gender were found in measurement where boys had higher achievement than did girls in a number of countries. At the eighth grade, the differences were statistically significant in Korea, Portugal, Spain, and Denmark. At the seventh grade, a significant difference was found in Iran.

Results in the area of proportionality paralleled those in fractions and number sense, with boys and girls performing similarly in most countries. There were no significant gender differences at the eighth grade. At the seventh grade, boys performed better than girls in Iceland, Japan, and Denmark.

In some respects, the TIMSS findings about gender differences parallel those found in the Second International Mathematics Study (SIMS) conducted in 1980-82.[8] Based on testing the grade with the most 13-year-old students, SIMS results indicated that girls were more likely to achieve better than boys in computation-level arithmetic, whole numbers, estimation and approximation, and algebra. Boys tended to be better in measurement, geometry, and proportional thinking. Even though the SIMS gender differences in arithmetic, geometry, and proportional thinking did not appear in the

[8] Robitaille, D.F. (1989). "Students' Achievements: Population A" in D.F. Robitaille, and R.A. Garden (eds.), *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics.* New York: Pergamon Press.

TIMSS results, the patterns of higher achievement for girls in algebra and of higher achievement for boys in measurement are consistent from the second to the third IEA mathematics studies. In the SIMS report, the authors suggested that "boys' familiarity with the application of, and relationships between, units of measure may well be related to their link with traditionally male occupations, hobbies, and pastimes, and the gender differences for this subtest may underline the effect that experience can have on learning." This potential explanation for boys' advantage in the content area of measurement may also be worth considering in the context of the TIMSS data.

Table 2.4

Average Percent Correct for Boys and Girls by Mathematics Content Areas Upper Grade (Eighth Grade*)

Country	Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	65 (2.0)	66 (1.9)	71 (1.8)	72 (1.7)	63 (2.1)	64 (2.1)	60 (2.5)	65 (2.4)
Canada	59 (0.7)	59 (0.6)	63 (0.8)	64 (0.7)	58 (0.9)	58 (0.7)	52 (0.9)	55 (1.0)
Cyprus	47 (0.6)	48 (0.6)	50 (0.7)	50 (0.8)	47 (0.9)	48 (0.8)	46 (0.9)	49 (1.0)
Czech Republic	67 (1.0)	64 (1.3)	70 (1.1)	68 (1.3)	68 (1.1)	65 (1.4)	64 (1.4)	66 (1.4)
†[2] England	53 (1.3)	53 (0.9)	54 (1.3)	53 (1.0)	54 (1.5)	54 (1.3)	47 (1.6)	51 (1.1)
France	62 (0.8)	61 (0.9)	65 (0.9)	64 (1.0)	67 (1.0)	65 (1.1)	54 (1.1)	54 (1.3)
Hong Kong	72 (1.7)	68 (1.7)	74 (1.7)	70 (1.7)	74 (1.8)	71 (1.9)	71 (1.8)	69 (2.0)
Hungary	61 (0.8)	62 (0.8)	64 (1.0)	65 (0.9)	61 (1.0)	60 (1.0)	61 (1.0)	66 (1.1)
Iceland	49 (1.3)	50 (1.3)	54 (1.8)	55 (1.4)	50 (1.3)	52 (1.6)	39 (1.1)	41 (1.9)
Iran, Islamic Rep.	39 (0.8)	36 (0.8)	40 (0.9)	37 (0.8)	45 (1.1)	40 (1.2)	36 (0.9)	38 (1.2)
Ireland	60 (1.6)	58 (1.4)	65 (1.7)	64 (1.5)	54 (1.7)	49 (1.6)	54 (1.7)	53 (1.7)
Japan	74 (0.5)	73 (0.4)	76 (0.6)	75 (0.5)	79 (0.6)	80 (0.5)	72 (0.7)	72 (0.7)
Korea	▲ 73 (0.6)	70 (0.7)	▲ 76 (0.7)	72 (0.8)	77 (0.8)	73 (0.8)	70 (0.8)	69 (0.9)
[1] Latvia (LSS)	52 (1.0)	51 (0.8)	53 (1.2)	53 (1.0)	58 (1.0)	56 (1.1)	50 (1.3)	51 (0.9)
[1] Lithuania	48 (1.1)	49 (1.0)	51 (1.2)	52 (1.2)	54 (1.2)	53 (1.2)	45 (1.5)	49 (1.4)
New Zealand	55 (1.4)	53 (1.3)	58 (1.4)	55 (1.3)	54 (1.5)	55 (1.4)	48 (1.5)	49 (1.3)
Norway	54 (0.6)	53 (0.6)	58 (0.7)	58 (0.7)	50 (0.8)	51 (0.9)	44 (0.9)	46 (0.9)
Portugal	44 (0.8)	42 (0.7)	45 (0.9)	42 (0.8)	46 (1.2)	42 (0.9)	39 (1.0)	40 (1.0)
Russian Federation	59 (1.4)	61 (1.3)	61 (1.5)	62 (1.1)	62 (1.7)	64 (1.4)	61 (1.8)	64 (1.3)
Singapore	79 (1.1)	79 (1.0)	83 (1.0)	84 (0.8)	76 (1.3)	77 (1.2)	75 (1.3)	77 (1.3)
Slovak Republic	63 (0.9)	62 (0.8)	66 (1.0)	66 (0.8)	65 (0.9)	62 (1.0)	60 (1.1)	64 (1.0)
Spain	52 (0.7)	50 (0.7)	53 (0.7)	51 (0.7)	51 (0.8)	48 (0.8)	54 (1.0)	54 (0.9)
Sweden	56 (0.8)	56 (0.8)	62 (0.9)	62 (0.9)	48 (0.8)	49 (0.8)	43 (1.0)	45 (1.1)
[1] Switzerland	63 (0.8)	61 (0.7)	67 (0.8)	66 (0.9)	60 (1.1)	59 (0.9)	53 (1.1)	53 (0.9)
† United States	53 (1.2)	53 (1.1)	60 (1.3)	59 (1.2)	49 (1.4)	47 (1.1)	50 (1.4)	51 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):								
Australia	57 (1.2)	59 (1.1)	60 (1.2)	61 (1.1)	57 (1.3)	58 (1.2)	53 (1.3)	57 (1.2)
Austria	63 (0.8)	61 (1.2)	67 (0.9)	65 (1.1)	57 (1.3)	57 (1.4)	59 (0.9)	60 (1.2)
Belgium (Fr)	59 (1.1)	58 (1.0)	62 (1.4)	62 (0.9)	60 (1.3)	57 (1.1)	52 (1.6)	55 (1.3)
Netherlands	61 (1.8)	59 (1.6)	63 (1.8)	60 (1.7)	61 (2.1)	58 (1.8)	52 (1.8)	53 (1.8)
Scotland	53 (1.7)	50 (1.3)	55 (1.5)	51 (1.3)	54 (1.8)	50 (1.4)	46 (2.0)	46 (1.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):								
Colombia	30 (1.6)	29 (0.9)	31 (1.8)	30 (0.7)	29 (1.6)	29 (1.1)	28 (1.7)	28 (1.0)
†[1] Germany	54 (1.3)	54 (1.2)	60 (1.3)	57 (1.3)	51 (1.5)	53 (1.5)	47 (1.5)	49 (1.4)
Romania	49 (1.1)	49 (1.0)	48 (1.2)	48 (1.0)	53 (1.1)	51 (1.1)	50 (1.5)	54 (1.2)
Slovenia	62 (0.8)	60 (0.7)	64 (0.9)	62 (0.8)	61 (1.1)	59 (1.1)	61 (1.0)	61 (0.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):								
Denmark	▲ 54 (0.8)	50 (0.9)	55 (1.0)	51 (1.1)	56 (1.1)	53 (1.3)	47 (0.8)	44 (1.0)
Greece	51 (0.9)	48 (0.7)	54 (1.0)	51 (0.8)	▲ 53 (0.9)	48 (0.9)	46 (1.0)	46 (0.9)
Thailand	56 (1.4)	58 (1.7)	59 (1.5)	61 (1.8)	60 (1.3)	63 (1.5)	51 (1.8)	55 (2.0)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):								
[1] Israel	61 (1.5)	55 (1.5)	64 (1.6)	58 (1.6)	61 (1.3)	55 (1.8)	63 (1.7)	59 (1.9)
South Africa	25 (1.7)	22 (1.0)	28 (2.0)	24 (1.2)	25 (1.6)	24 (0.9)	24 (1.5)	23 (1.2)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Eighth grade in most countries; See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.4 (Continued)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Upper Grade (Eighth Grade*)

Country	Data Representation, Analysis & Probability		Measurement		Proportionality	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	72 (2.2)	73 (1.4)	60 (1.9)	59 (2.0)	52 (2.2)	53 (2.7)
Canada	69 (0.9)	69 (0.6)	52 (0.9)	50 (0.8)	48 (0.9)	48 (1.0)
Cyprus	52 (0.9)	54 (0.9)	44 (1.1)	43 (1.1)	40 (1.0)	39 (0.9)
Czech Republic	70 (0.9)	67 (1.4)	64 (1.2)	60 (1.5)	54 (1.4)	49 (1.7)
†2 England	67 (1.2)	65 (1.1)	51 (1.5)	48 (1.1)	42 (1.5)	40 (1.3)
France	72 (0.8)	70 (1.1)	58 (1.0)	56 (1.1)	50 (1.2)	48 (1.2)
Hong Kong	73 (1.6)	69 (1.4)	68 (1.9)	62 (2.1)	63 (1.5)	60 (1.9)
Hungary	66 (0.9)	65 (0.9)	57 (1.0)	56 (1.0)	47 (1.2)	46 (1.1)
Iceland	63 (1.6)	62 (1.4)	45 (1.8)	45 (2.0)	40 (1.6)	37 (1.4)
Iran, Islamic Rep.	42 (0.8)	40 (0.9)	32 (1.7)	26 (1.4)	38 (1.3)	34 (1.1)
Ireland	70 (1.6)	68 (1.3)	55 (1.9)	51 (1.6)	52 (1.8)	49 (1.2)
Japan	79 (0.5)	77 (0.5)	68 (0.6)	67 (0.6)	62 (0.8)	60 (0.8)
Korea	▲ 80 (0.7)	75 (0.8)	▲ 69 (0.9)	62 (1.0)	62 (0.9)	61 (0.9)
1 Latvia (LSS)	57 (1.0)	55 (1.0)	49 (1.2)	46 (1.1)	41 (1.1)	37 (1.0)
1 Lithuania	52 (1.2)	52 (1.1)	44 (1.1)	41 (1.2)	34 (1.1)	35 (1.2)
New Zealand	67 (1.3)	65 (1.3)	50 (1.5)	46 (1.4)	44 (1.5)	40 (1.4)
Norway	67 (0.8)	66 (0.8)	53 (0.8)	50 (0.7)	41 (0.8)	40 (0.8)
Portugal	55 (0.9)	53 (0.8)	▲ 41 (0.9)	36 (0.8)	33 (1.0)	30 (0.9)
Russian Federation	60 (1.2)	60 (1.4)	56 (1.3)	56 (1.8)	48 (1.6)	49 (1.6)
Singapore	79 (1.1)	79 (1.0)	77 (1.3)	77 (1.0)	75 (1.2)	76 (1.1)
Slovak Republic	62 (0.9)	61 (0.8)	62 (1.1)	59 (1.0)	50 (1.1)	48 (1.3)
Spain	61 (0.8)	59 (0.8)	▲ 47 (1.0)	42 (0.9)	42 (1.1)	38 (0.9)
Sweden	70 (0.9)	69 (0.9)	57 (1.1)	55 (1.0)	46 (1.1)	43 (1.1)
1 Switzerland	73 (1.0)	71 (0.7)	62 (1.0)	59 (1.0)	53 (1.0)	52 (0.9)
† United States	65 (1.1)	66 (1.2)	42 (1.2)	38 (1.2)	43 (1.1)	42 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	66 (1.1)	69 (1.0)	54 (1.2)	53 (1.1)	47 (1.3)	46 (1.1)
Austria	69 (0.9)	68 (1.2)	64 (1.0)	60 (1.6)	50 (1.0)	48 (1.3)
Belgium (Fr)	69 (1.4)	67 (1.1)	56 (1.2)	55 (1.2)	49 (1.1)	46 (1.2)
Netherlands	74 (2.0)	70 (1.5)	58 (1.8)	56 (1.7)	54 (2.4)	49 (1.9)
Scotland	67 (1.6)	63 (1.3)	50 (2.0)	45 (1.4)	43 (1.7)	37 (1.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	38 (1.9)	36 (1.1)	25 (1.9)	25 (2.5)	24 (1.5)	22 (0.9)
†1 Germany	65 (1.3)	64 (1.3)	52 (1.3)	50 (1.3)	44 (1.6)	41 (1.3)
Romania	49 (1.2)	48 (1.1)	49 (1.4)	47 (1.3)	41 (1.3)	42 (1.3)
Slovenia	67 (0.9)	65 (0.8)	60 (1.1)	57 (1.0)	50 (1.1)	48 (1.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	69 (1.0)	64 (1.3)	▲ 52 (1.0)	47 (1.2)	43 (1.2)	39 (0.9)
Greece	58 (1.2)	55 (0.8)	45 (1.0)	41 (1.0)	41 (1.3)	38 (1.1)
Thailand	62 (1.3)	63 (1.4)	50 (1.5)	51 (1.8)	50 (1.7)	52 (1.9)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	67 (1.6)	60 (1.6)	52 (1.9)	46 (1.8)	48 (2.0)	40 (1.6)
South Africa	28 (1.9)	25 (1.1)	20 (1.8)	16 (1.0)	23 (1.4)	20 (0.9)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Eighth grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.5

Average Percent Correct for Boys and Girls by Mathematics Content Areas Lower Grade (Seventh Grade*)

Country	Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	65 (1.1)	66 (1.1)	72 (1.1)	73 (1.0)	58 (1.2)	59 (1.3)	59 (1.5)	62 (1.2)
† Belgium (Fr)	56 (1.0)	53 (1.1)	61 (1.2)	58 (1.2)	56 (1.4)	53 (1.4)	44 (1.1)	43 (1.3)
Canada	52 (0.6)	52 (0.6)	58 (0.6)	58 (0.7)	51 (1.0)	50 (0.8)	41 (0.8)	▲ 44 (0.8)
Cyprus	42 (0.6)	42 (0.5)	46 (0.7)	45 (0.6)	43 (0.9)	43 (0.9)	38 (0.8)	39 (0.8)
Czech Republic	58 (1.1)	57 (1.3)	62 (1.4)	60 (1.4)	59 (1.0)	58 (1.5)	54 (1.2)	57 (1.4)
†2 England	49 (1.4)	45 (1.0)	49 (1.7)	46 (1.1)	51 (1.4)	47 (1.2)	42 (1.6)	40 (1.2)
France	52 (0.9)	50 (0.8)	54 (1.0)	52 (1.0)	59 (1.1)	57 (1.1)	39 (0.9)	39 (0.9)
Hong Kong	66 (2.2)	64 (2.0)	67 (2.2)	66 (1.9)	69 (2.4)	66 (2.0)	66 (2.5)	65 (2.3)
Hungary	53 (0.9)	54 (1.0)	58 (1.0)	59 (1.0)	53 (1.0)	51 (1.1)	50 (1.1)	54 (1.3)
Iceland	43 (0.7)	43 (0.7)	49 (1.1)	49 (0.9)	46 (1.0)	48 (0.8)	30 (0.6)	32 (0.8)
Iran, Islamic Rep.	33 (0.7)	31 (0.7)	35 (0.8)	33 (0.8)	41 (1.5)	38 (0.9)	29 (0.9)	28 (0.8)
Ireland	55 (1.5)	52 (1.1)	64 (1.6)	61 (1.3)	44 (1.4)	41 (1.1)	48 (1.7)	46 (1.4)
Japan	68 (0.6)	66 (0.4)	72 (0.5)	70 (0.5)	71 (0.7)	70 (0.5)	64 (0.7)	63 (0.7)
Korea	68 (0.8)	65 (0.9)	71 (0.8)	67 (1.0)	72 (1.0)	69 (1.1)	65 (1.1)	63 (1.1)
1 Latvia (LSS)	44 (1.0)	44 (0.8)	46 (1.0)	45 (0.9)	48 (1.1)	47 (1.0)	42 (1.3)	44 (1.1)
1 Lithuania	37 (0.9)	39 (0.9)	39 (1.1)	43 (1.1)	38 (1.1)	39 (1.3)	36 (1.1)	▲ 42 (1.4)
New Zealand	46 (1.0)	46 (0.9)	49 (1.1)	50 (1.0)	45 (1.3)	46 (1.2)	39 (1.0)	40 (1.0)
Norway	45 (0.8)	43 (0.8)	50 (1.0)	48 (1.0)	42 (0.9)	42 (1.1)	33 (0.8)	32 (1.1)
Portugal	37 (0.7)	36 (0.6)	39 (0.8)	39 (0.6)	40 (1.0)	36 (1.0)	31 (1.0)	31 (0.7)
Russian Federation	53 (1.2)	53 (0.8)	56 (1.3)	56 (0.8)	55 (1.4)	54 (1.2)	53 (1.5)	56 (0.9)
† Scotland	45 (1.1)	44 (0.9)	48 (1.2)	47 (1.1)	46 (1.3)	46 (1.1)	36 (1.1)	37 (0.9)
Singapore	73 (1.4)	73 (1.6)	79 (1.3)	79 (1.5)	68 (1.5)	69 (1.8)	68 (1.6)	68 (1.8)
Slovak Republic	55 (1.1)	54 (0.8)	59 (1.1)	58 (0.9)	58 (1.3)	55 (0.9)	49 (1.3)	52 (1.0)
Spain	43 (0.6)	42 (0.7)	43 (0.7)	42 (0.7)	44 (0.8)	42 (1.0)	41 (0.9)	41 (0.9)
Sweden	47 (0.7)	47 (0.8)	51 (0.8)	52 (1.0)	44 (0.8)	42 (1.0)	35 (0.7)	36 (0.8)
1 Switzerland	54 (0.6)	52 (0.6)	61 (0.8)	58 (0.7)	48 (0.9)	44 (0.9)	41 (0.6)	41 (0.8)
† United States	48 (1.3)	48 (1.3)	54 (1.4)	54 (1.5)	44 (1.3)	43 (1.2)	42 (1.4)	45 (1.4)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):								
Australia	52 (1.2)	53 (1.0)	56 (1.3)	57 (1.1)	50 (1.1)	53 (1.1)	45 (1.3)	48 (1.1)
Austria	55 (1.1)	56 (0.8)	60 (1.2)	61 (0.9)	52 (1.4)	53 (1.2)	46 (1.2)	50 (0.9)
Netherlands	56 (1.3)	55 (1.1)	61 (1.5)	59 (1.2)	55 (1.5)	53 (1.2)	41 (1.3)	42 (1.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):								
Colombia	27 (0.8)	25 (1.0)	29 (1.0)	27 (0.9)	27 (1.2)	25 (1.3)	24 (1.0)	23 (1.4)
†1 Germany	49 (1.3)	49 (1.1)	55 (1.4)	55 (1.3)	45 (1.4)	48 (1.3)	39 (1.6)	38 (1.4)
Romania	43 (0.9)	43 (0.9)	43 (1.0)	42 (0.9)	48 (1.1)	47 (1.1)	44 (1.2)	47 (1.2)
Slovenia	53 (0.8)	52 (0.8)	56 (0.9)	56 (0.8)	52 (1.1)	53 (0.9)	47 (1.1)	49 (0.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):								
Denmark	45 (0.7)	43 (0.7)	46 (0.9)	44 (0.9)	47 (1.0)	46 (1.1)	37 (0.9)	35 (0.9)
Greece	40 (0.7)	41 (0.6)	47 (0.8)	47 (0.8)	39 (0.8)	39 (0.9)	32 (0.9)	34 (0.7)
† South Africa	24 (1.4)	22 (0.8)	27 (1.5)	25 (1.0)	23 (1.4)	21 (0.8)	21 (1.3)	20 (0.7)
Thailand	51 (1.2)	52 (1.4)	56 (1.4)	56 (1.6)	57 (1.1)	58 (1.2)	44 (1.3)	46 (1.5)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.5 (Continued)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Lower Grade (Seventh Grade*)

Country	Data Representation, Analysis & Probability		Measurement		Proportionality	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	73 (1.1)	73 (1.2)	60 (1.2)	59 (1.4)	53 (1.2)	55 (1.4)
† Belgium (Fr)	66 (1.3)	62 (1.4)	55 (1.1)	52 (1.4)	45 (1.4)	43 (1.1)
Canada	63 (0.9)	62 (0.8)	45 (0.7)	43 (0.8)	43 (0.9)	41 (0.8)
Cyprus	48 (0.9)	48 (0.7)	36 (0.9)	33 (0.8)	36 (1.1)	35 (0.8)
Czech Republic	63 (1.1)	60 (1.3)	57 (1.2)	52 (1.4)	42 (1.2)	40 (1.6)
†2 England	63 (1.3)	61 (1.4)	46 (1.5)	40 (1.1)	41 (1.6)	35 (1.2)
France	64 (1.0)	61 (0.9)	50 (1.1)	47 (1.1)	42 (1.1)	40 (1.2)
Hong Kong	69 (2.0)	67 (1.5)	63 (2.4)	60 (2.2)	56 (2.0)	54 (1.9)
Hungary	60 (1.0)	60 (1.0)	50 (1.1)	48 (1.2)	39 (1.1)	38 (1.2)
Iceland	56 (0.9)	55 (1.1)	38 (0.9)	38 (1.0)	▲ 35 (0.8)	31 (0.9)
Iran, Islamic Rep.	37 (0.9)	34 (1.0)	▲ 25 (1.1)	21 (0.9)	32 (1.3)	29 (0.7)
Ireland	65 (1.3)	62 (1.2)	49 (1.7)	43 (1.3)	48 (1.8)	45 (1.2)
Japan	73 (0.6)	72 (0.6)	63 (0.8)	60 (0.6)	▲ 57 (0.8)	53 (0.7)
Korea	▲ 75 (0.7)	70 (0.9)	64 (1.2)	60 (1.0)	56 (1.1)	53 (1.1)
1 Latvia (LSS)	49 (1.1)	49 (0.9)	43 (1.1)	39 (1.0)	34 (1.4)	31 (1.1)
1 Lithuania	43 (1.1)	44 (0.9)	33 (1.1)	32 (1.0)	25 (0.9)	24 (1.0)
New Zealand	58 (1.2)	59 (1.1)	42 (1.2)	39 (1.1)	38 (1.2)	37 (1.1)
Norway	60 (1.1)	57 (1.0)	45 (1.1)	42 (1.1)	35 (0.9)	33 (0.8)
Portugal	48 (0.9)	45 (0.8)	36 (0.8)	32 (0.9)	27 (0.8)	23 (0.8)
Russian Federation	56 (1.3)	53 (0.9)	48 (1.2)	47 (1.0)	40 (1.3)	39 (1.3)
† Scotland	58 (1.2)	57 (1.0)	42 (1.2)	39 (1.1)	36 (0.9)	33 (1.1)
Singapore	72 (1.5)	73 (1.5)	70 (1.7)	70 (1.9)	70 (1.6)	71 (1.6)
Slovak Republic	57 (0.9)	55 (0.8)	54 (1.2)	50 (1.0)	42 (1.2)	40 (1.1)
Spain	53 (0.8)	51 (0.9)	39 (0.9)	36 (0.9)	36 (0.8)	34 (0.8)
Sweden	64 (1.0)	64 (1.1)	48 (1.0)	45 (1.0)	36 (0.9)	35 (1.0)
1 Switzerland	67 (0.9)	64 (0.8)	54 (1.0)	51 (0.9)	46 (0.9)	43 (0.9)
† United States	60 (1.3)	60 (1.4)	37 (1.4)	35 (1.6)	39 (1.3)	37 (1.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	62 (1.2)	63 (1.0)	48 (1.3)	47 (1.1)	41 (1.3)	41 (1.0)
Austria	62 (1.1)	64 (1.0)	56 (1.1)	54 (0.9)	44 (1.2)	44 (1.2)
Netherlands	69 (1.3)	68 (1.2)	53 (1.4)	52 (1.3)	51 (1.5)	51 (1.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	33 (1.0)	32 (1.3)	23 (1.0)	21 (0.9)	21 (1.4)	20 (0.8)
†1 Germany	62 (1.3)	61 (1.2)	48 (1.1)	44 (1.0)	39 (1.4)	36 (1.1)
Romania	44 (0.9)	43 (0.9)	42 (1.3)	41 (1.0)	35 (1.1)	35 (1.0)
Slovenia	61 (0.8)	59 (0.9)	51 (0.9)	48 (1.1)	41 (1.2)	38 (1.0)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	61 (1.1)	57 (1.0)	42 (1.0)	40 (0.9)	▲ 37 (1.1)	31 (1.1)
Greece	46 (1.0)	46 (0.7)	36 (0.8)	34 (0.9)	34 (0.8)	34 (0.8)
† South Africa	26 (1.6)	24 (0.9)	19 (1.5)	16 (0.8)	21 (1.2)	20 (0.7)
Thailand	57 (1.2)	57 (1.2)	44 (1.3)	44 (1.7)	45 (1.3)	46 (1.6)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Chapter 3

Performance on Items Within Each Mathematics Content Area

This chapter presents five or six example items within each of the mathematics content areas, including the performance on each of the items for each of the TIMSS countries. The example items were selected to illustrate the different topics covered within each content area as well as the different performance expectations. The items also were chosen to show the range of item formats used within each area. To provide some sense of what types of items were answered correctly by higher-performing as compared to lower-performing students, the items show a range of difficulty within each content area. Finally, it should be noted that all these items and others are released for use by the public.[1]

The presentation for each of the content areas begins with a brief description of the major topics included in the content area and a discussion of student performance in that content area. The discussion is followed by a table showing the percent correct on the example items for each of the TIMSS countries at both the seventh and eighth grades. After the table showing the country-by-country results, there is a figure relating achievement on each of the example items to performance on the TIMSS international mathematics scale. This "difficulty map" provides a pictorial representation of achievement on the scale in relation to achievement on the items. Following the difficulty map, each item is presented in its entirety. The correct answer is circled for multiple-choice items and shown in the answer space for short-answer items. For extended-response questions, the answer shown exemplifies the type of student responses that were given full credit. All of the responses shown have been reproduced from students' actual test booklets.

What Have Students Learned About Fractions and Number Sense?

The category of fractions and number sense included operations and problem solving with whole numbers, fractions, decimals, and percentages as well as estimating and rounding. Table 3.1 presents the percent of correct responses given by students in each of the TIMSS countries to each of the six example items presented within this category.

Figure 3.1 presents a pictorial representation of the relationship between performance on the TIMSS international mathematics scale and achievement on the six example items for fractions and number sense.[2] The international achievement on each example item is indicated both by the average percent correct across all countries at the seventh and eighth grades and by the international mathematics scale value, or

[1] The IEA retained about one-third of the TIMSS items as secure for possible future use in measuring international trends in mathematics and science achievement. All remaining items are available for general use.

[2] The three-digit item label shown in the lower right corner of the box locating each example item on the item difficulty map refers to the original item identification number used in the student test booklets.

Table 3.1

Percent Correct for Fractions and Number Sense Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 1 Subtraction problem with whole numbers:		Example 2: Write a larger fraction:		Example 3: Distance on map:	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	96 (1.1)	93 (2.9)	82 (2.6)	81 (3.1)	84 (1.8)	84 (2.6)
† Belgium (Fr)	95 (1.4)	91 (1.6)	70 (2.9)	72 (2.6)	76 (2.7)	82 (3.1)
Canada	91 (1.6)	91 (1.7)	74 (2.4)	80 (1.6)	62 (2.9)	63 (2.0)
Cyprus	81 (1.9)	85 (2.2)	80 (2.4)	77 (2.4)	49 (2.9)	61 (2.7)
Czech Republic	97 (1.1)	97 (0.9)	81 (2.2)	83 (2.1)	76 (2.3)	83 (2.5)
†2 England	59 (3.2)	65 (3.2)	79 (3.1)	79 (2.6)	61 (3.4)	69 (3.1)
France	92 (1.5)	97 (1.2)	66 (1.8)	75 (2.4)	72 (2.6)	84 (2.0)
Hong Kong	90 (1.4)	89 (1.9)	86 (2.2)	85 (2.2)	59 (2.4)	64 (2.5)
Hungary	95 (1.3)	96 (1.2)	85 (2.0)	87 (1.9)	73 (2.4)	82 (2.0)
Iceland	91 (2.0)	89 (3.2)	82 (3.4)	89 (2.8)	69 (3.2)	68 (4.4)
Iran, Islamic Rep.	86 (2.4)	83 (2.6)	38 (4.0)	31 (3.2)	30 (3.0)	32 (3.2)
Ireland	93 (1.5)	94 (1.5)	83 (1.9)	82 (2.0)	58 (2.9)	67 (2.4)
Japan	89 (1.4)	93 (1.2)	85 (1.3)	87 (1.2)	76 (1.7)	79 (1.7)
Korea	91 (1.6)	89 (1.8)	77 (2.3)	84 (2.2)	65 (2.1)	74 (2.3)
1 Latvia (LSS)	84 (2.3)	89 (2.1)	60 (2.6)	69 (3.1)	61 (2.8)	70 (2.8)
1 Lithuania	88 (2.3)	92 (1.6)	61 (3.8)	67 (3.0)	50 (3.5)	67 (3.0)
New Zealand	69 (3.5)	71 (2.3)	81 (2.4)	80 (2.0)	64 (2.6)	67 (2.2)
Norway	85 (5.5)	87 (2.0)	73 (5.3)	84 (1.6)	68 (3.8)	65 (2.7)
Portugal	78 (2.4)	87 (1.7)	62 (2.4)	63 (2.7)	48 (2.8)	56 (2.6)
Russian Federation	92 (1.6)	92 (1.6)	78 (1.9)	83 (1.9)	66 (2.2)	77 (2.3)
† Scotland	75 (2.5)	72 (2.5)	76 (2.4)	81 (2.4)	55 (2.8)	65 (3.1)
Singapore	98 (0.6)	98 (0.7)	84 (2.1)	88 (1.6)	79 (2.4)	84 (1.6)
Slovak Republic	94 (1.0)	93 (1.3)	80 (1.9)	85 (1.8)	70 (2.3)	76 (2.3)
Spain	94 (1.5)	98 (0.7)	71 (2.2)	71 (2.0)	53 (2.7)	62 (2.3)
Sweden	84 (2.2)	88 (1.6)	74 (2.6)	78 (2.5)	76 (2.2)	77 (1.9)
1 Switzerland	96 (0.9)	96 (1.1)	81 (2.0)	83 (2.0)	76 (2.5)	81 (2.5)
† United States	88 (2.1)	90 (1.1)	79 (2.2)	81 (1.9)	52 (3.4)	61 (2.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	82 (2.4)	82 (1.7)	76 (2.3)	78 (1.6)	68 (2.7)	69 (1.8)
Austria	94 (1.3)	96 (1.2)	89 (2.0)	87 (1.7)	76 (2.5)	78 (3.6)
Bulgaria	84 (3.3)	78 (2.8)	65 (4.7)	64 (4.7)	66 (5.0)	75 (4.4)
Netherlands	88 (2.6)	82 (3.6)	86 (2.5)	76 (3.3)	71 (2.7)	74 (3.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	57 (3.5)	64 (4.0)	66 (3.5)	77 (2.8)	34 (3.1)	31 (3.1)
†1 Germany	93 (1.4)	89 (2.0)	80 (2.2)	81 (2.3)	68 (2.9)	72 (2.9)
Romania	80 (2.0)	79 (2.4)	61 (2.9)	64 (2.7)	50 (2.9)	50 (2.7)
Slovenia	95 (1.2)	98 (0.8)	77 (2.7)	77 (2.7)	71 (2.4)	76 (2.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	86 (2.5)	88 (2.0)	64 (3.2)	65 (3.8)	73 (2.9)	85 (2.3)
Greece	87 (1.5)	91 (1.4)	82 (1.6)	77 (2.0)	42 (2.6)	50 (2.4)
† South Africa	57 (2.7)	56 (3.3)	45 (3.7)	50 (2.4)	23 (2.2)	24 (2.2)
Thailand	87 (1.6)	86 (1.6)	68 (2.3)	73 (2.1)	66 (2.4)	67 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	95 (1.4)	–	80 (3.1)	–	59 (3.3)
Kuwait	–	52 (3.5)	–	37 (5.7)	–	30 (4.6)

*Seventh and eighth grades in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.1 (Continued)

Percent Correct for Fractions and Number Sense Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

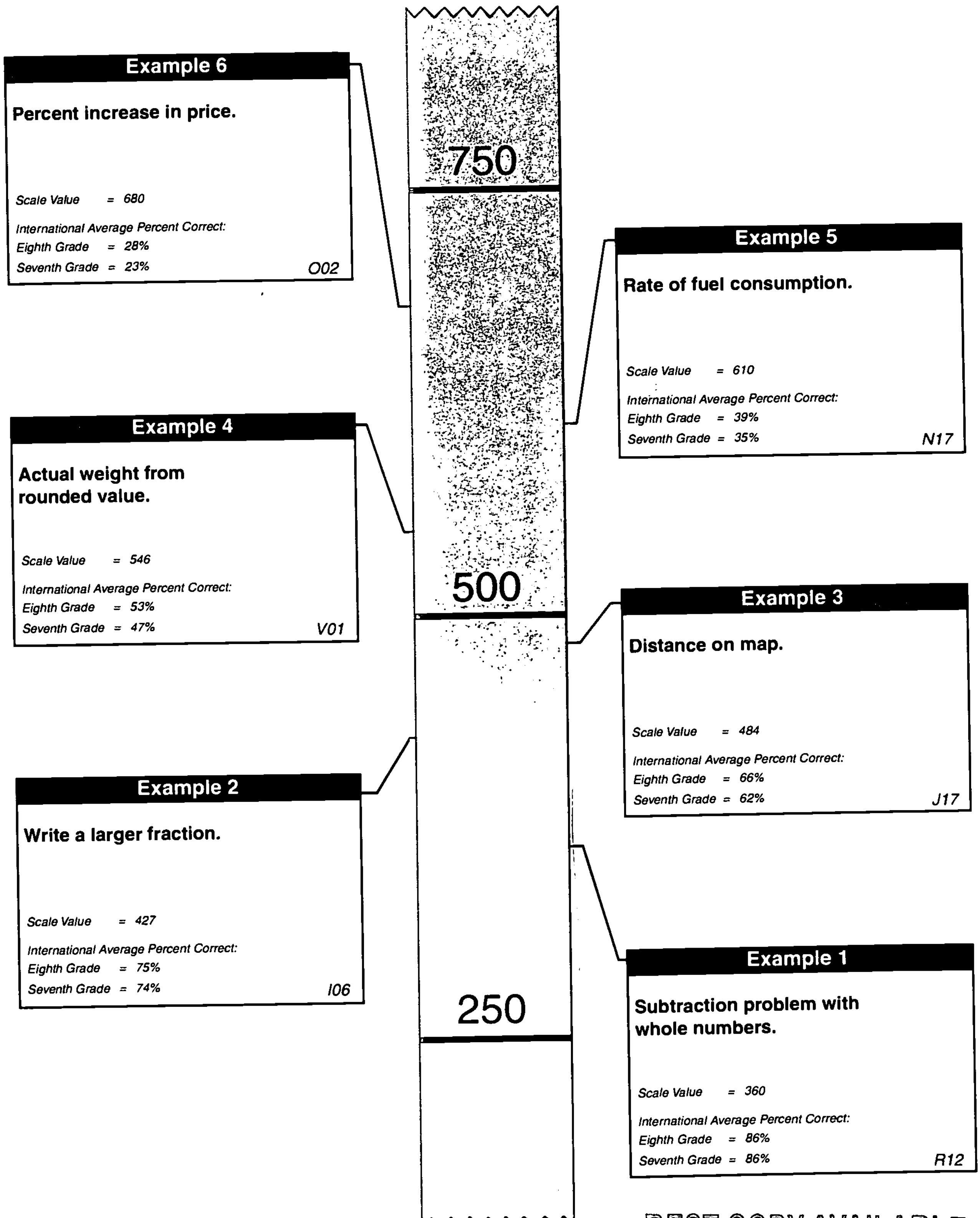
Country	Example 4 Actual weight from rounded value		Example 5 Rate of fuel consumption		Example 6 Percent increase in price	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	65 (2.7)	65 (2.4)	37 (2.9)	49 (3.0)	37 (2.9)	33 (2.4)
† Belgium (Fr)	23 (2.1)	30 (2.6)	36 (2.8)	36 (2.6)	29 (3.1)	36 (4.4)
Canada	60 (1.8)	67 (1.7)	32 (2.0)	36 (2.0)	16 (1.3)	20 (1.7)
Cyprus	12 (1.2)	17 (1.9)	29 (2.8)	30 (2.5)	19 (2.4)	19 (2.8)
Czech Republic	69 (2.3)	80 (1.7)	43 (3.3)	43 (4.1)	29 (2.9)	38 (3.4)
†2 England	62 (2.5)	72 (2.5)	30 (2.7)	40 (2.9)	18 (2.4)	21 (2.5)
France	–	–	27 (2.4)	34 (2.5)	17 (2.3)	29 (2.7)
Hong Kong	47 (3.4)	56 (2.8)	44 (2.8)	48 (3.1)	47 (2.9)	54 (2.7)
Hungary	60 (2.0)	67 (2.0)	40 (2.3)	46 (3.0)	36 (2.3)	46 (2.8)
Iceland	51 (2.6)	59 (4.1)	39 (4.0)	25 (4.1)	9 (1.9)	24 (3.2)
Iran, Islamic Rep.	5 (1.6)	6 (1.1)	33 (2.5)	30 (2.3)	15 (2.9)	11 (2.2)
Ireland	65 (2.1)	68 (2.0)	44 (2.9)	42 (2.5)	35 (2.5)	39 (3.2)
Japan	67 (1.3)	76 (1.3)	–	–	34 (2.0)	41 (2.0)
Korea	80 (1.6)	85 (1.3)	41 (2.9)	50 (2.7)	36 (3.1)	37 (2.8)
1 Latvia (LSS)	38 (2.0)	49 (2.5)	36 (3.0)	38 (3.3)	14 (2.4)	17 (2.4)
1 Lithuania	37 (2.5)	47 (2.5)	36 (2.9)	38 (3.3)	12 (2.0)	14 (2.5)
New Zealand	65 (2.0)	74 (1.8)	36 (2.7)	40 (2.7)	21 (2.3)	30 (2.4)
Norway	64 (2.4)	77 (1.6)	37 (3.6)	37 (2.7)	16 (2.6)	29 (2.5)
Portugal	29 (1.9)	33 (1.9)	32 (2.3)	37 (2.6)	10 (1.4)	11 (1.6)
Russian Federation	54 (2.0)	59 (2.8)	42 (2.5)	41 (2.9)	16 (1.8)	26 (2.4)
† Scotland	62 (2.6)	74 (2.0)	32 (2.5)	38 (2.9)	19 (2.2)	25 (3.2)
Singapore	82 (2.2)	89 (1.3)	62 (3.1)	70 (2.6)	69 (3.0)	78 (2.4)
Slovak Republic	41 (2.0)	52 (2.1)	33 (2.3)	38 (2.4)	20 (2.3)	34 (2.6)
Spain	17 (1.4)	28 (2.1)	30 (2.5)	25 (2.2)	11 (1.6)	11 (1.6)
Sweden	80 (1.7)	88 (1.3)	34 (2.8)	43 (2.8)	19 (2.3)	32 (2.1)
1 Switzerland	49 (2.0)	59 (1.8)	34 (2.1)	44 (2.1)	16 (2.1)	25 (1.8)
† United States	57 (2.1)	66 (2.1)	32 (2.1)	34 (1.8)	14 (2.1)	20 (1.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	73 (1.7)	81 (1.4)	34 (2.5)	42 (2.2)	21 (2.0)	28 (1.9)
Austria	57 (2.4)	63 (2.1)	31 (2.3)	33 (2.7)	32 (2.9)	40 (2.7)
Bulgaria	32 (3.3)	44 (3.8)	41 (5.2)	63 (5.2)	24 (3.3)	29 (4.6)
Netherlands	51 (2.1)	61 (2.9)	32 (3.1)	50 (3.5)	33 (3.7)	44 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	6 (0.9)	6 (1.1)	33 (4.5)	29 (3.4)	11 (2.1)	11 (2.0)
†1 Germany	48 (2.5)	55 (2.4)	37 (3.1)	37 (2.7)	27 (2.8)	32 (3.5)
Romania	25 (1.9)	26 (2.0)	33 (2.4)	39 (2.9)	13 (1.9)	20 (2.2)
Slovenia	27 (1.8)	38 (2.4)	32 (2.4)	31 (2.9)	21 (2.4)	31 (2.6)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	59 (2.7)	71 (2.0)	30 (2.7)	31 (3.5)	17 (3.2)	22 (2.3)
Greece	49 (2.0)	56 (2.0)	29 (2.1)	29 (2.6)	20 (2.0)	19 (2.0)
† South Africa	20 (2.0)	16 (2.2)	24 (2.1)	23 (2.1)	24 (1.7)	18 (1.7)
Thailand	40 (2.4)	40 (2.4)	38 (2.8)	44 (2.7)	26 (2.3)	33 (3.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	63 (3.6)	–	41 (5.1)	–	31 (4.5)
Kuwait	–	10 (1.6)	–	22 (2.3)	–	13 (2.6)

*Seventh and eighth grades in most countries: See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for France on Example 4 and Japan on Example 5.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.1

International Difficulty Map for Fractions and Number Sense Example Items Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

item difficulty level, for each item. Since the scale was developed based on the performance of students at both grades in all countries, the international scale values apply to both grades and to all countries.

For the figure, the item results have been placed on the scale at the point where students at that level were more likely than not (65% probability) to answer the question correctly. For example, students scoring at or above 546 on the scale were likely to provide a correct response to the rounding item about the dolphin's actual weight (Example Item 4), and those scoring at or above 610 were likely to have responded correctly to the problem about rate of fuel consumption (Example Item 5). Considering that the international average on the scale was 513 at the eighth grade, however, students achieving at about the level of the international average were unlikely to have answered Example Item 5 (or Example Item 6 about percent increases) correctly. These results, however, varied dramatically by country. Eighth-grade students in Singapore, whose mean achievement was 643, had relatively high probabilities of answering all but the most difficult fractions and number sense items correctly. Indeed, this is borne out by Singapore's average percent correct of 79% in this content area at the eighth grade.

The six example items are presented in their entirety beginning on the next page. Example Item 1 is a subtraction problem with whole numbers that requires regrouping (borrowing). The international averages for the percent correct (86% for both grades) indicate that most seventh and eighth graders were successful on this item. In general, the lack of variation in performance between grades and across countries suggest that students in most countries have developed a grasp of how to solve this type of problem prior to the seventh and eighth grades.

Example Item 2 about understanding the relative size of fractions required students to provide their response, rather than select an answer in the multiple-choice format. On average, approximately three-fourths of both the seventh and eighth graders (74% and 75%, respectively) provided a correct response (any fraction larger than two-sevenths). Again, there were few differences in performance across countries or grade levels. With the exception of Iran, Kuwait, and South Africa, at least 60% of the seventh and eighth graders in each of the participating countries responded correctly.

Internationally, on average, about two-thirds of the students at seventh and eighth grades (62% and 66%) correctly interpreted the information about scale provided on the map shown in Example Item 3. As might be expected, the eighth graders performed better than seventh graders in many countries. Notwithstanding the between-grade increases, in all but a few cases, the majority of seventh graders answered the question correctly.

Averaged across countries, Example Item 4, which required students to demonstrate their understanding of rounded values, was answered correctly by approximately half the students at seventh and eighth grades (47% and 53%). Any value within the range of 165 through 174 was coded as a correct response. On this item, however, there was considerable variation in performance across countries. For example, 80% or more of the students at one or both grades in the Czech Republic, Korea, Singapore, Sweden, and Australia provided a correct answer to this question. In contrast, fewer than 20% of the students did so at one or both grades in Cyprus, Iran, Spain, Colombia, Kuwait, and South Africa.

Multi-step problems such as the one shown in Example Item 5 were difficult for students around the world. On average, 35% of the seventh-grade students and 39% of those in eighth grade responded correctly. The most prevalent mistake was to select the amount of fuel used on the trip (option C) rather than the amount of fuel remaining in the tank.

The international averages for Example Item 6 indicate that working with percentages is a challenge for students in most countries. Only about one-fourth of the students at seventh and eighth grades (23% and 28%) responded correctly to this multiple-choice item. Singapore posted by far the best performance on this item (69% and 78% correct at grades 7 and 8), with Hong Kong having the next highest achievement (47% and 54% correct).

EXAMPLE ITEM 1
FRACTIONS & NUMBER SENSE

Subtraction problem with whole numbers

Subtract: 6000
−2369

A. 4369

B. 3742

(C.) 3631

D. 3531

Performance Category: Performing Routine Procedures

EXAMPLE ITEM 2
FRACTIONS & NUMBER SENSE

Write a larger fraction

Write a fraction that is larger than $\frac{2}{7}$.

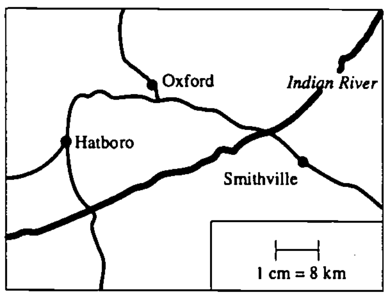
Answer: $\frac{3}{7}$

Performance Category: Knowing

EXAMPLE ITEM 3
FRACTIONS & NUMBER SENSE

Distance on map

One centimeter on the map represents 8 kilometers on the land.



About how far apart are Oxford and Smithville on the land?

A. 4 km

B. 16 km

(C.) 35 km

D. 50 km

Performance Category: Using Complex Procedures

EXAMPLE ITEM 4
FRACTIONS & NUMBER SENSE

Actual weight from rounded value

Rounded to the nearest 10 kg the weight of a dolphin was reported as 170 kg.
Write down a weight that might have been the actual weight of the dolphin.

Answer: 168

Performance Category: Using Complex Procedures

395

Example Item 5
Fractions & Number Sense

Rate of fuel consumption

A car has a fuel tank that holds 35 L of fuel. The car consumes 7.5 L of fuel for each 100 km driven. A trip of 250 km was started with a full tank of fuel. How much fuel remained in the tank at the end of the trip?

(A.) 16.25 L

B. 17.65 L

C. 18.75 L

D. 23.75 L

Performance Category: Solving Problems

Example Item 6
Fractions & Number Sense

Percent increase in price

If the price of a can of beans is raised from 60 cents to 75 cents, what is the percent increase in the price?

A. 15%

B. 20%

(C.) 25%

D. 30%

Performance Category: Performing Routine Procedures

WHAT HAVE STUDENTS LEARNED ABOUT GEOMETRY?

There was perhaps more variation in the geometry curriculum across countries than in any of the other mathematics content areas. The TIMSS geometry items required students to visualize geometric figures and to demonstrate their understanding of the properties of geometric figures. The concepts measured included symmetry, congruence, and similarity. Table 3.2 presents the results for the example items in geometry. Figure 3.2 presents the international difficulty map for the example items in geometry. Considering the international mean on the mathematics scale of 513 (for eighth grade), it can be seen that students performing above the mean were much more likely to understand the properties of geometric figures.

The range of student understanding in geometry is demonstrated by their performance on Example Items 7 through 12. Example Item 7 assessed spatial visualization skills, and Example Item 8 lines of symmetry. Although the content differed, internationally about two-thirds of the seventh- and eighth-grade students answered these questions correctly (Example Item 7 - 63% and 67%, Example Item 8 - 63% and 66%). Some countries did much better on these items than others. At the eighth grade, 80% or more students answered Example Item 7 correctly in Belgium (Flemish), the Czech Republic, Iceland, Japan, Latvia (LSS), the Slovak Republic, Switzerland, and Austria. This compares to fewer than half answering correctly in Cyprus, Iran, Colombia, South Africa, and Kuwait. Similarly, a number of countries were at about the 80% level on Example Item 8, while a few were at or below the level of 50% correct responses.

On average, Example Item 9, requiring understanding of ratio and perimeter, was answered correctly by 50% of the students at seventh grade and 56% at the eighth grade. In general, these international results reflect increases in achievement between the two grades shown in many countries and seem consistent with a curricular emphasis in geometry during the eighth grade.

The majority of students in many countries had difficulties with Example Item 10 on the properties of parallelograms. The international averages for the percents correct were 44% and 49% at the seventh and eighth grades, respectively. Only in Flemish-speaking Belgium (79%), Korea, (79%), and Bulgaria (78%) did more than three-fourths of the eighth-grade students answer this question correctly.

When given its coordinates and asked about another point on a line (Example Item 11), students showed great variation in performance from country to country. On average, the results were low at both seventh and eighth grades (38% and 41%). In the Netherlands, the top-performing country on this item, the corresponding figures were 62% and 66%. Students in England (58% and 55%) and Scotland (54% and 52%) also performed relatively well compared to their counterparts in other countries.

One of the most difficult geometry items assessed understanding of the properties of congruent triangles (Example Item 12). Internationally, the average percent of correct responses was 27% for the seventh grade and 35% for the eighth grade. Still, about two-thirds of the eighth-grade students responded correctly in Japan, Korea, and Singapore.

Table 3.2

Percent Correct for Geometry Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 7 Rotated 3-dimensional figure		Example 8 Lines of symmetry		Example 9 Ratio of side length to perimeter	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	83 (1.8)	83 (2.1)	78 (2.2)	78 (3.3)	71 (2.7)	72 (3.5)
† Belgium (Fr)	76 (2.5)	74 (2.4)	71 (3.0)	80 (2.4)	66 (3.1)	62 (3.1)
Canada	68 (2.2)	75 (2.1)	78 (1.9)	76 (2.1)	51 (2.5)	69 (1.8)
Cyprus	49 (3.1)	43 (3.0)	56 (2.7)	58 (2.2)	35 (2.7)	55 (2.7)
Czech Republic	78 (1.9)	87 (1.9)	69 (2.8)	74 (2.6)	53 (2.6)	60 (2.9)
†2 England	72 (3.0)	77 (2.9)	79 (2.7)	82 (2.6)	49 (3.4)	52 (3.3)
France	71 (2.4)	77 (2.1)	79 (2.1)	80 (2.3)	58 (3.3)	69 (2.5)
Hong Kong	72 (3.0)	75 (2.7)	78 (2.6)	73 (2.4)	63 (3.6)	71 (2.6)
Hungary	61 (2.6)	71 (2.6)	80 (2.2)	82 (2.1)	43 (3.1)	55 (2.7)
Iceland	71 (3.1)	81 (2.2)	76 (2.4)	55 (3.5)	28 (2.7)	32 (3.1)
Iran, Islamic Rep.	52 (3.9)	42 (2.6)	68 (3.3)	68 (3.3)	57 (3.9)	50 (3.6)
Ireland	69 (2.2)	75 (2.5)	59 (2.6)	64 (2.6)	47 (2.6)	54 (3.2)
Japan	74 (1.9)	80 (1.3)	82 (1.6)	77 (1.6)	76 (1.8)	80 (1.6)
Korea	62 (2.5)	74 (2.6)	49 (3.0)	58 (2.7)	77 (2.0)	78 (2.1)
1 Latvia (LSS)	85 (1.9)	81 (2.6)	45 (3.4)	50 (3.1)	40 (3.5)	54 (3.2)
1 Lithuania	60 (3.0)	69 (3.1)	49 (3.2)	58 (3.6)	33 (2.8)	46 (3.0)
New Zealand	65 (2.9)	67 (2.3)	70 (2.7)	80 (2.0)	40 (2.6)	48 (2.5)
Norway	73 (2.9)	78 (2.1)	47 (3.1)	42 (2.7)	33 (3.0)	41 (2.5)
Portugal	51 (2.8)	58 (2.5)	46 (2.3)	44 (2.7)	45 (2.8)	48 (2.3)
Russian Federation	69 (2.4)	75 (2.8)	61 (2.4)	67 (3.3)	49 (3.1)	55 (4.3)
† Scotland	65 (2.6)	72 (2.3)	83 (2.3)	86 (1.7)	47 (2.8)	48 (3.0)
Singapore	77 (1.9)	79 (1.9)	77 (3.0)	81 (2.1)	75 (2.5)	80 (1.8)
Slovak Republic	71 (2.3)	81 (2.1)	70 (2.7)	75 (2.2)	59 (2.3)	67 (2.3)
Spain	68 (2.4)	71 (2.2)	47 (2.6)	51 (2.5)	48 (2.7)	55 (2.6)
Sweden	49 (3.0)	53 (2.6)	51 (2.7)	44 (2.4)	40 (2.8)	47 (2.5)
1 Switzerland	79 (2.3)	82 (2.0)	58 (2.8)	76 (2.6)	44 (2.6)	55 (2.4)
† United States	63 (2.3)	62 (2.5)	66 (3.0)	70 (2.2)	45 (3.0)	55 (1.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	69 (2.5)	73 (1.7)	70 (1.8)	69 (2.0)	54 (3.0)	60 (2.1)
Austria	70 (2.6)	80 (2.8)	53 (2.6)	57 (3.9)	54 (3.5)	69 (3.0)
Bulgaria	48 (3.5)	58 (5.3)	66 (4.3)	78 (4.7)	61 (5.2)	56 (3.4)
Netherlands	64 (3.3)	77 (2.7)	85 (2.4)	72 (3.9)	54 (2.7)	60 (4.5)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	46 (3.8)	41 (3.6)	40 (3.6)	44 (3.9)	30 (4.3)	37 (4.2)
†1 Germany	72 (2.2)	72 (2.7)	58 (3.1)	64 (3.1)	36 (3.2)	45 (3.3)
Romania	50 (2.8)	53 (2.4)	49 (2.5)	46 (2.7)	52 (2.9)	59 (2.8)
Slovenia	72 (2.3)	73 (2.5)	51 (2.8)	69 (2.5)	53 (2.4)	69 (2.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	68 (3.4)	73 (3.1)	51 (3.2)	52 (3.2)	31 (3.5)	35 (3.1)
Greece	55 (2.1)	64 (2.7)	50 (2.4)	62 (3.0)	49 (2.3)	61 (2.2)
† South Africa	30 (2.2)	36 (2.3)	31 (2.6)	29 (2.3)	36 (2.3)	31 (2.5)
Thailand	42 (2.2)	50 (2.5)	79 (1.8)	80 (1.8)	56 (2.9)	64 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	57 (3.5)	–	76 (3.5)	–	69 (3.5)
Kuwait	–	29 (3.1)	–	61 (4.2)	–	38 (4.8)

*Seventh and eighth grades in most countries: See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.2 (Continued)

Percent Correct for Geometry Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

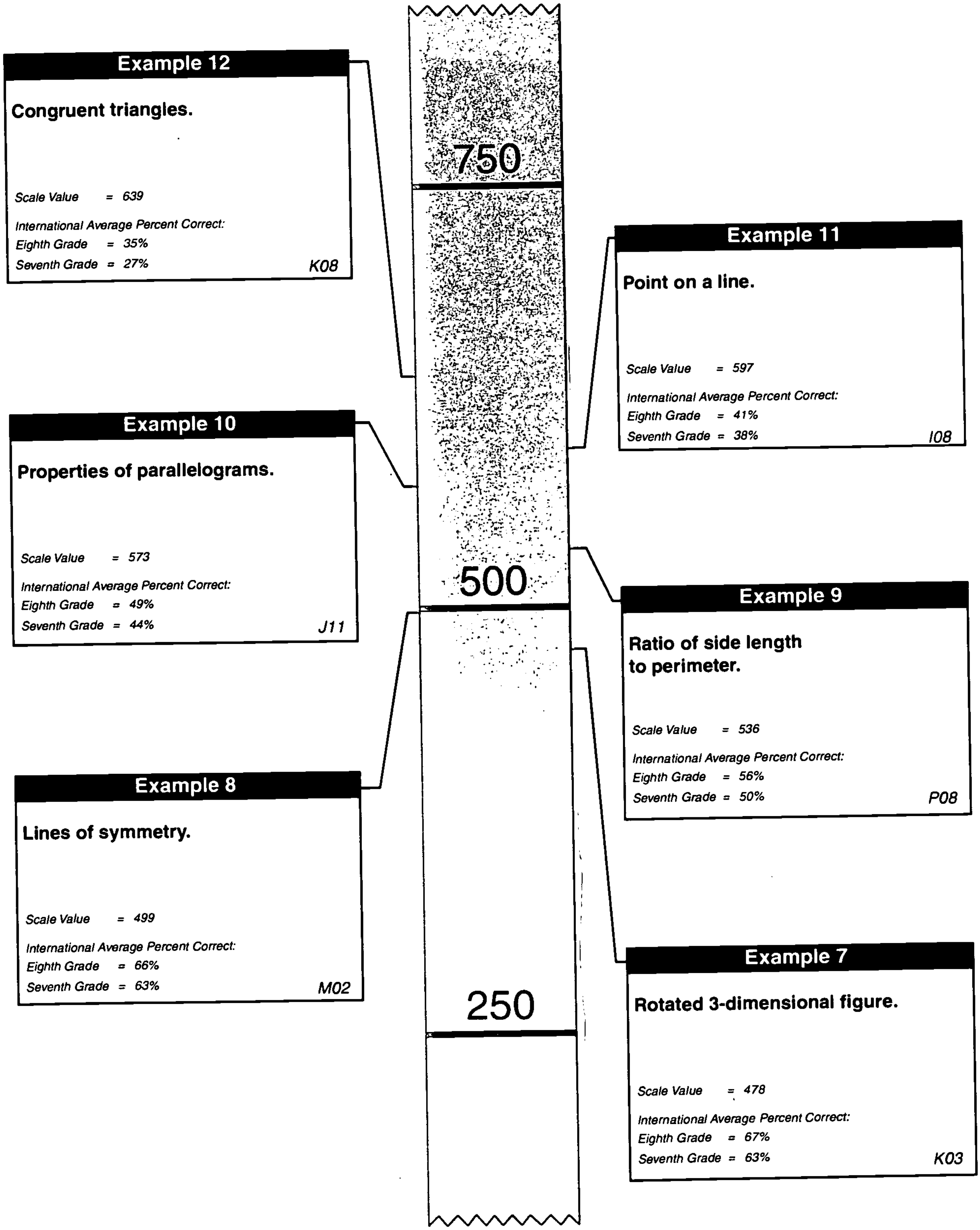
Country	Example 10 Properties of parallelograms.		Example 11 Point on a line.		Example 12 Congruent triangles.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	78 (2.5)	79 (2.0)	39 (2.4)	44 (3.5)	29 (2.8)	43 (2.8)
† Belgium (Fr)	50 (3.2)	57 (2.5)	24 (3.0)	23 (2.6)	29 (3.0)	32 (2.8)
Canada	48 (2.8)	48 (2.5)	43 (2.1)	49 (2.0)	20 (2.3)	29 (2.5)
Cyprus	37 (2.7)	41 (3.0)	29 (2.6)	30 (2.5)	33 (2.6)	41 (2.4)
Czech Republic	47 (3.0)	57 (3.0)	30 (2.9)	34 (3.1)	43 (3.7)	51 (3.0)
†2 England	39 (3.3)	48 (3.4)	58 (3.6)	55 (3.7)	24 (2.8)	31 (3.7)
France	48 (2.8)	62 (3.0)	24 (2.2)	34 (2.5)	38 (3.2)	50 (2.8)
Hong Kong	58 (3.4)	56 (2.5)	51 (2.5)	50 (2.8)	55 (3.0)	61 (2.7)
Hungary	42 (2.7)	57 (2.6)	47 (3.2)	51 (2.6)	28 (2.4)	39 (2.8)
Iceland	41 (4.7)	43 (3.3)	39 (4.2)	43 (3.4)	24 (3.2)	43 (3.6)
Iran, Islamic Rep.	30 (3.3)	31 (2.4)	22 (3.0)	17 (2.4)	28 (3.8)	35 (2.8)
Ireland	44 (2.5)	47 (2.9)	45 (2.7)	46 (2.6)	26 (2.2)	34 (2.6)
Japan	–	–	39 (2.1)	47 (2.2)	40 (2.1)	69 (1.7)
Korea	59 (2.3)	79 (2.1)	42 (3.0)	42 (3.2)	55 (2.8)	66 (2.1)
† Latvia (LSS)	27 (2.8)	51 (3.1)	34 (3.1)	38 (3.0)	20 (2.3)	25 (2.9)
† Lithuania	30 (3.5)	47 (3.2)	21 (3.0)	24 (2.8)	10 (2.0)	27 (2.8)
New Zealand	42 (2.7)	44 (2.8)	45 (3.1)	52 (2.8)	19 (2.0)	26 (2.5)
Norway	37 (3.6)	45 (2.6)	29 (3.2)	44 (3.1)	25 (2.5)	30 (2.3)
Portugal	33 (2.7)	33 (2.2)	35 (2.7)	46 (2.5)	21 (2.0)	21 (2.3)
Russian Federation	42 (2.4)	69 (3.3)	35 (3.3)	46 (3.3)	33 (3.2)	39 (2.9)
† Scotland	40 (3.1)	42 (2.5)	54 (2.7)	52 (3.1)	25 (2.2)	29 (2.7)
Singapore	58 (2.9)	57 (2.3)	47 (2.6)	59 (2.3)	55 (2.8)	69 (2.3)
Slovak Republic	43 (2.6)	46 (3.3)	33 (2.5)	40 (2.8)	35 (2.0)	45 (2.5)
Spain	39 (2.6)	40 (2.5)	37 (2.9)	39 (2.6)	17 (2.0)	14 (1.9)
Sweden	40 (2.7)	44 (2.6)	38 (2.5)	51 (2.3)	18 (2.3)	34 (2.4)
† Switzerland	39 (3.1)	52 (2.9)	46 (2.8)	51 (2.7)	25 (2.1)	33 (2.8)
† United States	39 (2.8)	40 (2.2)	37 (2.8)	41 (1.8)	15 (1.8)	17 (1.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	44 (2.5)	46 (2.1)	47 (2.4)	51 (1.8)	29 (2.2)	34 (1.8)
Austria	49 (3.2)	48 (3.5)	46 (2.8)	54 (3.3)	32 (3.0)	29 (2.9)
Bulgaria	72 (4.0)	78 (4.5)	38 (4.5)	38 (5.1)	45 (5.4)	44 (5.1)
Netherlands	27 (2.9)	37 (3.8)	62 (3.4)	66 (4.5)	14 (2.4)	21 (3.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	32 (2.9)	34 (3.9)	24 (4.6)	28 (4.3)	8 (1.5)	12 (2.6)
†1 Germany	42 (3.1)	55 (3.2)	32 (2.9)	38 (2.9)	28 (2.7)	29 (3.0)
Romania	60 (2.9)	67 (2.9)	18 (2.0)	22 (2.3)	34 (2.5)	41 (2.9)
Slovenia	34 (2.9)	40 (2.9)	37 (2.8)	32 (2.9)	26 (2.7)	37 (3.3)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	41 (3.4)	43 (3.0)	45 (3.0)	51 (3.7)	19 (2.7)	33 (3.2)
Greece	48 (2.7)	47 (2.7)	32 (2.2)	25 (2.4)	19 (2.2)	37 (2.3)
† South Africa	27 (2.2)	27 (2.0)	28 (2.2)	25 (2.2)	11 (1.3)	14 (1.8)
Thailand	62 (1.8)	62 (2.4)	47 (2.3)	44 (2.7)	22 (1.8)	33 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	57 (3.1)	–	42 (3.6)	–	43 (3.4)
Kuwait	–	13 (2.4)	–	24 (3.0)	–	20 (3.2)

*Seventh and eighth grades in most countries: See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Japan on Example 10.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.2

International Difficulty Map for Geometry Example Items Lower and Upper Grades (Seventh and Eighth Grades*)



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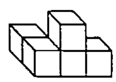
*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

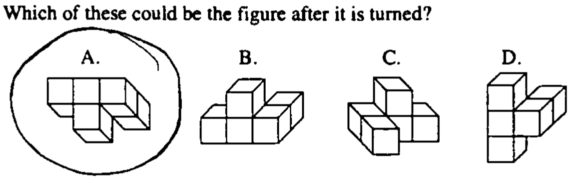
EXAMPLE ITEM 7
GEOMETRY

Rotated 3-dimensional figure

This figure will be turned to a different position.



Which of these could be the figure after it is turned?

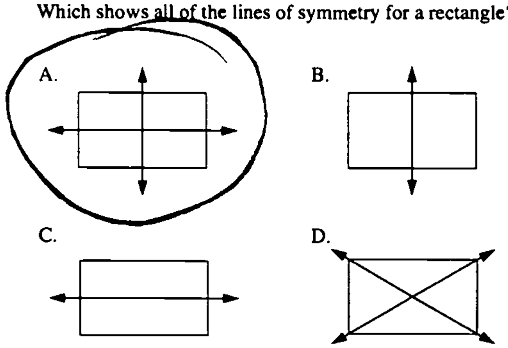


Performance Category: Using Complex Procedures

EXAMPLE ITEM 8
GEOMETRY

Lines of symmetry

Which shows all of the lines of symmetry for a rectangle?



Performance Category: Knowing

EXAMPLE ITEM 9
GEOMETRY

Ratio of side length to perimeter

What is the ratio of the length of a side of a square to its perimeter?

A. $\frac{1}{1}$

B. $\frac{1}{2}$

C. $\frac{1}{3}$

D. $\frac{1}{4}$

Performance Category: Solving Problems

EXAMPLE ITEM 10
GEOMETRY

Properties of parallelograms

A quadrilateral MUST be a parallelogram if it has

A. one pair of adjacent sides equal

B. one pair of parallel sides

C. a diagonal as axis of symmetry

D. two adjacent angles equal

E. two pairs of parallel sides

Performance Category: Knowing

EXAMPLE ITEM 11
GEOMETRY

Point on a line

A straight line on a graph passes through the points (3,2) and (4,4). Which of these points also lies on the line?

A. (1,1)

B. (2,4)

C. (5,6)

D. (6,3)

E. (6,5)

Performance Category: Solving Problems

EXAMPLE ITEM 12
GEOMETRY

Congruent triangles

These triangles are congruent. The measures of some of the sides and angles of the triangles are shown.

What is the value of x ?

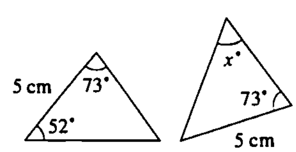
A. 52

B. 55

C. 65

D. 73

E. 75



Performance Category: Performing Routine Procedures

WHAT HAVE STUDENTS LEARNED ABOUT ALGEBRA?

To demonstrate their understanding of algebraic concepts, students were asked to solve a variety of problems involving patterns, relations, expressions, and equations. The country-by-country results for the example algebra items are presented in Table 3.3. Figure 3.3, showing the relationship between performance on these items and performance on the mathematics scale, suggests that even some of the eighth graders in most countries had considerable difficulty with all but the most straightforward algebra questions. Questions involving expressions and equations were most likely to be answered correctly by only the higher-performing students (students achieving approximately at or above the eighth-grade mean of 513).

Example Items 13 through 17 illustrate the range of student performance. As shown by Example Item 13, the easiest items measured concepts underlying algebra such as the ability to detect patterns. In most countries, students performed very well on this item at both grades (87% and 90% correct responses averaged across countries).

Example Item 14 is a two-part item requiring students to supply their answers. In the first part of the item, students generally were able to establish the number of small triangles in the figures (72% and 75% average correct at the seventh and eighth grades, respectively). Of course, finding the answers of 4 and 9 could have been accomplished by actually counting the small triangles. In contrast, very few students demonstrated their ability to extend the pattern and determine that 64 small triangles would be needed for the 8th figure (international averages of 18% and 26%). In only Japan (52%) and Singapore (50%) did at least half the eighth-grade students provide a correct response to this question.

Example Items 15, 16, and 17 required students to work with algebraic equations and expressions. The international results for Example Item 15 indicate that students in most countries were relatively successful in solving a simple linear equation for x (on average, 62% and 72% correct at the seventh and eighth grades). As shown by the data for Example Item 16, they had more difficulty recognizing that $m + m + m + m$ was equivalent to $4m$ (international averages of 47% and 58%). It should be noted, however, that three-fourths or more of the eighth-grade students answered this question correctly in the Czech Republic, Hong Kong, Japan, the Russian Federation, Singapore, the Slovak Republic, and Slovenia. Considering the performance on Example Item 16, it is not surprising that students had even more difficulty identifying the correct expression to represent the number of Clarissa's hats as required by Example Item 17. International performance on this item averaged 37% at the seventh grade and 47% at the eighth grade.

Table 3.3

Percent Correct for Algebra Example Items Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 13 Shapes in a pattern		Example 14A Sequence of triangles: chart finding pattern		Example 14B Sequence of triangles: extending pattern	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	96 (0.9)	94 (2.2)	84 (2.1)	83 (2.4)	26 (2.5)	31 (2.9)
† Belgium (Fr)	93 (1.8)	96 (1.4)	87 (2.1)	84 (2.5)	13 (2.2)	22 (2.5)
Canada	91 (1.7)	97 (0.8)	78 (2.0)	82 (1.7)	21 (1.8)	33 (2.4)
Cyprus	73 (2.3)	83 (2.6)	66 (2.5)	69 (2.7)	11 (1.9)	20 (2.4)
Czech Republic	96 (0.9)	98 (0.6)	75 (2.8)	75 (2.4)	19 (2.3)	32 (3.4)
†2 England	94 (1.9)	95 (1.6)	84 (2.6)	86 (2.4)	20 (2.6)	42 (3.4)
France	93 (1.6)	92 (1.4)	80 (2.1)	80 (2.1)	12 (1.8)	18 (2.5)
Hong Kong	91 (1.8)	90 (2.1)	83 (2.7)	82 (1.9)	43 (2.8)	48 (2.7)
Hungary	93 (1.6)	93 (1.3)	84 (1.9)	91 (1.4)	20 (2.9)	34 (2.8)
Iceland	83 (2.5)	83 (3.7)	74 (3.5)	77 (3.6)	6 (1.7)	16 (2.7)
Iran, Islamic Rep.	88 (2.2)	95 (1.3)	64 (3.0)	65 (2.8)	2 (0.8)	12 (2.7)
Ireland	92 (1.6)	94 (1.3)	72 (2.2)	73 (2.3)	19 (2.0)	25 (2.6)
Japan	97 (0.6)	96 (0.8)	89 (1.4)	94 (0.8)	43 (2.2)	52 (2.2)
Korea	96 (1.2)	97 (0.9)	80 (2.6)	84 (2.1)	32 (2.8)	38 (2.6)
1 Latvia (LSS)	93 (1.6)	96 (1.2)	67 (2.8)	76 (2.7)	13 (2.2)	17 (2.4)
1 Lithuania	87 (2.0)	91 (1.9)	56 (3.4)	66 (3.2)	6 (1.6)	13 (2.2)
New Zealand	90 (1.9)	94 (1.2)	72 (2.5)	81 (2.0)	23 (2.5)	31 (2.5)
Norway	88 (2.1)	92 (1.5)	73 (3.0)	77 (2.3)	14 (2.4)	22 (2.4)
Portugal	89 (1.9)	94 (1.3)	62 (2.6)	71 (2.6)	6 (1.5)	13 (1.8)
Russian Federation	92 (1.5)	95 (1.2)	70 (1.8)	76 (2.3)	11 (1.5)	22 (2.0)
† Scotland	89 (1.7)	94 (1.1)	85 (1.9)	89 (1.8)	18 (2.0)	35 (2.8)
Singapore	93 (1.3)	95 (0.8)	79 (2.4)	83 (1.5)	37 (2.9)	50 (2.8)
Slovak Republic	90 (1.7)	92 (1.5)	67 (2.5)	73 (2.4)	15 (1.9)	27 (2.4)
Spain	89 (1.7)	93 (1.3)	71 (2.4)	80 (2.0)	17 (2.2)	22 (2.0)
Sweden	90 (1.7)	89 (1.4)	75 (2.5)	75 (2.1)	8 (1.6)	17 (2.0)
1 Switzerland	95 (1.1)	95 (1.4)	80 (2.1)	86 (1.7)	27 (2.6)	38 (2.5)
† United States	90 (1.8)	93 (0.8)	73 (2.2)	75 (2.2)	18 (2.4)	25 (1.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	91 (1.3)	93 (1.3)	76 (2.5)	80 (1.3)	26 (2.5)	32 (1.8)
Austria	95 (1.4)	95 (1.4)	91 (1.9)	91 (2.1)	27 (2.2)	35 (3.4)
Bulgaria	83 (3.5)	88 (3.4)	69 (4.5)	76 (3.5)	18 (4.3)	18 (3.5)
Netherlands	87 (2.4)	91 (1.9)	82 (2.8)	84 (2.5)	29 (2.9)	38 (3.8)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	44 (3.6)	55 (4.2)	45 (3.9)	46 (4.2)	7 (4.8)	11 (4.1)
†1 Germany	86 (2.1)	92 (1.6)	79 (2.9)	81 (2.4)	16 (2.4)	18 (2.6)
Romania	83 (2.0)	85 (2.0)	53 (2.9)	63 (2.6)	15 (2.0)	20 (2.4)
Slovenia	87 (2.0)	89 (1.6)	76 (2.2)	82 (2.4)	20 (2.4)	31 (3.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	91 (1.6)	93 (1.8)	68 (2.7)	77 (2.9)	13 (2.0)	24 (3.4)
Greece	77 (2.2)	86 (1.6)	69 (2.1)	79 (2.2)	4 (1.0)	13 (2.1)
† South Africa	44 (2.7)	53 (3.3)	19 (2.5)	20 (2.5)	3 (0.9)	3 (1.3)
Thailand	94 (0.9)	96 (0.8)	78 (1.9)	86 (1.3)	19 (1.6)	26 (2.7)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	91 (1.4)	–	78 (2.7)	–	25 (3.4)
Kuwait	–	78 (4.1)	–	34 (3.9)	–	20 (4.0)

*Seventh and eighth grades in most countries: See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.3 (Continued)

Percent Correct for Algebra Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

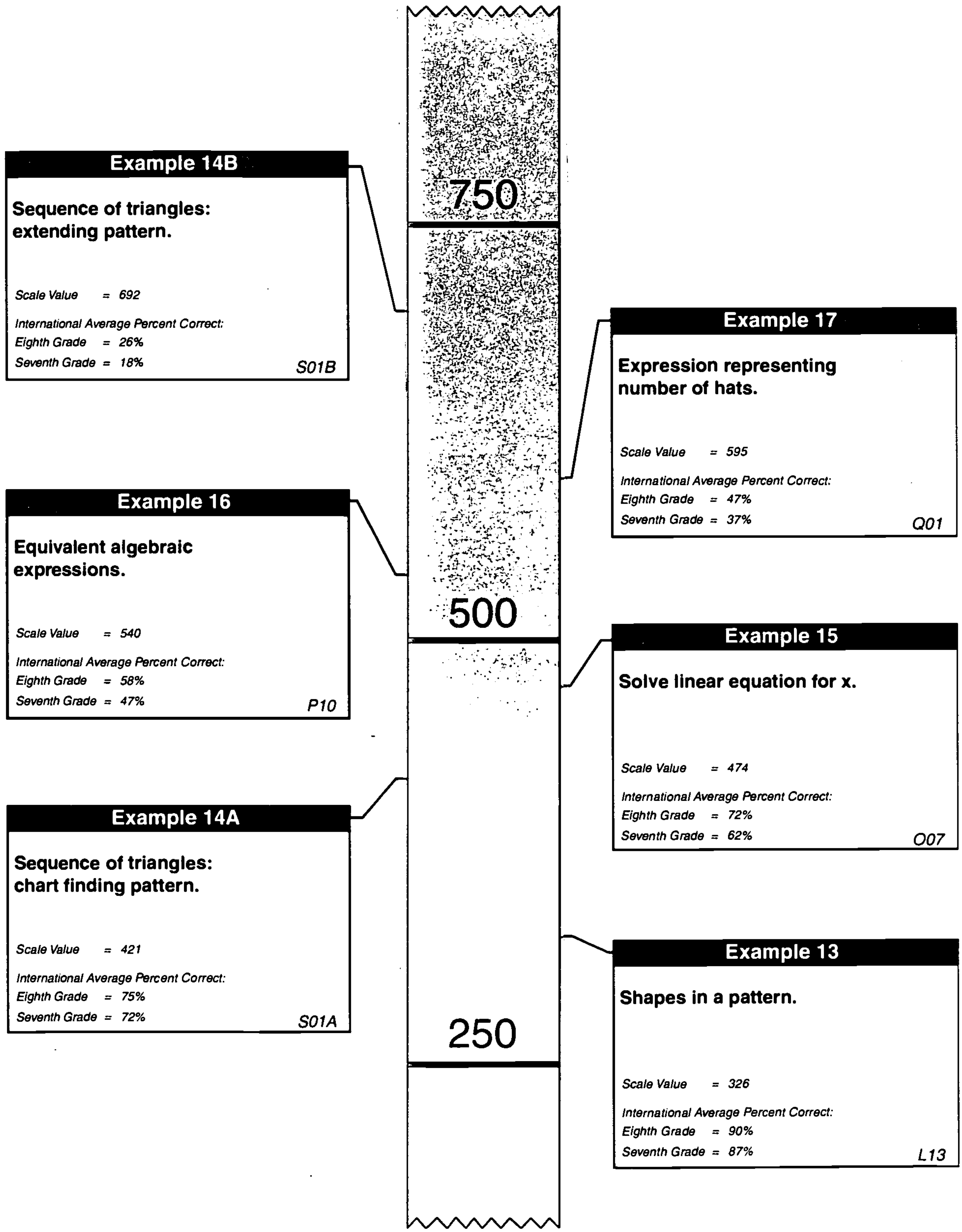
Country	Example 15: Solve linear equation for x		Example 16: Equivalent algebraic expressions		Example 17: Expression representing number of hats	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	84 (2.3)	80 (2.8)	69 (2.8)	69 (4.2)	41 (3.0)	53 (3.8)
† Belgium (Fr)	69 (3.4)	76 (2.5)	56 (3.7)	64 (2.7)	35 (3.5)	46 (3.1)
Canada	55 (2.6)	73 (2.6)	40 (2.3)	61 (2.1)	33 (2.5)	45 (2.7)
Cyprus	65 (3.4)	71 (3.2)	43 (2.6)	59 (2.9)	34 (2.9)	47 (3.0)
Czech Republic	81 (2.6)	86 (2.2)	69 (3.2)	75 (2.7)	56 (3.1)	70 (3.7)
†2 England	51 (3.2)	61 (3.4)	46 (3.6)	42 (3.6)	25 (3.2)	37 (3.0)
France	62 (2.6)	82 (2.3)	53 (2.8)	65 (2.5)	39 (2.7)	55 (2.8)
Hong Kong	87 (2.4)	92 (1.9)	72 (3.3)	79 (3.3)	64 (3.4)	65 (3.2)
Hungary	79 (2.1)	89 (1.7)	61 (2.7)	72 (2.4)	40 (3.2)	57 (3.0)
Iceland	45 (3.7)	56 (3.4)	35 (3.0)	59 (4.0)	11 (2.2)	14 (3.2)
Iran, Islamic Rep.	36 (4.5)	47 (3.7)	31 (3.3)	34 (3.2)	29 (3.2)	38 (3.8)
Ireland	65 (2.6)	72 (3.0)	39 (2.9)	53 (2.8)	44 (2.1)	51 (2.6)
Japan	85 (1.7)	90 (1.3)	60 (2.0)	75 (1.9)	48 (2.3)	57 (2.2)
Korea	87 (1.9)	92 (1.6)	56 (3.1)	65 (2.6)	60 (3.2)	64 (2.7)
1 Latvia (LSS)	70 (3.1)	75 (2.5)	49 (3.3)	58 (3.0)	45 (3.2)	42 (3.3)
1 Lithuania	66 (3.3)	72 (3.4)	48 (3.4)	56 (3.8)	39 (3.2)	46 (3.5)
New Zealand	56 (2.9)	69 (2.4)	40 (2.8)	55 (2.6)	27 (2.8)	38 (2.6)
Norway	32 (2.8)	52 (2.5)	42 (4.2)	52 (2.7)	13 (2.8)	23 (2.3)
Portugal	47 (2.6)	60 (2.2)	26 (2.9)	42 (2.9)	30 (2.6)	42 (2.3)
Russian Federation	84 (2.0)	88 (1.7)	61 (2.9)	75 (2.9)	54 (2.5)	58 (3.8)
† Scotland	40 (2.7)	62 (2.8)	53 (3.0)	53 (3.0)	18 (2.1)	36 (3.1)
Singapore	91 (1.7)	96 (0.9)	77 (2.2)	82 (2.0)	78 (2.4)	86 (1.7)
Slovak Republic	83 (1.8)	84 (2.1)	63 (3.1)	77 (2.6)	54 (2.8)	66 (2.6)
Spain	58 (2.8)	76 (2.3)	43 (2.5)	59 (2.7)	46 (2.4)	61 (2.3)
Sweden	42 (2.7)	51 (2.7)	37 (2.5)	51 (2.6)	16 (2.3)	20 (2.0)
1 Switzerland	54 (2.3)	77 (2.2)	38 (2.5)	54 (2.7)	28 (2.4)	41 (3.1)
† United States	63 (3.8)	73 (2.3)	40 (2.8)	46 (2.5)	39 (2.9)	49 (2.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	65 (2.5)	73 (1.6)	51 (2.7)	65 (1.8)	31 (2.3)	45 (2.0)
Austria	70 (2.8)	80 (2.1)	51 (2.7)	73 (2.8)	38 (2.9)	51 (3.1)
Bulgaria	82 (3.1)	84 (2.6)	69 (3.5)	72 (3.1)	64 (5.1)	64 (3.9)
Netherlands	49 (4.0)	65 (4.3)	33 (4.1)	51 (4.5)	27 (2.9)	45 (4.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	30 (3.3)	43 (3.7)	19 (3.6)	34 (4.5)	23 (3.5)	33 (3.7)
†1 Germany	62 (3.6)	79 (2.0)	43 (3.4)	57 (3.3)	27 (2.5)	41 (3.0)
Romania	70 (2.6)	77 (2.7)	57 (2.6)	64 (2.7)	45 (3.0)	52 (3.0)
Slovenia	74 (2.5)	86 (1.8)	55 (2.8)	75 (2.7)	43 (2.8)	55 (3.0)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	53 (3.9)	70 (3.3)	31 (2.7)	36 (3.1)	16 (2.3)	29 (2.8)
Greece	62 (2.2)	75 (2.2)	40 (2.7)	57 (2.5)	29 (2.1)	36 (2.7)
† South Africa	38 (2.1)	39 (2.5)	25 (2.0)	33 (2.7)	21 (2.1)	19 (2.4)
Thailand	71 (2.4)	79 (2.2)	40 (2.5)	49 (3.1)	40 (2.6)	46 (2.6)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	86 (2.9)	–	70 (3.7)	–	73 (3.3)
Kuwait	–	50 (3.9)	–	29 (2.8)	–	27 (3.3)

*Seventh and eighth grades in most countries: See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.3

International Difficulty Map for Algebra Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

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EXAMPLE ITEM 13
ALGEBRA

Shapes in a pattern

These shapes are arranged in a pattern.

○△○○△△○○○△△△

Which set of shapes is arranged in the same pattern?

A. ★□★□★★□□★★□□

B. □★□□★□□□★□□□□

(C.) ★□★★□□★★★□□□

D. □□★★□★□□★★□★

Performance Category: Knowing

EXAMPLE ITEM 14
ALGEBRA

Sequence of triangles

Here is a sequence of three similar triangles. All of the small triangles are congruent.

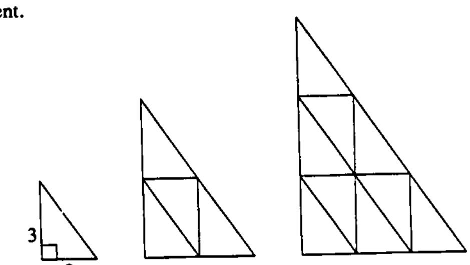

Figure 1 Figure 2 Figure 3

a. Complete the chart by finding how many small triangles make up each figure.

Figure	Number of small triangles
1	1
2	4
3	9

b. The sequence of similar triangles is extended to the 8th Figure. How many small triangles would be needed for Figure 8?

9+7+9+11+13+15 18 18 28 64

64 small triangls

Performance Category: Solving Problems

EXAMPLE ITEM 15
ALGEBRA

Solve linear equation for x

If $3(x + 5) = 30$, then $x =$

A. 2

(B.) 5

C. 10

D. 95

Performance Category: Performing Routine Procedures

EXAMPLE ITEM 16
ALGEBRA

Equivalent algebraic expressions

If m represents a positive number, which of these is equivalent to $m + m + m + m$?

A. $m + 4$

(B.) $4m$

C. m^4

D. $4(m + 1)$

Performance Category: Knowing

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EXAMPLE ITEM 17
ALGEBRA

Expression representing number of hats

Juan has 5 fewer hats than Maria, and Clarissa has 3 times as many hats as Juan. If Maria has n hats, which of these represents the number of hats that Clarissa has?

A. $5 - 3n$

B. $3n$

C. $n - 5$

D. $3n - 5$

(E.) $3(n - 5)$

Performance Category: Using Complex Procedures

WHAT HAVE STUDENTS LEARNED ABOUT DATA REPRESENTATION, ANALYSIS, AND PROBABILITY?

As illustrated by Example Items 18 through 23, the types of items in this content area required students to represent and analyze data using charts, tables, and graphs and to demonstrate their understanding of basic concepts underlying uncertainty and probability. The results for the example items are presented in Table 3.4. As shown in Figure 3.4, the international difficulty map for data representation, analysis, and probability indicates that the higher performing students were more likely to demonstrate the ability to apply concepts and integrate their understandings.

Example Item 18 asked students to read a chart of daily temperatures. Performance on reading the chart of temperatures was high in nearly all countries (international averages of 85% and 87%). Performance also was relatively high on Example Item 19 which required students to complete a pictograph (international averages of 79% and 81%).

Example Item 21, requiring students to read a line graph, posed a greater challenge for students in many countries. On average, 51% of the students at the seventh grade across countries and 58% at the eighth grade answered this question correctly. There were large differences in performance among countries. At the eighth grade, performance at 75% correct or better was achieved in Flemish-speaking Belgium (82%), France (81%), Japan (75%), Switzerland (77%), the Netherlands (76%), and Denmark (75%). Performance below 45% occurred in Cyprus (40%), Iran (25%), Colombia (20%), Romania (36%), South Africa (17%), and Kuwait (24%).

Example Items 20 and 22 assessed the area of probability. In general, students appeared to understand that the probability of picking the one red marble was highest for the fewest number of marbles (Example Item 20). The international averages were 73% and 76% at the seventh and eighth grades, respectively. Eighty-five percent or more of the students at both grades answered this question correctly in Belgium (Flemish), Canada, Hong Kong, Korea, and the Netherlands. In contrast, asking students to integrate their understanding of both cubes and probability proved to be more difficult for them (Example Item 22). The international averages of correct responses were 41% at the seventh grade and 47% at the eighth grade. Although the eighth-grade students performed quite well in Singapore (88%) and two-thirds or more answered correctly in Flemish-speaking Belgium (68%), Hong Kong (72%), Japan (75%), and Korea (68%), performance fell below 40% correct in a number of countries.

Example Item 23 required students to apply their mathematics understanding to an everyday situation — that of extracting and using appropriate information from a newspaper advertisement to determine which office space had the lower rent. Students were asked to show their work. Although the scoring approach provided information about partial solutions to the problem, the results reported herein for each country are for those students receiving complete credit for the item. That is, students indicated that Building A had the lower price and showed accurate computations to support this conclusion. Performance was quite low in most of the countries. Only in Singapore (55%) did more than half the eighth-grade students provide a complete solution to this problem, although performance in Japan (47%) and Korea (50%) also was higher than in other countries.

Table 3.4

Percent Correct for Data Representation, Analysis, and Probability Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 18 Highest temperature on chart. Seventh Grade	Example 18 Eighth Grade	Example 19 Pictograph of number of students. Seventh Grade	Example 19 Eighth Grade	Example 20 Chance of picking red marble. Seventh Grade	Example 20 Eighth Grade
† Belgium (Fl)	94 (1.4)	91 (2.5)	93 (1.2)	86 (3.8)	90 (1.9)	86 (1.9)
† Belgium (Fr)	92 (1.7)	90 (2.3)	84 (2.3)	82 (2.8)	83 (2.4)	85 (2.3)
Canada	90 (1.6)	92 (1.7)	91 (1.3)	89 (1.5)	85 (1.9)	90 (1.1)
Cyprus	72 (2.7)	78 (2.5)	75 (2.5)	82 (1.8)	63 (2.4)	68 (2.9)
Czech Republic	97 (1.0)	96 (0.8)	76 (2.4)	84 (2.3)	66 (2.6)	76 (2.8)
†2 England	89 (2.1)	91 (2.2)	87 (2.7)	92 (1.7)	81 (2.7)	86 (2.3)
France	89 (1.7)	90 (1.7)	85 (1.9)	88 (1.6)	82 (2.4)	82 (2.3)
Hong Kong	85 (1.9)	79 (2.8)	86 (2.0)	81 (2.0)	85 (2.5)	89 (1.6)
Hungary	92 (1.5)	91 (1.4)	83 (2.0)	87 (1.7)	77 (2.3)	82 (2.1)
Iceland	88 (2.0)	90 (2.2)	87 (2.8)	87 (2.9)	76 (3.0)	77 (2.8)
Iran, Islamic Rep.	72 (3.1)	75 (2.9)	52 (3.3)	67 (2.9)	31 (5.4)	37 (3.1)
Ireland	90 (1.5)	92 (1.6)	84 (2.0)	89 (1.8)	76 (2.3)	82 (2.1)
Japan	94 (1.0)	93 (1.1)	93 (0.9)	94 (1.0)	81 (1.7)	83 (1.4)
Korea	82 (2.4)	85 (1.8)	92 (1.7)	90 (1.6)	86 (2.0)	91 (1.6)
1 Latvia (LSS)	80 (2.6)	86 (2.2)	72 (2.4)	82 (1.9)	51 (2.8)	60 (3.0)
1 Lithuania	74 (3.2)	87 (2.1)	59 (3.3)	75 (2.8)	56 (3.1)	68 (2.9)
New Zealand	91 (1.9)	93 (1.3)	87 (1.9)	92 (1.4)	74 (2.3)	82 (1.7)
Norway	88 (2.0)	92 (1.5)	85 (2.3)	86 (1.9)	79 (2.8)	85 (1.7)
Portugal	84 (2.0)	90 (1.6)	78 (2.1)	86 (1.8)	60 (2.4)	67 (2.3)
Russian Federation	84 (2.2)	91 (1.5)	77 (2.2)	78 (2.2)	63 (2.8)	70 (2.5)
† Scotland	89 (1.7)	91 (1.7)	83 (1.8)	88 (1.7)	77 (2.4)	82 (2.0)
Singapore	80 (2.1)	88 (1.4)	92 (1.3)	94 (1.1)	82 (2.0)	81 (1.9)
Slovak Republic	90 (1.5)	93 (1.4)	79 (2.0)	80 (2.0)	70 (2.4)	70 (2.6)
Spain	86 (1.7)	88 (1.7)	77 (2.5)	86 (1.7)	80 (2.2)	83 (2.0)
Sweden	93 (1.5)	94 (1.3)	86 (1.9)	87 (1.5)	84 (1.7)	81 (1.9)
1 Switzerland	94 (1.1)	92 (1.8)	86 (2.3)	88 (2.1)	81 (2.5)	86 (1.4)
† United States	89 (1.7)	90 (1.1)	87 (1.5)	89 (1.2)	82 (1.9)	86 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	94 (1.1)	92 (1.4)	91 (1.4)	88 (1.4)	79 (2.1)	84 (1.6)
Austria	90 (1.5)	91 (1.9)	84 (2.5)	87 (2.1)	77 (2.6)	82 (2.3)
Bulgaria	82 (3.5)	81 (2.8)	74 (3.6)	75 (4.1)	77 (3.6)	85 (3.8)
Netherlands	92 (2.0)	89 (2.4)	89 (2.3)	87 (3.6)	89 (2.1)	91 (1.9)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	66 (2.9)	71 (4.0)	53 (3.6)	64 (4.2)	40 (3.4)	47 (4.0)
†1 Germany	89 (2.1)	87 (2.2)	83 (2.0)	82 (2.7)	78 (2.1)	83 (2.2)
Romania	72 (3.1)	69 (2.8)	64 (3.0)	64 (2.7)	52 (2.8)	52 (2.7)
Slovenia	93 (1.3)	95 (1.2)	82 (1.8)	77 (2.0)	81 (2.1)	85 (2.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	93 (1.8)	92 (2.1)	84 (2.7)	88 (2.2)	76 (2.5)	83 (2.2)
Greece	78 (2.2)	85 (1.7)	63 (2.7)	77 (2.5)	61 (2.2)	71 (1.9)
† South Africa	48 (2.7)	55 (2.6)	17 (2.5)	17 (3.1)	30 (2.5)	28 (2.8)
Thailand	83 (1.8)	86 (1.5)	93 (1.3)	94 (1.0)	74 (2.0)	76 (1.9)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	89 (2.2)	–	87 (3.3)	–	77 (3.2)
Kuwait	–	82 (2.7)	–	29 (4.6)	–	53 (4.4)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.4 (Continued)

Percent Correct for Data Representation, Analysis, and Probability Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 21 Speed of car from graph		Example 22 Number of red cube faces		Example 23 Price of renting office space	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	76 (2.6)	82 (3.8)	73 (3.1)	68 (2.7)	25 (2.3)	23 (1.9)
† Belgium (Fr)	60 (2.8)	64 (3.8)	55 (3.2)	61 (3.8)	14 (1.5)	20 (2.5)
Canada	55 (2.2)	66 (1.9)	49 (2.6)	57 (2.2)	16 (1.5)	24 (1.7)
Cyprus	41 (2.6)	40 (3.2)	37 (2.8)	46 (3.0)	5 (0.7)	8 (1.6)
Czech Republic	57 (3.1)	71 (2.8)	39 (3.2)	36 (3.2)	18 (1.8)	28 (2.6)
†2 England	66 (2.8)	69 (3.1)	36 (3.2)	39 (3.1)	12 (1.5)	20 (2.0)
France	75 (2.1)	81 (2.5)	43 (3.0)	54 (3.0)	16 (1.5)	26 (2.1)
Hong Kong	65 (2.9)	65 (2.5)	70 (3.2)	72 (2.7)	25 (2.3)	37 (2.5)
Hungary	57 (3.0)	61 (2.7)	43 (2.7)	55 (2.8)	11 (1.2)	20 (1.6)
Iceland	37 (3.6)	56 (4.3)	36 (2.9)	57 (4.2)	6 (1.3)	15 (1.8)
Iran, Islamic Rep.	17 (3.2)	25 (2.8)	26 (2.4)	24 (3.9)	1 (0.4)	1 (0.4)
Ireland	50 (2.6)	63 (2.4)	58 (2.4)	64 (3.3)	18 (1.6)	25 (2.3)
Japan	71 (1.9)	75 (1.8)	69 (2.1)	75 (1.6)	38 (1.5)	47 (1.5)
Korea	61 (2.5)	67 (2.6)	66 (2.7)	68 (3.2)	38 (2.1)	50 (1.8)
1 Latvia (LSS)	43 (3.2)	57 (3.0)	22 (2.1)	28 (3.0)	5 (1.2)	9 (1.2)
1 Lithuania	47 (3.0)	53 (3.3)	18 (2.7)	22 (2.9)	3 (0.9)	7 (1.2)
New Zealand	51 (2.6)	66 (2.6)	37 (2.6)	52 (2.4)	15 (1.5)	22 (2.0)
Norway	58 (3.4)	73 (2.3)	42 (3.5)	57 (2.6)	16 (1.8)	23 (1.6)
Portugal	38 (2.4)	49 (2.6)	18 (1.9)	21 (1.9)	4 (0.7)	8 (0.9)
Russian Federation	49 (3.2)	49 (3.0)	29 (2.7)	33 (2.6)	11 (1.3)	14 (1.7)
† Scotland	60 (3.2)	70 (2.7)	36 (2.9)	48 (3.3)	12 (1.4)	20 (2.3)
Singapore	57 (2.5)	67 (2.0)	80 (2.1)	88 (1.7)	49 (2.6)	55 (2.0)
Slovak Republic	42 (2.5)	56 (2.8)	37 (2.4)	43 (2.9)	10 (1.3)	15 (1.7)
Spain	39 (2.7)	47 (2.6)	24 (2.1)	34 (2.6)	6 (0.8)	15 (1.3)
Sweden	62 (3.0)	74 (2.3)	45 (3.1)	55 (2.7)	18 (1.9)	23 (1.7)
1 Switzerland	67 (2.9)	77 (2.3)	55 (2.7)	64 (3.0)	16 (1.5)	26 (1.5)
† United States	59 (2.9)	72 (1.9)	37 (3.3)	47 (3.0)	15 (2.2)	18 (1.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	62 (2.3)	72 (1.7)	49 (2.8)	53 (2.2)	18 (1.6)	22 (1.3)
Austria	59 (2.9)	74 (2.2)	47 (2.7)	54 (3.3)	17 (1.6)	25 (1.8)
Bulgaria	35 (3.7)	49 (4.3)	38 (4.0)	46 (5.7)	9 (1.5)	6 (1.4)
Netherlands	70 (3.4)	76 (3.8)	60 (3.3)	62 (3.6)	14 (2.2)	24 (2.6)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	16 (2.2)	20 (2.7)	16 (2.6)	15 (2.0)	1 (0.4)	1 (0.5)
†1 Germany	68 (2.8)	69 (3.2)	50 (3.8)	45 (3.5)	14 (1.9)	14 (1.7)
Romania	31 (2.6)	36 (2.8)	20 (2.2)	33 (2.8)	7 (1.2)	12 (1.7)
Slovenia	57 (2.8)	57 (2.9)	33 (2.7)	42 (2.7)	12 (1.5)	20 (1.6)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	60 (4.0)	75 (2.8)	36 (3.9)	46 (2.9)	12 (2.0)	22 (2.2)
Greece	29 (2.1)	48 (2.8)	34 (2.1)	38 (2.6)	9 (1.2)	13 (1.2)
† South Africa	17 (1.9)	17 (2.3)	12 (1.7)	15 (1.9)	2 (0.8)	2 (1.1)
Thailand	48 (2.4)	56 (2.7)	40 (2.8)	55 (2.9)	13 (1.7)	21 (2.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	56 (4.1)	–	53 (4.4)	–	15 (2.5)
Kuwait	–	24 (3.9)	–	19 (3.7)	–	4 (1.2)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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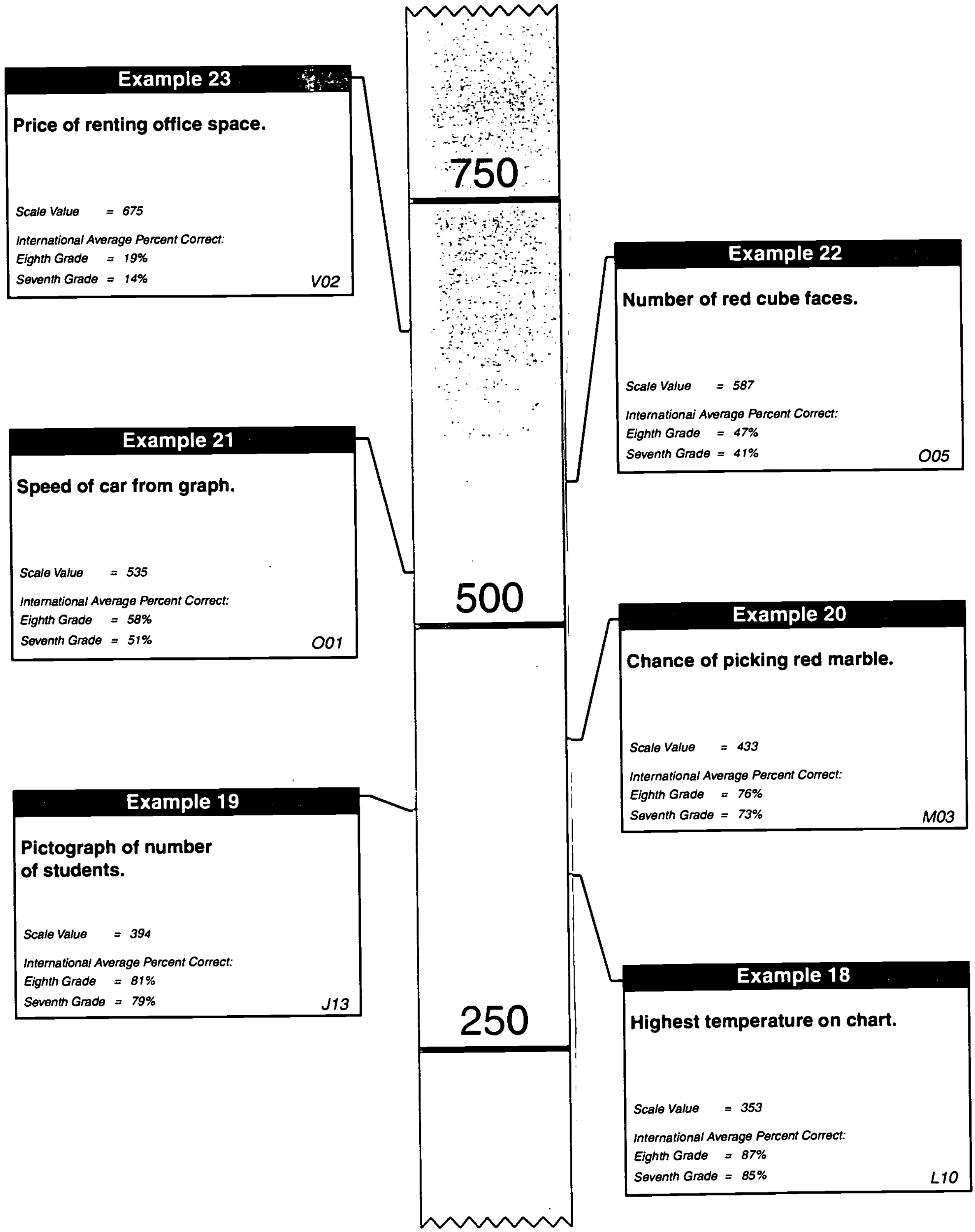
Figure 3.4

International Difficulty Map for Data Representation, Analysis, and Probability Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

Example Item 18
Data Representation, Analysis & Probability

Highest temperature on chart

This chart shows temperature readings made at different times on four days.

TEMPERATURES					
	6 a.m.	9 a.m.	Noon	3 p.m.	8 p.m.
Monday	15°	17°	20°	21°	19°
Tuesday	15°	15°	15°	10°	9°
Wednesday	8°	10°	14°	13°	15°
Thursday	8°	11°	14°	17°	20°

When was the highest temperature recorded?

A. Noon on Monday

(B) 3 p.m. on Monday

C. Noon on Tuesday

D. 3 p.m. on Wednesday

Performance Category: Using Complex Procedures

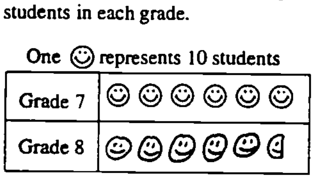
Example Item 19
Data Representation, Analysis & Probability

Pictograph of number of students

The table shows the number of students in the 7th and 8th grades in a given school.

Grade	Number of Students
7	60
8	55

Complete the Grade 8 row in the pictograph below to represent the number of students in each grade.

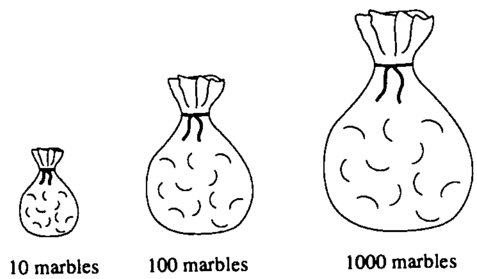


Performance Category: Using Complex Procedures

EXAMPLE ITEM 20
DATA REPRESENTATION, ANALYSIS & PROBABILITY

Chance of picking red marble

There is only one red marble in each of these bags.



Without looking in the bags, you are to pick a marble out of one of the bags. Which bag would give you the greatest chance of picking the red marble?

(A.) The bag with 10 marbles

B. The bag with 100 marbles

C. The bag with 1000 marbles

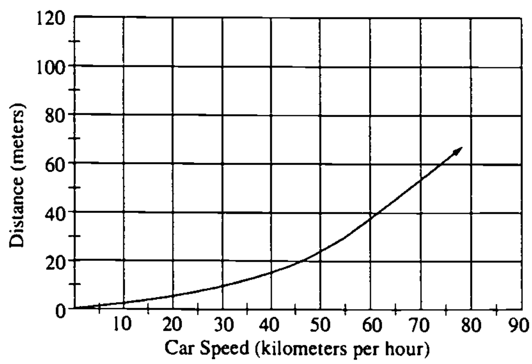
D. All bags would give the same chance.

Performance Category: Solving Problems

EXAMPLE ITEM 21
DATA REPRESENTATION, ANALYSIS & PROBABILITY

Speed of car from graph

The graph shows the distance traveled before coming to a stop after the brakes are applied for a typical car traveling at different speeds.



A car traveling on a highway stopped 30 m after the brakes were applied. About how fast was the car traveling?

A. 48 km per hour

(B.) 55 km per hour

C. 70 km per hour

D. 160 km per hour

Performance Category: Solving Problems

EXAMPLE ITEM 22
DATA REPRESENTATION, ANALYSIS & PROBABILITY

Number of red cube faces

Each of the six faces of a certain cube is painted either red or blue. When the cube is tossed, the probability of the cube landing with a red face up is $\frac{2}{3}$.

How many faces are red?

A. One

B. Two

C. Three

(D.) Four

E. Five

Performance Category: Solving Problems

EXAMPLE ITEM 23
DATA REPRESENTATION, ANALYSIS & PROBABILITY

Price of renting office space

The following two advertisements appeared in a newspaper in a country where the units of currency are *zeds*.

BUILDING A	BUILDING B
Office space available	Office space available
85 - 95 square meters 475 *zeds* per month	35 - 260 square meters 90 *zeds* per square meter per year
100 - 120 square meters 800 *zeds* per month	

If a company is interested in renting an office of 110 square meters in that country for a year, at which office building, A or B, should they rent the office in order to get the lower price? Show your work.

Price of Renting in Building A in a year = 800 × 12
= 9600 (zeds)

Price of Renting in Building B in a year = 110 × 90
= 9900 (zeds)

∴ 9600 < 9900

∴ They should rent the office at Building A in order to get the lower price.

Performance Category: Solving Problems

WHAT HAVE STUDENTS LEARNED ABOUT MEASUREMENT?

The measurement items focused on students' understanding of units of length, weight, time, area, and volume as well as on interpreting scales of measures. Table 3.5 contains the percent-correct results for the example items in measurement, numbered Example Items 24 through 29. The international difficulty map for the measurement items (Figure 3.5) indicates that only the students with higher-than-average mathematics scores internationally were likely to demonstrate an ability to use measurement skills in situations involving several steps.

A more detailed look at performance on the example items suggests that students in many countries had a solid grasp of a variety of measuring units and how to interpret them. Students in most countries were able to read the weight shown on the scale (Example Item 24). The international averages on this item were 83% at the seventh grade and 87% at the eighth grade. Students also did relatively well on Example

Item 25 about pacing off the width of a room (on average, 69% and 74% at the seventh and eighth grades). This item required some thought to understand that the longer the paces, the fewer required to cross the room. The most prevalent misconception was to indicate that the greatest number of paces was related to the longest pace.

Example Item 26 required familiarity with the number of degrees in circles or parts of circles to identify the angle closest to 30 degrees. On average, it was answered correctly by 62% and 64% of the seventh- and eighth-grade students, respectively. For this item, the pattern of increased performance between the grades was fairly inconsistent, with a number of countries having the same or lower performance at the eighth as at the seventh grade.

Internationally, approximately half the students at the seventh and eighth grades (on average, 49% and 52%) were able to determine 10.5 cm as the length of the pencil (Example Item 27). Performance was generally consistent across most countries, although at the eighth grade, students did particularly well in Switzerland (73%), Austria (73%), and Germany (72%). They had the most difficulty in South Africa (17%).

Example Item 28 was a two-part task that first required students to actually draw a new rectangle whose length was one and one-half times the length of a given rectangle and whose width was half the width of that rectangle. All correctly drawn and labeled 9 cm by 2 cm rectangles were given full credit. In the second part of the item, students were asked to determine the ratio of the area of the new rectangle to the area of the one shown. In most countries, students had considerable difficulty with the first part of this multifaceted task, and even more trouble with the second part (even though the scoring for full credit permitted correct ratios based on incorrect drawings). On average, just 24% of the seventh-grade students and 31% of those at eighth grade provided a correct drawing of the new rectangle. In only two countries did at least half the eighth-grade students correctly draw the new rectangle, Korea (54%) and Austria (51%). Fewer than 20% were successful in Iceland (18%), the United States (16%), Colombia (5%), South Africa (4%), and Kuwait (10%). Internationally, the second part of the item was very difficult. On average, just 6% and 10% of the students at the two grades provided a correct ratio between the newly drawn and given rectangles.

Table 3.5

Percent Correct for Measurement Example Items Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 24 Weight shown on scale.		Example 25 Measuring the width of a room.		Example 26 Angle closest to 30 degrees.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	95 (1.3)	98 (0.7)	86 (2.1)	86 (2.7)	64 (2.6)	64 (3.2)
† Belgium (Fr)	92 (1.8)	89 (2.7)	81 (2.7)	84 (2.0)	73 (3.0)	67 (2.7)
Canada	88 (1.9)	90 (1.6)	60 (2.7)	70 (2.3)	62 (2.7)	65 (2.1)
Cyprus	67 (2.4)	72 (2.4)	54 (3.1)	63 (2.9)	60 (2.7)	64 (2.8)
Czech Republic	89 (1.8)	92 (1.7)	81 (2.1)	94 (1.4)	76 (2.9)	76 (3.0)
†2 England	85 (2.3)	94 (1.7)	62 (3.0)	73 (3.5)	63 (3.1)	62 (2.9)
France	93 (1.8)	94 (1.5)	79 (2.0)	81 (2.6)	64 (2.6)	76 (2.5)
Hong Kong	92 (1.5)	91 (1.7)	70 (2.9)	72 (2.8)	69 (2.6)	68 (2.3)
Hungary	92 (1.4)	92 (1.5)	62 (2.6)	59 (2.6)	71 (2.3)	77 (2.3)
Iceland	86 (2.2)	88 (2.2)	71 (3.6)	80 (4.0)	76 (2.6)	61 (4.4)
Iran, Islamic Rep.	61 (2.7)	71 (2.9)	40 (3.3)	57 (3.3)	52 (3.1)	63 (2.7)
Ireland	83 (2.2)	91 (1.7)	81 (2.1)	83 (2.0)	54 (2.6)	63 (2.6)
Japan	94 (1.0)	97 (0.6)	81 (1.7)	86 (1.3)	77 (2.0)	76 (1.8)
Korea	94 (1.3)	95 (1.2)	73 (2.8)	77 (2.2)	77 (2.5)	76 (2.2)
1 Latvia (LSS)	82 (2.5)	84 (2.2)	78 (2.6)	91 (1.5)	64 (2.9)	65 (3.0)
1 Lithuania	77 (2.4)	84 (2.2)	64 (3.3)	74 (3.4)	60 (3.1)	63 (2.9)
New Zealand	86 (1.9)	91 (1.4)	57 (3.3)	69 (2.3)	55 (2.8)	63 (2.4)
Norway	85 (2.1)	88 (1.7)	73 (2.9)	79 (2.2)	70 (3.0)	70 (2.0)
Portugal	81 (2.1)	84 (2.0)	73 (2.5)	79 (2.2)	48 (2.4)	48 (2.8)
Russian Federation	83 (2.2)	92 (1.3)	81 (2.2)	89 (1.5)	71 (2.4)	72 (2.8)
† Scotland	86 (1.8)	92 (1.5)	58 (3.0)	66 (3.0)	53 (2.7)	58 (2.7)
Singapore	93 (1.1)	96 (0.9)	70 (3.0)	77 (2.3)	73 (2.4)	73 (1.9)
Slovak Republic	88 (1.7)	88 (1.6)	82 (1.8)	88 (1.7)	79 (1.9)	74 (2.4)
Spain	73 (2.4)	83 (1.8)	74 (2.1)	81 (1.7)	56 (2.9)	59 (2.3)
Sweden	87 (1.6)	92 (1.3)	82 (2.0)	86 (1.8)	57 (2.6)	61 (2.5)
1 Switzerland	92 (1.6)	97 (1.1)	90 (1.5)	87 (1.6)	51 (2.7)	73 (2.4)
† United States	83 (1.9)	87 (1.7)	36 (3.4)	48 (2.6)	55 (1.9)	57 (1.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	89 (1.7)	94 (0.9)	63 (2.8)	70 (1.9)	63 (1.6)	64 (2.3)
Austria	88 (1.6)	90 (2.2)	80 (2.9)	86 (2.3)	80 (2.6)	74 (3.1)
Bulgaria	80 (2.9)	87 (4.4)	82 (3.2)	77 (3.4)	62 (4.0)	78 (3.3)
Netherlands	94 (1.9)	97 (1.1)	85 (2.4)	82 (3.0)	52 (4.7)	64 (3.3)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	53 (4.3)	58 (4.5)	45 (3.6)	55 (3.8)	32 (3.6)	37 (3.6)
†1 Germany	93 (1.6)	94 (1.6)	79 (2.3)	79 (2.4)	65 (2.6)	63 (2.8)
Romania	72 (2.5)	74 (2.3)	65 (2.8)	70 (2.9)	58 (2.8)	59 (2.9)
Slovenia	89 (1.6)	95 (1.3)	87 (2.0)	90 (1.7)	80 (2.4)	77 (2.6)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	88 (2.3)	88 (1.6)	75 (2.7)	80 (2.6)	61 (2.8)	69 (3.1)
Greece	79 (1.8)	86 (1.7)	61 (2.1)	70 (2.2)	56 (2.5)	64 (2.3)
† South Africa	49 (2.8)	52 (2.5)	18 (2.1)	23 (2.7)	33 (2.5)	34 (2.5)
Thailand	90 (1.4)	92 (1.1)	72 (2.5)	81 (1.8)	70 (2.2)	78 (1.7)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	86 (3.5)	–	79 (3.3)	–	50 (4.2)
Kuwait	–	58 (2.5)	–	39 (3.6)	–	49 (3.7)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( )Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.5 (Continued)

Percent Correct for Measurement Example Items Lower and Upper Grades (Seventh and Eighth Grades*)

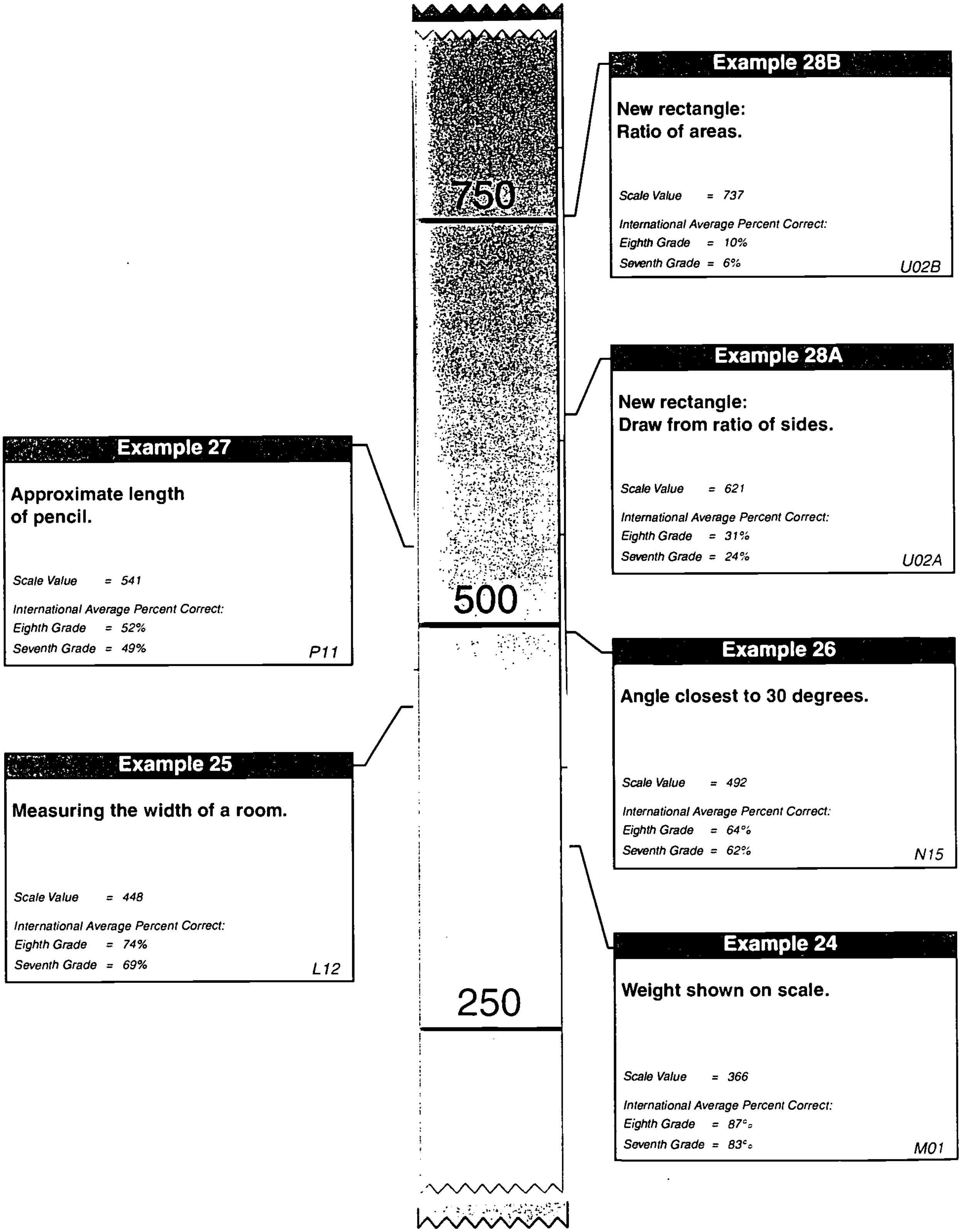
Country	Example 27 Approximate length of pencil.		Example 28A New rectangle: Draw from ratio of sides.		Example 28B New rectangle: Ratio of areas.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	72 (2.5)	69 (3.3)	47 (2.4)	48 (2.2)	7 (1.1)	9 (1.2)
† Belgium (Fr)	45 (3.7)	57 (3.7)	40 (2.6)	43 (2.5)	6 (1.4)	5 (1.1)
Canada	50 (2.9)	53 (2.0)	21 (1.5)	27 (1.7)	8 (0.7)	17 (1.2)
Cyprus	35 (2.9)	40 (3.4)	27 (2.0)	35 (2.1)	11 (1.5)	20 (1.8)
Czech Republic	63 (2.6)	67 (2.6)	27 (1.8)	36 (2.4)	5 (1.0)	13 (2.0)
†2 England	44 (3.7)	52 (3.0)	21 (1.9)	28 (2.1)	8 (1.1)	12 (1.9)
France	55 (2.9)	61 (2.6)	34 (2.3)	43 (2.2)	2 (0.5)	6 (0.9)
Hong Kong	59 (2.8)	60 (3.2)	39 (2.8)	46 (2.8)	17 (1.7)	25 (2.4)
Hungary	56 (2.9)	58 (2.6)	37 (1.9)	43 (2.1)	3 (0.6)	9 (0.9)
Iceland	27 (3.6)	27 (2.6)	11 (1.4)	18 (2.3)	1 (0.6)	5 (1.4)
Iran, Islamic Rep.	34 (2.9)	34 (3.3)	13 (2.0)	24 (2.0)	4 (1.1)	8 (1.4)
Ireland	40 (3.1)	52 (2.4)	26 (2.1)	35 (2.5)	18 (1.7)	20 (1.8)
Japan	52 (2.2)	64 (2.3)	–	–	–	–
Korea	56 (2.6)	60 (2.7)	48 (2.2)	54 (2.1)	31 (2.1)	39 (2.5)
1 Latvia (LSS)	56 (2.5)	60 (2.5)	29 (2.3)	31 (2.3)	5 (1.2)	6 (1.4)
1 Lithuania	37 (3.5)	41 (3.1)	14 (1.8)	24 (2.1)	0 (0.2)	6 (1.0)
New Zealand	48 (2.9)	52 (2.7)	17 (1.8)	27 (1.7)	3 (0.5)	8 (1.4)
Norway	52 (4.8)	62 (2.4)	21 (2.2)	32 (1.7)	2 (0.4)	2 (0.5)
Portugal	37 (3.3)	43 (2.7)	14 (1.3)	22 (1.8)	2 (0.6)	2 (0.5)
Russian Federation	51 (2.4)	59 (3.1)	27 (1.8)	39 (2.8)	7 (1.4)	17 (2.0)
† Scotland	39 (2.4)	45 (3.0)	19 (1.7)	27 (2.7)	3 (0.7)	12 (2.2)
Singapore	62 (2.6)	64 (2.3)	–	–	–	–
Slovak Republic	55 (2.7)	63 (2.8)	29 (1.8)	35 (2.1)	10 (1.3)	15 (1.5)
Spain	43 (3.0)	52 (2.6)	18 (1.6)	28 (1.7)	1 (0.4)	2 (0.4)
Sweden	61 (2.9)	67 (2.0)	18 (1.5)	30 (1.9)	6 (0.9)	11 (1.2)
1 Switzerland	70 (2.5)	73 (2.6)	37 (2.4)	47 (1.9)	3 (0.5)	7 (1.0)
† United States	46 (2.7)	45 (2.2)	11 (1.4)	16 (1.6)	10 (1.6)	10 (0.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	49 (2.2)	55 (1.9)	22 (1.5)	31 (1.6)	8 (0.9)	15 (1.2)
Austria	66 (3.0)	73 (2.5)	41 (2.0)	51 (2.8)	4 (1.0)	8 (1.3)
Bulgaria	43 (4.6)	45 (4.5)	35 (4.1)	27 (3.7)	9 (2.1)	10 (3.1)
Netherlands	68 (3.2)	62 (3.3)	31 (2.5)	40 (3.2)	6 (1.2)	8 (1.5)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	30 (2.9)	29 (2.5)	3 (0.8)	5 (1.0)	0 (0.0)	0 (0.2)
†1 Germany	70 (2.2)	72 (3.0)	28 (2.2)	34 (2.6)	2 (0.5)	4 (0.8)
Romania	40 (2.6)	41 (2.6)	23 (2.0)	28 (2.1)	10 (1.6)	15 (1.9)
Slovenia	60 (2.6)	70 (2.8)	26 (2.0)	37 (2.3)	5 (1.3)	10 (1.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	49 (3.6)	52 (3.2)	16 (1.8)	24 (2.1)	3 (0.8)	5 (1.0)
Greece	28 (2.4)	33 (2.5)	15 (1.4)	23 (1.8)	4 (0.7)	12 (1.3)
† South Africa	20 (1.9)	17 (2.1)	4 (0.9)	4 (1.3)	0 (0.2)	0 (0.2)
Thailand	49 (2.2)	57 (2.5)	16 (1.7)	20 (1.7)	9 (2.1)	12 (1.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	44 (4.4)	–	48 (3.1)	–	7 (1.7)
Kuwait	–	31 (5.4)	–	10 (2.7)	–	6 (2.5)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Japan and Singapore on Examples 28A & 28B.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.5

International Difficulty Map for Measurement Example Items Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 24
MEASUREMENT

Weight shown on scale

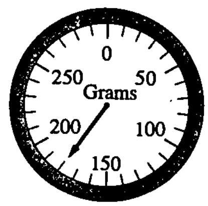
What is the weight (mass) shown on the scale?

A. 153 g

B. 160 g

C. 165 g

(D.) 180 g



Performance Category: Knowing

EXAMPLE ITEM 25
MEASUREMENT

Measuring the width of a room

Four children measured the width of a room by counting how many paces it took them to cross it. The chart shows their measurements.

Who had the longest pace?

A. Stephen

B. Erlane

C. Ana

(D.) Carlos

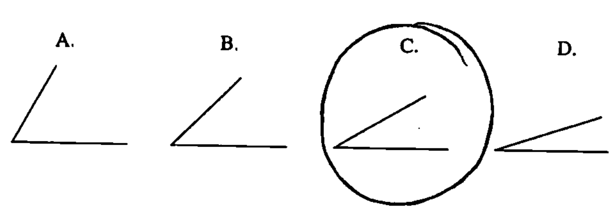
Name	Number of Paces
Stephen	10
Erlane	8
Ana	9
Carlos	7

Performance Category: Solving Problems

EXAMPLE ITEM 26
MEASUREMENT

Angle closest to 30 degrees

Which of these angles has a measure closest to 30° ?



Performance Category: Knowing

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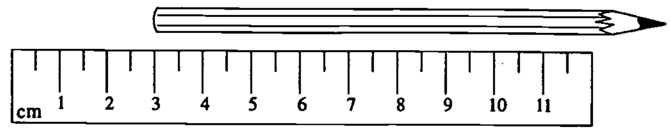
EXAMPLE ITEM 27
MEASUREMENT

Approximate length of pencil



Which of these is closest to the length of the pencil in the figure?

A. 9 cm

(B.) 10.5 cm

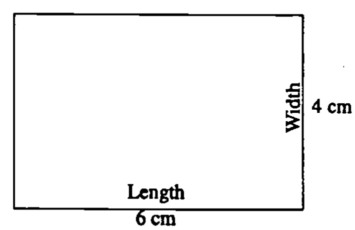
C. 12 cm

D. 13.5 cm

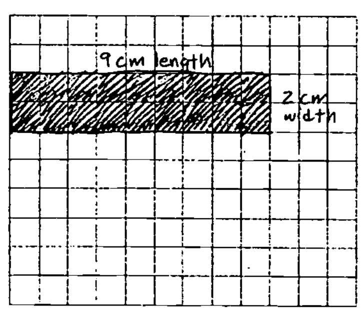
Performance Category: Using Complex Procedures

EXAMPLE ITEM 28
MEASUREMENT

New Rectangle



a. In the space below, draw a new rectangle whose length is one and one half times the length of the rectangle above, and whose width is half the width of the rectangle above. Show the length and width of the new rectangle in centimeters on the figure.



b. What is the ratio of the area of the new rectangle to the area of the first one?

Show your work.

new A = 18 cm² ÷ 3 = 6/8 or 3/4
old A = 24 cm² ÷ 3 =

3 to 4

Performance Category: Solving Problems

What Have Students Learned About Proportionality?

A small set (11) of the mathematics items was designed to focus specifically on proportionality concepts and problems. Arguably, these items could have been classified in other content areas, usually fractions and number sense, but the decision was made to analyze them separately because they assess an important kind of mathematical reasoning. Example Items 29 through 33 illustrate these types of questions. The percent of correct responses for each country for the example items are provided in Table 3.6.

As described previously in Chapter 2, this item group was relatively more difficult for students than those for the other content areas. Figure 3.6 shows the extreme difficulty of these items for students. Only those students scoring above 600 on the mathematics scale were likely to answer most of these types of questions correctly.

Example Item 29, the least difficult of the items shown here, was one of the few proportionality items answered correctly by the majority of students in most countries. The item asked about adding 5 boys and 5 girls to a class that was three-fifths girls. On average, 62% of the students at seventh grade and 65% at eighth grade correctly answered that there would still be more girls than boys in the class.

Despite the overall difficulty encountered by students in this content area, there was an extremely large range in performance across countries. Example Item 32, requiring the students to determine the number of girls in a class of 28 based on the ratio of girls to boys, illustrates the extent of the difference in achievement levels. At the eighth grade, the question was answered correctly by 92% of the students in Singapore compared to very few in Colombia (12%), Greece (13%), South Africa (9%), and Kuwait (12%).

Table 3.6

Percent Correct for Proportionality Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 29 More boys or girls in class.		Example 30 Ratio of red paint in mixture.		Example 31 Amount paid for portion of items.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	85 (2.1)	82 (2.9)	47 (2.4)	48 (2.4)	57 (3.4)	58 (4.1)
† Belgium (Fr)	74 (2.6)	76 (2.8)	45 (2.8)	49 (2.9)	34 (3.5)	41 (3.1)
Canada	68 (2.4)	66 (2.5)	46 (2.1)	56 (1.8)	22 (2.1)	26 (2.3)
Cyprus	59 (2.9)	63 (2.7)	35 (2.0)	34 (2.1)	21 (2.6)	30 (3.0)
Czech Republic	60 (3.5)	70 (2.7)	19 (1.9)	29 (1.9)	47 (3.3)	63 (2.8)
†2 England	66 (3.4)	69 (3.3)	34 (2.2)	39 (2.7)	14 (1.9)	17 (2.9)
France	66 (2.7)	75 (2.4)	48 (2.0)	51 (2.5)	38 (2.6)	54 (2.9)
Hong Kong	79 (2.1)	78 (1.7)	67 (2.8)	70 (2.4)	52 (3.3)	62 (3.2)
Hungary	60 (2.8)	67 (2.3)	29 (1.9)	36 (2.1)	30 (2.4)	42 (2.5)
Iceland	70 (3.4)	66 (4.6)	26 (2.2)	49 (4.1)	15 (2.7)	25 (4.1)
Iran, Islamic Rep.	51 (3.3)	51 (3.2)	27 (2.2)	31 (2.3)	15 (2.3)	19 (2.6)
Ireland	71 (2.7)	78 (2.4)	37 (1.9)	42 (2.3)	32 (2.8)	41 (3.3)
Japan	76 (1.9)	82 (1.9)	57 (1.5)	66 (1.4)	61 (2.2)	71 (2.0)
Korea	78 (2.1)	82 (2.2)	78 (1.8)	87 (1.4)	63 (2.3)	62 (2.5)
1 Latvia (LSS)	44 (3.1)	57 (3.4)	23 (2.0)	27 (1.9)	25 (2.7)	39 (2.9)
1 Lithuania	44 (3.1)	51 (3.0)	8 (1.2)	14 (1.5)	28 (3.4)	36 (3.2)
New Zealand	69 (2.5)	70 (2.3)	43 (2.3)	47 (1.9)	19 (2.4)	22 (2.0)
Norway	70 (4.2)	73 (2.4)	28 (2.2)	37 (2.0)	16 (2.5)	27 (2.4)
Portugal	39 (2.2)	50 (2.6)	16 (1.6)	21 (1.6)	9 (1.5)	20 (2.5)
Russian Federation	47 (3.1)	47 (2.5)	27 (2.0)	39 (2.6)	50 (2.5)	49 (3.8)
† Scotland	65 (2.4)	71 (2.7)	38 (2.2)	38 (2.2)	12 (2.0)	19 (2.6)
Singapore	83 (1.9)	85 (1.7)	89 (1.6)	95 (0.8)	79 (2.4)	83 (1.8)
Slovak Republic	57 (2.6)	62 (2.9)	24 (2.0)	32 (2.1)	38 (3.1)	54 (2.7)
Spain	63 (2.3)	62 (3.0)	24 (1.6)	34 (1.7)	30 (2.4)	42 (2.7)
Sweden	68 (2.5)	74 (2.0)	50 (2.1)	64 (1.7)	21 (2.2)	30 (2.0)
1 Switzerland	73 (2.2)	76 (2.2)	39 (2.1)	42 (1.9)	47 (2.0)	60 (2.4)
† United States	58 (2.5)	62 (2.2)	45 (2.0)	53 (1.8)	18 (2.8)	23 (2.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	71 (2.2)	74 (1.4)	41 (1.7)	42 (2.0)	21 (1.9)	31 (1.8)
Austria	69 (2.5)	73 (2.7)	21 (2.4)	21 (1.9)	56 (3.2)	67 (3.0)
Bulgaria	65 (5.4)	57 (4.4)	28 (3.2)	37 (3.8)	46 (8.5)	34 (4.4)
Netherlands	85 (2.7)	77 (2.7)	58 (2.8)	65 (2.7)	44 (4.7)	41 (3.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students: See Appendix A for Details):						
Colombia	26 (3.0)	30 (3.9)	14 (2.3)	15 (2.1)	3 (1.1)	7 (1.6)
†1 Germany	70 (2.7)	67 (3.3)	26 (2.0)	26 (2.1)	29 (2.9)	37 (3.4)
Romania	48 (2.6)	52 (3.0)	29 (2.0)	39 (2.4)	30 (2.3)	32 (2.6)
Slovenia	62 (2.7)	66 (2.5)	29 (2.3)	39 (2.2)	39 (2.6)	52 (3.0)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	54 (3.3)	68 (2.9)	30 (2.4)	31 (2.1)	16 (2.2)	28 (2.6)
Greece	55 (2.4)	59 (2.5)	41 (1.9)	50 (2.1)	33 (2.4)	39 (2.7)
† South Africa	32 (2.8)	31 (2.2)	18 (1.4)	16 (1.5)	2 (1.0)	2 (0.8)
Thailand	55 (2.4)	56 (2.7)	44 (2.2)	55 (2.4)	37 (2.9)	43 (2.9)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	75 (4.0)	–	39 (4.2)	–	42 (4.8)
Kuwait	–	25 (4.1)	–	14 (2.1)	–	2 (0.8)

*Seventh and eighth grades in most countries: see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.6 (Continued)

Percent Correct for Proportionality Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)

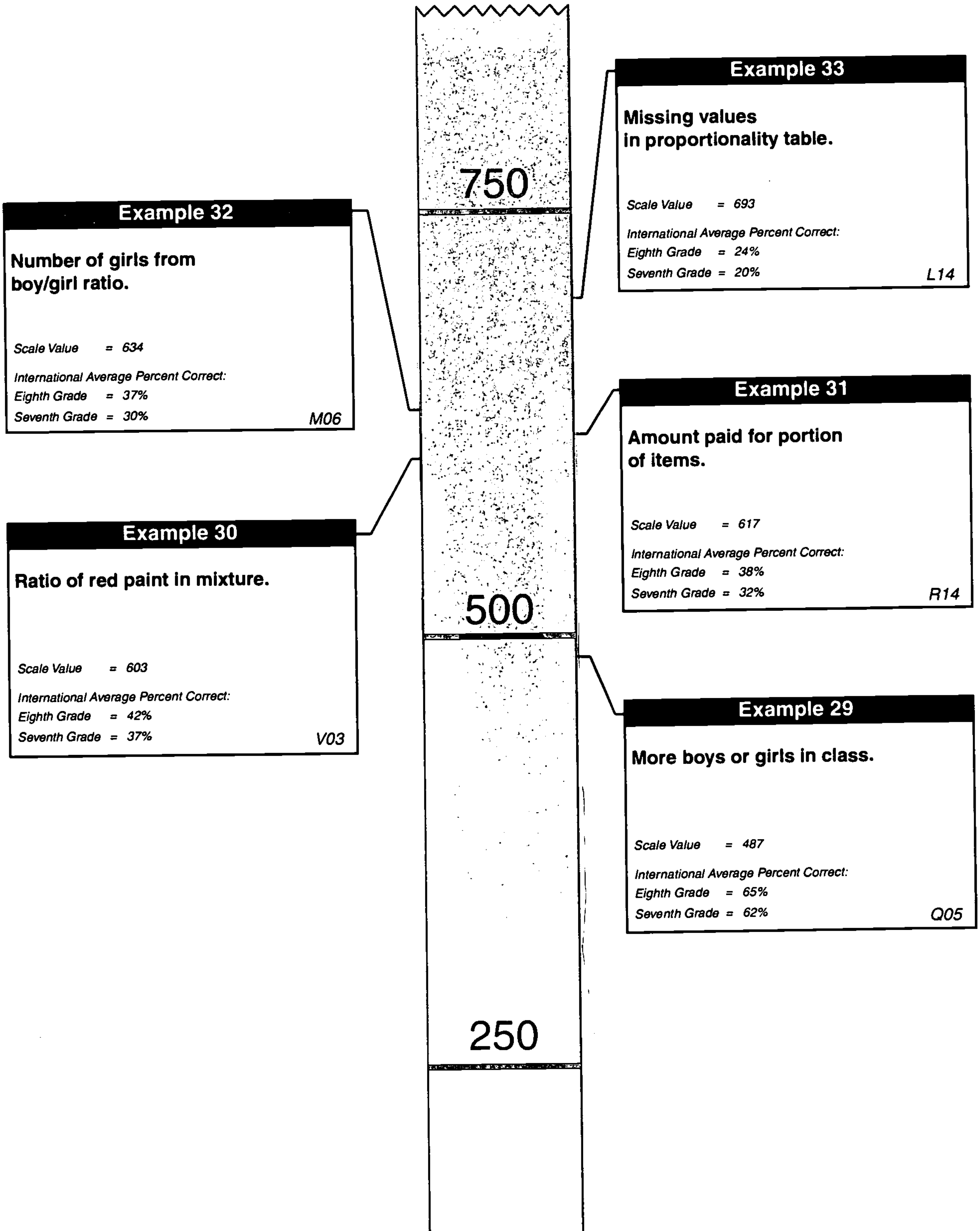
Country	Example 32 Number of girls from boy/girl ratio.		Example 33 Missing values in proportionality table.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	37 (2.6)	34 (3.7)	27 (2.5)	33 (2.9)
† Belgium (Fr)	38 (3.0)	48 (3.1)	14 (2.1)	19 (2.6)
Canada	28 (2.4)	43 (2.4)	24 (2.3)	26 (2.1)
Cyprus	18 (2.4)	24 (2.6)	18 (2.3)	24 (2.4)
Czech Republic	47 (3.3)	60 (3.7)	21 (3.1)	30 (3.2)
†2 England	40 (3.5)	42 (3.4)	15 (2.8)	18 (3.0)
France	29 (2.8)	43 (3.1)	30 (2.3)	33 (2.6)
Hong Kong	47 (3.3)	63 (3.3)	32 (2.3)	38 (2.9)
Hungary	37 (2.7)	57 (2.6)	19 (2.1)	24 (2.4)
Iceland	22 (3.3)	18 (3.1)	9 (2.0)	14 (3.2)
Iran, Islamic Rep.	19 (2.6)	22 (2.4)	20 (3.0)	31 (4.3)
Ireland	56 (2.9)	56 (2.9)	21 (2.1)	25 (2.1)
Japan	47 (1.9)	53 (1.8)	48 (2.2)	49 (2.2)
Korea	58 (3.1)	64 (2.6)	34 (3.1)	41 (2.6)
1 Latvia (LSS)	21 (3.0)	32 (3.1)	12 (1.9)	21 (2.6)
1 Lithuania	13 (2.7)	30 (2.7)	6 (1.4)	14 (2.2)
New Zealand	30 (2.7)	37 (2.5)	13 (1.8)	19 (2.1)
Norway	15 (2.2)	19 (2.2)	11 (1.8)	15 (1.8)
Portugal	8 (1.4)	17 (1.8)	19 (2.1)	21 (2.3)
Russian Federation	25 (2.1)	37 (3.1)	20 (2.5)	27 (2.3)
† Scotland	26 (2.6)	37 (3.3)	14 (2.2)	15 (2.4)
Singapore	89 (1.7)	92 (1.3)	42 (2.9)	47 (2.8)
Slovak Republic	46 (3.1)	58 (2.7)	27 (2.5)	27 (2.9)
Spain	14 (1.7)	24 (2.2)	16 (1.7)	10 (1.5)
Sweden	19 (2.0)	24 (2.0)	11 (1.4)	14 (1.8)
1 Switzerland	26 (2.4)	38 (2.5)	20 (2.1)	29 (2.4)
† United States	27 (2.6)	34 (2.3)	19 (2.2)	20 (1.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):				
Australia	33 (2.4)	50 (2.3)	18 (2.1)	22 (1.7)
Austria	42 (4.0)	46 (2.6)	15 (1.9)	18 (2.1)
Bulgaria	46 (5.5)	54 (4.3)	22 (4.9)	44 (6.4)
Netherlands	43 (3.5)	43 (4.6)	33 (3.3)	29 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	11 (3.4)	12 (2.0)	10 (1.9)	11 (2.2)
†1 Germany	19 (2.6)	30 (3.4)	11 (1.7)	18 (2.2)
Romania	22 (2.6)	29 (2.7)	22 (2.5)	29 (2.9)
Slovenia	19 (2.1)	43 (2.7)	17 (2.5)	24 (2.1)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	25 (3.1)	35 (3.5)	10 (1.9)	13 (2.3)
Greece	10 (1.5)	13 (1.9)	26 (2.6)	30 (2.3)
† South Africa	5 (1.5)	9 (1.7)	13 (1.3)	13 (1.4)
Thailand	37 (2.7)	48 (2.7)	36 (2.3)	39 (2.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	22 (3.4)	–	17 (2.8)
Kuwait	–	12 (3.5)	–	15 (2.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.6

International Difficulty Map for Proportionality Example Items Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international mathematics scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 29
PROPORTIONALITY

More boys or girls in class

Three-fifths of the students in a class are girls. If 5 girls and 5 boys are added to the class, which statement is true of the class?

A. There are more girls than boys.

B. There are the same number of girls as there are boys.

C. There are more boys than girls.

D. You cannot tell whether there are more girls or boys from the information given.

Performance Category: Solving Problems

EXAMPLE ITEM 30
PROPORTIONALITY

Ratio of red paint in mixture

To mix a certain color of paint, Alana combines 5 liters of red paint, 2 liters of blue paint, and 2 liters of yellow paint. What is the ratio of red paint to the total amount of paint?

A. $\frac{5}{2}$

B. $\frac{9}{4}$

C. $\frac{5}{4}$

D. $\frac{5}{9}$

Performance Category: Performing Routine Procedures

EXAMPLE ITEM 31
PROPORTIONALITY

Amount paid for portion of items

Peter bought 70 items and Sue bought 90 items. Each item cost the same and the items cost $800 altogether. How much did Sue pay?

Answer: Sue paid $450

Performance Category: Solving Problems

EXAMPLE ITEM 32
PROPORTIONALITY

Number of girls from boy/girl ratio

A class has 28 students. The ratio of girls to boys is 4 : 3. How many girls are in the class?

Answer: 16

Performance Category: Solving Problems

EXAMPLE ITEM 33
PROPORTIONALITY

Missing values in proportionality table

The table shows the values of x and y, where x is proportional to y.

x	3	6	P
y	7	Q	35

What are the values of P and Q?

A. $P = 14$ and $Q = 31$

B. $P = 10$ and $Q = 14$

C. $P = 10$ and $Q = 31$

D. $P = 14$ and $Q = 15$

E. $P = 15$ and $Q = 14$

Performance Category: Performing Routine Procedures

Chapter 4

Students' Backgrounds and Attitudes Towards Mathematics

To provide an educational context for interpreting the mathematics achievement results, TIMSS collected a full range of descriptive information from students about their backgrounds as well as their activities in and out of school. This chapter presents eighth-grade students' responses to a selected subset of these questions. In an effort to explore the degree to which the students' home and social environment fostered academic development, some of the questions presented herein address the availability of educational resources in the home. Another group of questions is provided to help examine whether or not students typically spend their out-of-school time in ways that support their in-school academic performance. Because students' attitudes and opinions about mathematics reflect what happens in school and their perceptions of the value of mathematics in broader social contexts, results also are described for several questions from the affective domain. More specifically, these questions asked students to express their opinions about the abilities necessary for success in mathematics, provide information about what motivates them to do well in mathematics, and indicate their attitudes towards mathematics.

Student and teacher questionnaire data for two countries are unavailable for this report and thus do not appear in this chapter – Bulgaria and South Africa. Bulgaria had complications with data entry, and South Africa joined the study later than the other countries.

What Educational Resources Do Students Have in Their Homes?

Students specifically were asked about the availability at home of three types of educational resources – a dictionary, a study desk or table for their own use, and a computer. Table 4.1 reveals that in most countries eighth-grade students with all three of these educational study aids had higher mathematics achievement than students who did not have ready access to these study aids. In almost all the countries, nearly all students reported having a dictionary in their homes. There was more variation among countries in the percentages of students reporting their own study desk or table. Of the three study aids, the most variation was in the number of eighth-grade students reporting having a home computer. In several countries, more than 70% of students reported having a computer in the home, including the more than 85% who so reported in England, the Netherlands, and Scotland. For these three countries, it is likely that these high percentages include computers used for entertainment purposes, such as computer games.

The number of books in the home can be an indicator of a home environment that values literacy, the acquisition of knowledge, and general academic support. Table 4.2 presents eighth-grade students' reports about the number of books in their homes in relation to their achievement on the TIMSS mathematics test. In most countries, the more books students reported in the home, the higher their mathematics

Table 4.1

Students' Reports on Educational Aids in the Home: Dictionary, Study Desk/Table and Computer - Mathematics - Upper Grade (Eighth Grade*)

Country	Have All Three Educational Aids		Do Not Have All Three Educational Aids		Have Dictionary	Have Study Desk/Table for Own Use	Have Computer
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Percent of Students	Percent of Students
Australia	66 (1.2)	542 (4.3)	34 (1.2)	509 (4.5)	88 (0.7)	97 (0.4)	73 (1.2)
Austria	56 (1.5)	548 (3.6)	44 (1.5)	530 (3.9)	98 (0.3)	93 (0.8)	59 (1.5)
Belgium (Fl)	64 (1.3)	577 (4.9)	36 (1.3)	547 (7.2)	99 (0.5)	96 (0.5)	67 (1.3)
Belgium (Fr)	58 (1.4)	541 (3.3)	42 (1.4)	510 (4.8)	97 (0.5)	96 (0.5)	60 (1.4)
Canada	57 (1.4)	539 (2.4)	43 (1.4)	513 (3.2)	97 (0.4)	89 (0.6)	61 (1.3)
Colombia	10 (1.2)	407 (9.3)	90 (1.2)	383 (3.4)	96 (0.5)	84 (1.0)	11 (1.2)
Cyprus	37 (0.9)	486 (2.8)	63 (0.9)	468 (2.4)	97 (0.3)	96 (0.5)	39 (0.9)
Czech Republic	33 (1.3)	583 (5.8)	67 (1.3)	555 (5.0)	94 (0.6)	90 (0.6)	36 (1.2)
Denmark	66 (1.5)	510 (3.0)	34 (1.5)	492 (4.6)	85 (1.1)	98 (0.3)	76 (1.2)
England	80 (1.0)	512 (3.1)	20 (1.0)	485 (5.6)	98 (0.4)	90 (0.8)	89 (0.8)
France	49 (1.3)	547 (3.6)	51 (1.3)	531 (3.6)	99 (0.2)	96 (0.4)	50 (1.3)
Germany	66 (1.1)	515 (4.3)	34 (1.1)	500 (5.5)	98 (0.4)	93 (0.6)	71 (1.0)
Greece	28 (1.0)	502 (5.4)	72 (1.0)	478 (2.8)	97 (0.3)	93 (0.5)	29 (1.0)
Hong Kong	33 (1.8)	606 (7.3)	67 (1.8)	582 (6.5)	99 (0.1)	80 (1.1)	39 (1.9)
Hungary	32 (1.2)	574 (3.7)	68 (1.2)	523 (3.4)	77 (1.2)	92 (0.7)	37 (1.2)
Iceland	72 (1.6)	490 (5.2)	28 (1.6)	479 (4.5)	95 (0.5)	96 (0.6)	77 (1.4)
Iran, Islamic Rep.	1 (0.3)	~ ~	99 (0.3)	430 (2.2)	54 (1.5)	40 (2.0)	4 (0.4)
Ireland	67 (1.2)	536 (5.2)	33 (1.2)	514 (6.3)	99 (0.3)	86 (0.9)	78 (1.1)
Israel	75 (2.1)	534 (5.8)	25 (2.1)	497 (8.8)	100 (0.2)	98 (0.4)	76 (2.1)
Japan	- -	- -	- -	- -	- -	- -	- -
Korea	38 (1.2)	635 (3.6)	62 (1.2)	591 (2.7)	98 (0.2)	95 (0.4)	39 (1.2)
Kuwait	38 (2.0)	398 (3.8)	62 (2.0)	389 (2.6)	84 (1.1)	73 (2.0)	53 (2.1)
Latvia (LSS)	13 (0.8)	492 (5.4)	87 (0.8)	495 (3.1)	94 (0.6)	98 (0.3)	13 (0.9)
Lithuania	35 (1.3)	485 (4.0)	65 (1.3)	474 (4.0)	88 (1.0)	95 (0.6)	42 (1.4)
Netherlands	83 (1.3)	545 (8.2)	17 (1.3)	524 (7.7)	100 (0.1)	99 (0.2)	85 (1.2)
New Zealand	56 (1.4)	522 (5.0)	44 (1.4)	491 (4.6)	99 (0.2)	91 (0.6)	60 (1.3)
Norway	63 (1.1)	512 (2.7)	37 (1.1)	489 (2.9)	97 (0.3)	98 (0.2)	64 (1.1)
Portugal	35 (1.8)	471 (3.6)	65 (1.8)	446 (2.2)	98 (0.4)	84 (0.9)	39 (1.8)
Romania	8 (1.0)	531 (8.5)	92 (1.0)	479 (3.8)	60 (1.6)	69 (1.3)	19 (1.2)
Russian Federation	30 (1.4)	541 (5.5)	70 (1.4)	534 (6.1)	88 (1.1)	95 (0.7)	35 (1.5)
Scotland	74 (1.2)	506 (5.8)	26 (1.2)	480 (6.6)	96 (0.5)	84 (1.2)	90 (0.6)
Singapore	47 (1.5)	657 (5.0)	53 (1.5)	631 (5.1)	99 (0.1)	92 (0.5)	49 (1.5)
Slovak Republic	27 (1.2)	570 (4.3)	73 (1.2)	539 (3.6)	96 (0.5)	86 (0.9)	31 (1.2)
Slovenia	43 (1.4)	563 (3.7)	57 (1.4)	525 (3.4)	94 (0.5)	93 (0.6)	47 (1.3)
Spain	40 (1.3)	501 (2.9)	60 (1.3)	479 (2.1)	99 (0.1)	93 (0.5)	42 (1.2)
Sweden	58 (1.3)	532 (2.9)	42 (1.3)	501 (3.5)	94 (0.4)	100 (0.1)	60 (1.3)
Switzerland	63 (1.2)	555 (3.2)	37 (1.2)	531 (3.6)	97 (0.4)	95 (0.4)	66 (1.2)
Thailand	4 (0.8)	577 (14.9)	96 (0.8)	521 (5.4)	68 (2.1)	66 (2.1)	4 (0.9)
United States	56 (1.7)	521 (4.7)	44 (1.7)	474 (4.2)	97 (0.4)	90 (0.7)	59 (1.7)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.2

Students' Reports on the Number of Books in the Home Mathematics - Upper Grade (Eighth Grade*)

Country	None or Very Few (0-10 Books)		About One Shelf (11-25 Books)		About One Bookcase (26-100 Books)		About Two Bookcases (101-200 Books)		Three or More Bookcases (More than 200 Books)	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	3 (0.3)	449 (7.2)	7 (0.6)	482 (5.4)	24 (0.8)	512 (3.7)	25 (0.6)	534 (4.1)	42 (1.4)	555 (4.7)
Austria	11 (1.0)	485 (5.8)	17 (1.1)	505 (4.8)	31 (1.2)	534 (3.9)	17 (0.9)	567 (5.7)	24 (1.4)	579 (4.5)
Belgium (Fl)	11 (1.2)	521 (11.6)	18 (0.8)	549 (8.0)	33 (1.0)	571 (4.9)	18 (1.0)	587 (4.9)	21 (0.9)	575 (7.1)
Belgium (Fr)	7 (0.7)	461 (11.5)	10 (0.7)	484 (6.0)	28 (1.1)	517 (4.7)	21 (0.9)	537 (4.0)	34 (1.5)	555 (4.1)
Canada	4 (0.3)	505 (8.4)	10 (0.7)	510 (5.7)	28 (1.0)	528 (3.4)	25 (0.8)	532 (3.2)	33 (1.4)	534 (3.4)
Colombia	26 (1.5)	376 (5.5)	31 (1.1)	375 (3.7)	27 (1.3)	395 (3.8)	9 (0.7)	404 (7.7)	7 (1.0)	402 (10.4)
Cyprus	6 (0.6)	428 (7.6)	18 (0.8)	448 (3.4)	34 (0.8)	479 (2.9)	23 (0.8)	494 (3.8)	20 (0.8)	490 (4.0)
Czech Republic	1 (0.2)	~ ~	4 (0.5)	506 (8.1)	30 (1.5)	539 (4.9)	32 (0.9)	569 (6.4)	34 (1.8)	588 (5.8)
Denmark	3 (0.6)	452 (13.5)	9 (0.8)	471 (6.8)	30 (1.2)	494 (3.3)	21 (0.9)	506 (4.4)	37 (1.5)	522 (3.8)
England	6 (0.6)	431 (7.7)	13 (1.0)	463 (5.2)	27 (1.3)	495 (4.0)	22 (0.8)	518 (5.1)	32 (1.5)	540 (4.3)
France	5 (0.5)	511 (9.1)	17 (1.0)	520 (3.8)	36 (1.1)	536 (3.7)	21 (1.0)	559 (4.8)	20 (1.2)	547 (4.7)
Germany	8 (0.8)	447 (6.4)	14 (1.1)	464 (4.5)	26 (1.0)	499 (4.4)	19 (0.9)	532 (5.8)	33 (1.7)	542 (5.4)
Greece	5 (0.4)	450 (5.7)	22 (0.9)	454 (3.3)	43 (0.9)	485 (3.4)	18 (0.7)	509 (5.8)	12 (0.7)	519 (5.8)
Hong Kong	21 (1.2)	559 (9.4)	29 (1.0)	594 (5.9)	29 (0.9)	599 (7.4)	10 (0.7)	602 (7.8)	10 (0.9)	606 (9.2)
Hungary	4 (0.6)	455 (10.7)	8 (0.7)	479 (6.1)	25 (1.0)	517 (4.2)	21 (1.0)	545 (4.1)	42 (1.4)	569 (3.8)
Iceland	1 (0.2)	~ ~	5 (0.8)	465 (9.6)	29 (1.4)	477 (4.9)	28 (1.2)	486 (5.7)	37 (1.7)	501 (6.6)
Iran, Islamic Rep.	37 (1.8)	415 (2.9)	32 (0.9)	432 (2.3)	17 (0.9)	438 (3.3)	6 (0.5)	437 (6.8)	7 (0.7)	452 (5.3)
Ireland	7 (0.6)	468 (7.6)	16 (0.8)	491 (5.9)	34 (1.0)	530 (5.0)	21 (0.7)	550 (5.1)	22 (1.2)	555 (6.3)
Israel	4 (0.6)	482 (14.7)	13 (1.6)	498 (7.7)	31 (1.9)	514 (7.1)	26 (1.4)	539 (8.0)	25 (2.0)	542 (7.6)
Japan	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Korea	10 (0.6)	535 (6.1)	12 (0.8)	560 (6.4)	33 (0.9)	599 (3.6)	23 (0.8)	634 (3.6)	21 (0.9)	652 (4.1)
Kuwait	22 (1.4)	382 (3.2)	27 (1.5)	389 (3.4)	28 (1.6)	400 (3.9)	10 (1.0)	404 (5.4)	13 (0.9)	402 (4.7)
Latvia (LSS)	1 (0.3)	~ ~	4 (0.6)	448 (7.9)	17 (1.0)	471 (4.3)	21 (1.1)	484 (5.0)	57 (1.4)	509 (3.5)
Lithuania	3 (0.4)	415 (7.1)	17 (0.9)	442 (4.5)	35 (1.2)	470 (4.1)	21 (0.9)	496 (4.6)	24 (1.1)	507 (5.2)
Netherlands	8 (1.0)	488 (10.7)	16 (1.3)	507 (10.1)	34 (1.3)	538 (7.3)	19 (0.9)	558 (7.7)	22 (1.7)	577 (7.4)
New Zealand	3 (0.4)	441 (8.2)	7 (0.6)	452 (6.5)	24 (0.8)	488 (4.7)	25 (0.7)	516 (4.8)	41 (1.4)	531 (5.2)
Norway	2 (0.3)	~ ~	6 (0.4)	467 (5.2)	25 (0.9)	483 (3.0)	22 (0.7)	504 (3.2)	45 (1.2)	524 (3.1)
Portugal	10 (0.8)	428 (2.9)	26 (1.3)	443 (2.7)	32 (1.0)	454 (2.6)	15 (0.8)	472 (3.4)	17 (1.4)	475 (4.3)
Romania	24 (1.3)	459 (7.0)	22 (1.3)	466 (5.2)	19 (1.0)	476 (4.8)	11 (0.7)	498 (5.5)	24 (1.7)	523 (5.4)
Russian Federation	2 (0.3)	~ ~	11 (0.8)	495 (10.6)	36 (1.3)	523 (5.2)	24 (0.8)	550 (4.4)	26 (1.3)	562 (4.8)
Scotland	11 (1.2)	441 (4.8)	17 (1.1)	468 (4.7)	28 (1.0)	490 (4.5)	19 (1.0)	525 (5.9)	25 (2.0)	540 (8.0)
Singapore	11 (0.8)	611 (4.8)	22 (0.9)	622 (5.5)	41 (0.8)	648 (4.8)	14 (0.7)	665 (6.8)	12 (1.0)	674 (6.1)
Slovak Republic	2 (0.3)	~ ~	11 (0.6)	497 (6.8)	45 (1.1)	541 (3.2)	23 (0.9)	562 (4.3)	18 (1.0)	581 (5.9)
Slovenia	2 (0.4)	~ ~	15 (0.9)	500 (4.8)	38 (1.2)	532 (3.5)	22 (0.9)	560 (4.7)	22 (1.1)	571 (4.4)
Spain	4 (0.4)	443 (6.1)	18 (1.1)	460 (3.1)	33 (1.0)	482 (2.6)	20 (0.8)	498 (3.2)	26 (1.2)	513 (3.0)
Sweden	3 (0.3)	468 (8.3)	8 (0.7)	464 (5.0)	24 (1.0)	503 (4.3)	24 (0.8)	524 (3.3)	41 (1.5)	541 (3.5)
Switzerland	8 (1.0)	480 (6.9)	16 (0.9)	511 (4.7)	30 (1.0)	542 (3.1)	20 (0.9)	568 (3.7)	26 (1.2)	579 (4.7)
Thailand	19 (1.2)	507 (4.8)	30 (1.0)	514 (5.1)	33 (1.2)	528 (6.5)	9 (0.6)	537 (8.1)	9 (1.0)	552 (9.2)
United States	8 (0.8)	435 (4.5)	13 (0.8)	462 (5.2)	28 (0.9)	491 (3.5)	21 (0.6)	517 (5.2)	31 (1.5)	531 (5.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

achievement. Although the main purpose of the question was to gain some information about the relative importance of academic pursuits in the students' home environments rather than to determine the actual number of books in students' homes, there was a substantial amount of variation from country to country in eighth-grade students' reports about the number of books in their homes. In Colombia, Hong Kong, Iran, Kuwait, Romania, and Thailand, 40% or more of the students reported 25 or fewer books in the home. Conversely, 40% or more of the students in Australia, Hungary, Latvia (LSS), New Zealand, Norway, and Sweden reported more than 200 books in their homes.

Information about their parents' educational levels was gathered by asking students to indicate the highest level of education completed by their fathers and mothers. Table 4.3 presents the relationship between eighth-grade students' mathematics achievement and their reports of the highest level of education of either parent. Results are presented at three educational levels: finished university, finished upper secondary school but not university, and finished primary school but not upper secondary school. These three educational levels are based on internationally-defined categories, which may not be strictly comparable across countries due to differences in national education systems. Although the majority of countries translated and defined the educational categories used in their questionnaires to be comparable to the internationally-defined levels, some countries used modified response options to conform to their national education systems. Also, for a few countries, the percentages of students responding to this question fell below 85%. When this happened, the percentages shown in the table are annotated with an "r" for a response rate of 70% to 84% or an "s" if the response rate was from 50% to 69%.

Despite the different educational approaches, structures, and organizations across the TIMSS countries, it is clear from the data in Table 4.3 that parents' education is positively related to students' mathematics achievement. In every country, the pattern was for those eighth-grade students whose parents had more education to also be those who had higher achievement in mathematics. Once again, the purpose of this question was not to ascertain precisely the educational levels of students' parents, but to gain further understanding about the relative importance of schooling in their home environments. As indicated by the results, there was variation among countries in the percentages of students reporting that they did not know their parents' educational levels, as well as in the percentages of students reporting that their parents had completed successively higher educational levels. For example, in Canada, Israel, Lithuania, the Russian Federation, and the United States, more than 30% of the students reported that at least one of their parents had finished university, and only relatively small percentages (fewer than 12%) reported that they did not know the educational levels of their parents. In contrast, almost all students (90% or more) in Hong Kong, Iran, Kuwait, Portugal, and Thailand also reported knowing their parents' educational levels, but for these countries, fewer than 10% of students reported that either parent had finished university.

Table 4.3

Students' Reports on the Highest Level of Education of Either Parent[1]
Mathematics - Upper Grade (Eighth Grade*)

Country	Finished University[2]		Finished Upper Secondary School But Not University[3]		Finished Primary School But Not Upper Secondary School[4]		Do Not Know	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	28 (1.4)	572 (4.4)	37 (0.9)	528 (4.4)	24 (0.9)	510 (3.6)	11 (0.6)	494 (4.9)
Austria	10 (0.7)	574 (7.2)	70 (1.1)	547 (3.7)	8 (0.9)	496 (7.4)	12 (0.9)	513 (6.1)
Belgium (Fl)	20 (1.6)	599 (6.0)	34 (1.3)	572 (5.3)	21 (2.4)	538 (10.3)	25 (1.4)	548 (5.9)
Belgium (Fr)	27 (1.6)	557 (3.9)	34 (1.3)	537 (3.9)	11 (1.3)	491 (6.2)	27 (1.6)	501 (7.4)
Canada	37 (1.3)	544 (3.4)	39 (1.2)	526 (2.9)	13 (0.9)	510 (5.1)	10 (0.5)	504 (4.2)
Colombia	15 (1.6)	410 (8.2)	28 (1.6)	396 (4.3)	47 (2.3)	378 (4.1)	10 (0.9)	371 (6.8)
Cyprus	r 15 (0.9)	521 (4.8)	29 (1.1)	502 (4.0)	52 (1.4)	455 (2.9)	4 (0.5)	454 (8.8)
Czech Republic	21 (1.7)	604 (7.5)	47 (1.5)	571 (4.9)	25 (1.5)	532 (4.1)	7 (0.8)	516 (7.8)
Denmark	13 (1.0)	528 (5.5)	46 (1.5)	512 (3.5)	8 (0.7)	488 (8.0)	33 (1.7)	498 (4.0)
England	- -	- -	- -	- -	- -	- -	- -	- -
France	r 13 (1.2)	576 (5.8)	36 (1.3)	549 (3.6)	19 (1.2)	530 (4.1)	31 (1.3)	529 (3.8)
Germany	11 (1.0)	553 (8.5)	32 (1.3)	526 (5.0)	38 (1.6)	504 (4.2)	19 (1.3)	488 (6.7)
Greece	18 (1.1)	537 (6.3)	39 (1.3)	492 (4.5)	40 (1.8)	462 (2.9)	3 (0.3)	457 (8.1)
Hong Kong	7 (1.0)	638 (8.6)	30 (1.2)	607 (6.6)	55 (1.8)	584 (5.9)	7 (0.7)	554 (12.6)
Hungary	r 24 (1.8)	594 (4.9)	66 (1.7)	539 (3.2)	11 (0.9)	492 (6.0)	- -	- -
Iceland	25 (2.8)	505 (7.0)	44 (2.0)	495 (4.7)	15 (1.4)	467 (6.8)	15 (1.0)	472 (6.5)
Iran, Islamic Rep.	r 3 (0.6)	468 (7.1)	21 (1.8)	447 (2.5)	68 (2.2)	426 (2.5)	7 (1.0)	424 (5.6)
Ireland	17 (1.3)	564 (7.6)	46 (1.0)	535 (4.7)	26 (1.2)	510 (5.7)	10 (0.7)	499 (6.6)
Israel	37 (2.5)	552 (7.8)	45 (2.2)	518 (5.8)	10 (1.3)	486 (5.9)	8 (0.9)	506 (8.5)
Japan	- -	- -	- -	- -	- -	- -	- -	- -
Korea	22 (1.3)	654 (5.1)	47 (1.3)	607 (2.8)	26 (1.1)	575 (4.2)	5 (0.5)	573 (9.3)
Kuwait	s 3 (1.2)	429 (11.6)	3 (0.9)	387 (13.2)	92 (2.1)	390 (2.9)	1 (0.7)	~ ~
Latvia (LSS)	r 27 (1.5)	528 (5.5)	49 (1.4)	493 (3.7)	13 (1.0)	470 (6.2)	11 (1.0)	473 (6.4)
Lithuania	s 37 (1.6)	508 (4.4)	44 (1.6)	474 (4.1)	7 (1.0)	449 (6.3)	12 (1.2)	472 (6.4)
Netherlands	12 (1.4)	570 (10.6)	55 (1.8)	549 (7.7)	10 (0.7)	524 (9.2)	23 (1.4)	522 (7.8)
New Zealand	25 (1.3)	543 (6.0)	38 (1.1)	504 (4.4)	15 (0.8)	491 (5.7)	21 (1.1)	494 (5.4)
Norway	25 (1.2)	524 (4.5)	38 (1.1)	505 (3.1)	9 (0.6)	487 (4.6)	27 (1.2)	495 (3.2)
Portugal	9 (1.2)	494 (4.6)	13 (1.0)	473 (4.0)	73 (2.0)	447 (2.1)	5 (0.4)	452 (5.8)
Romania	10 (1.3)	517 (8.7)	47 (1.5)	497 (4.9)	33 (1.9)	467 (7.2)	10 (0.9)	460 (6.5)
Russian Federation	34 (1.8)	565 (4.9)	54 (1.6)	526 (6.4)	5 (0.5)	484 (8.0)	6 (0.8)	519 (10.8)
Scotland	14 (1.4)	559 (8.4)	33 (1.4)	499 (5.3)	14 (0.8)	485 (5.5)	39 (1.3)	487 (5.6)
Singapore	8 (1.0)	692 (7.5)	69 (1.0)	645 (5.0)	23 (1.2)	623 (4.9)	- -	- -
Slovak Republic	20 (1.4)	588 (5.4)	50 (1.1)	551 (3.2)	23 (1.2)	517 (4.5)	6 (0.5)	521 (7.5)
Slovenia	19 (1.1)	583 (4.4)	59 (1.4)	542 (3.4)	18 (1.3)	503 (4.6)	4 (0.4)	522 (9.0)
Spain	15 (1.2)	517 (3.6)	21 (0.9)	502 (3.3)	54 (1.8)	479 (2.3)	10 (0.8)	478 (3.5)
Sweden	22 (1.2)	544 (3.9)	34 (1.1)	524 (3.4)	9 (0.6)	494 (4.6)	35 (1.1)	511 (3.4)
Switzerland	11 (0.8)	588 (5.4)	61 (1.3)	552 (2.6)	13 (0.9)	520 (5.1)	15 (1.0)	534 (4.7)
Thailand	9 (1.4)	571 (9.5)	14 (1.4)	543 (8.9)	73 (2.6)	513 (4.4)	3 (0.5)	524 (12.3)
United States	33 (1.4)	527 (5.9)	54 (1.3)	494 (4.0)	7 (0.8)	455 (4.8)	5 (0.4)	489 (8.5)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1] The response categories were defined by each country to conform to their own educational system and may not be strictly comparable across countries. See Figure 4.1 for country modifications to the definitions of educational levels. Also, no response category was provided for students whose parents had no formal education or did not finish primary school, except in France where a small percentage of students in this category are included in the missing responses.

[2] In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

[3] Finished upper secondary school with or without some tertiary education not equivalent to a university degree. In most countries, finished secondary corresponds to completion of an upper-secondary track terminating after 11 to 13 years of schooling.

[4] Finished primary school or some secondary school not equivalent to completion of upper secondary.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

Data for Singapore not obtained from students; entered at ministry level.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.1 Country Modifications to the Definitions of Educational Levels for Parents' Highest Level of Education[1]

Finished Primary School But Not Upper Secondary School

Internationally-Defined Levels: *Finished Primary School or Finished Some Secondary School*

Countries with Modified Nationally-Defined Levels:

Austria:	*Compulsory (Pflichtschulabschluß; 9 grades)*
Denmark:	*Basic school (Folkeskolen, Realeksamen; 9 or 10 grades)*
France:	*Lower Secondary (Collége, CAP)*
Germany:	*Lower secondary (Hauptschulabschluß; 9 or 10 grades) or* *Medium secondary (Fachoberschulreife, Realschulabschluß or Polytechnische Oberschule; 10 grades)*
Hungary:	*Some or all of general school (8 grades)*
Norway:	*Compulsory (9 grades) or some upper secondary*
Scotland:	*Some secondary school*
Singapore:	*Primary school*
Sweden:	*Compulsory (9 grades) or started upper secondary*
Switzerland:	*Compulsory (9 grades)*

Finished Upper Secondary School[2] But Not University

Internationally-Defined Levels: *Finished Secondary School or Some Vocational/Technical Education After Secondary School or Some University*

Countries with Modified Nationally-Defined Levels:

Austria:	*Upper-secondary tracks: apprenticeship (Berufsschul-/Lehrabschluß), medium vocational (Handelsschule, Fachschule), higher vocational (HAK, HTL. etc.), or higher academic (Gymnasium, Realgymnasium)*
Cyprus:	*Upper-secondary tracks: academic or vocational/technical or* *Post-Secondary: Finished college*
Denmark:	*Upper-secondary tracks: academic or general/vocational (gymnasium, hf, htx, hhx) vocational training (erhvervsfaglig uddannelse)* *Post-Secondary: Medium-cycle higher education (mellemlang uddannselse)*
France:	*Upper-secondary tracks: BEP (11 grades) or baccalauréat (général, technologique or professionnel; 12 or 13 grades)* *Post-Secondary: 2 or 3 years study after baccalauréat (BTS, DUT, Licence)*
Germany:	*Upper-secondary tracks: general/academic or apprenticeship/vocational training (Lehrabschluß, Berufsfachschule)* *Post-Secondary: Higher vocational schools (Fachhochschulabschluß)*
Hungary:	*Upper-secondary tracks: apprenticeship (general + 3 years) or final exam in secondary (general + 4 years)*
Sweden:	*Upper-secondary tracks: academic or vocational (gymnasieutbildning or yrkesinriktad utbildning)* *Post-Secondary: Less than 3 years of university studies*
Switzerland:	*Upper-secondary tracks: occupational (apprentissage, école professionnelle), academic (gymnase, baccalauréat, maturité cantonale), or teacher training (école normale, formation d'enseignant)* *Post-Secondary: Applied science university (haute école professionnelle ou commerciale)*

Finished University

Internationally-Defined Level: *Finished University*

Countries with Modified Nationally-Defined Levels:

Austria:	*University (master's degree)*
Canada:	*University or college*
Cyprus:	*University degree or post-graduate studies*
France:	*4 years of study after baccalauréat*
Germany:	*University, Technical University or Pedagogical Institute*
Hungary:	*University or college diploma*
New Zealand:	*University or Teachers' College*
Norway:	*University or college*
Portugal:	*University or polytechnic*
Sweden:	*3 years university studies or more*
Switzerland:	*University or insitute of technology*
United States:	*Bachelor's degree at college or university*

[1]Educational levels were translated and defined in most countries to be comparable to the internationally-defined levels. Countries that used modified response options to conform to their national education systems are indicated to aid in the interpretation of the reporting categories presented in Table 4.3.

[2]Upper-secondary corresponds to ISCED level 3 tracks terminating after 11 to 13 years in most countries. (Education at a Glance, OECD, 1995)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.1 shows the definitions of the educational categories used by TIMSS and the modifications made to them by some countries. In several countries, the finished primary school but not upper secondary school category included only a single level corresponding to finishing compulsory education (8 to 10 grades) and did not include finishing only primary school. In addition, in Germany, the completion of medium secondary education was considered part of this category, while in Austria, which has an educational system similar to Germany's, the medium-level vocational education was included in the second category reporting upper-secondary education.

The second reporting category (finished upper secondary school but not university) was complicated because, in many countries, particularly in Europe, there are several upper-secondary tracks leading to university or other tertiary institutions as well as vocational/apprenticeship programs. In most countries, finishing upper secondary means completion of 11 to 13 years of education. In some systems, however, the general secondary education may be completed after 9 or 10 years, followed by 2 to 4 years of full- or part-time vocational/apprenticeship training that may be either included as part of the secondary educational system or considered as post-secondary. All of the upper-secondary tracks and any upper-secondary or post-secondary vocational education programs included as response options are combined in the second reporting category.

Several countries also differed in their interpretation of what is included in the category of finished university. For example, degrees obtained from technical institutes and other non-university institutions of higher education are considered equivalent to a university degree in some countries but not in others. Completion of a degree at one of these institutions, therefore, may have been included in either the finished university or the finished upper secondary school but not university categories. In countries such as Canada, New Zealand, Portugal, and the United States, the finished university category includes the completion of the equivalent of a bachelor's degree at either a university, college, or polytechnic, while in Austria and France, this category corresponds to the equivalent of a master's degree received at a university.

What Are the Academic Expectations of Students, Their Families, and Their Friends?

Tables 4.4, 4.5, and 4.6 present eighth-grade students' reports about how they themselves, their mothers, and their friends feel about the importance of doing well in various academic and non-academic activities. The first three questions asked about the degree of agreement with the importance of doing well in the academic subjects of mathematics, science, and language, respectively. In almost every country, nearly all eighth-graders agreed or strongly agreed that it was important to do well in mathematics. The percentages were in the high 90s for many countries and exceeded 90% in all countries except one, and that was Romania, with 88% agreement. Similarly, approximately the same high percentages of students were in agreement with the importance of doing well in language. In many countries, somewhat fewer eighth-grade students agreed with the importance of doing well in science. Still, the percentages were relatively high, ranging from more than 90% agreement in a number of countries to a low of 68% in Switzerland and 72% in Germany.

For the most part, eighth-grade students indicated that their mothers' opinions about the importance of these academic activities corresponded very closely to their own feelings. In contrast, however, students reported that their friends were not in as much agreement about the importance of academic success. Although students' friends purportedly were in general agreement with the importance of doing well in mathematics, the percentages were generally in the 80s rather than the 90s. According to students, their friends were in the lowest degree of agreement about doing well in mathematics in Germany and Sweden (70% for both countries).

As with the students' reports about their own feelings and those of their mothers, students indicated a close alignment in their friends' degree of agreement about the importance of academic success in mathematics and that in language. Apparently, even though the relative importance varies from group to group, students, their mothers, and their friends find it very nearly equally important to do well in mathematics and language. According to students in some countries, however, their friends do not have nearly the same positive feeling about the importance of doing well in science. Countries where fewer than two-thirds of eighth-graders reported that their friends agreed or strongly agreed it was important to do well in science included Australia (64%), Austria (45%), the Czech Republic (61%), France (53%), Germany (35%), Hungary (66%), Iceland (65%), Ireland (59%), Israel (56%), Latvia (LSS) (53%), Lithuania (55%), New Zealand (66%), the Slovak Republic (60%), Slovenia (56%), Sweden (61%), and Switzerland (40%).

For purposes of comparison, eighth-grade students also were asked about the importance of two non-academic activities – having time to have fun and being good at sports. In most countries, very high percentages of the students (more than 95%) felt it was important to have time to have fun. The percentages in agreement were similar to those agreeing that it was important to do well in mathematics and language. Generally, there was less agreement about the importance of being good at sports which was rather similar to the level of agreement about the importance of doing well in science.

It needs to be emphasized, however, that the relative rankings given to the five activities by students varied from country to country.

In nearly all countries, 80% or more of the eighth-grade students reported that their mothers agreed that it was important to have time to have fun. The exceptions were Hong Kong (74%), Iran (79%), Korea (58%), Kuwait (63%), and Singapore (79%), where students reported from 8% to 29% lower agreement for their mothers than for themselves. According to students, their mothers give a moderate to high degree of support to the importance of being good at sports. In nearly all countries, the percentages of students' reporting such agreement were in the 70s, 80s, and 90s, except in Austria (56%), Germany (48%), Kuwait (69%), the Netherlands (63%), and Switzerland (59%).

As might be anticipated, students reported that most of their friends agreed that it was important to have fun – more than 90% in all countries except Iran (87%), Korea (88%), Kuwait (77%), and Romania (86%). Internationally, eighth-graders reported that their friends generally were in moderate agreement that it was important to do well in sports. The percentages of their friends' agreement as reported by students ranged from a low of 64% in Germany to a high of 96% in Colombia.

Table 4.4

Students' Reports on Whether They Agree or Strongly Agree That It Is Important to Do Various Activities - Mathematics - Upper Grade (Eighth Grade*)

Country	Percent of Students: Do Well in Mathematics	Do Well in Science	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	96 (0.4)	89 (0.6)	95 (0.4)	98 (0.2)	85 (0.6)
Austria	94 (0.5)	82 (1.2)	93 (0.6)	98 (0.3)	82 (0.9)
Belgium (Fl)	98 (0.3)	93 (0.6)	98 (0.4)	98 (0.3)	80 (1.0)
Belgium (Fr)	98 (0.3)	94 (0.7)	98 (0.3)	98 (0.4)	87 (0.8)
Canada	98 (0.2)	94 (0.7)	97 (0.3)	99 (0.2)	86 (0.6)
Colombia	99 (0.2)	99 (0.2)	99 (0.2)	98 (0.3)	97 (0.3)
Cyprus	94 (0.5)	86 (1.0)	94 (0.6)	94 (0.5)	85 (1.0)
Czech Republic	98 (0.5)	88 (1.0)	98 (0.3)	98 (0.3)	84 (0.9)
Denmark	97 (0.4)	87 (1.0)	97 (0.4)	99 (0.3)	83 (0.8)
England	99 (0.2)	96 (0.5)	99 (0.3)	99 (0.3)	80 (1.1)
France	97 (0.4)	83 (1.2)	97 (0.5)	97 (0.4)	80 (0.8)
Germany	93 (0.6)	72 (1.0)	91 (0.6)	97 (0.4)	72 (1.1)
Greece	96 (0.4)	93 (0.5)	96 (0.4)	96 (0.4)	91 (0.6)
Hong Kong	96 (0.5)	90 (0.9)	96 (0.5)	94 (0.5)	83 (0.9)
Hungary	95 (0.5)	86 (0.8)	95 (0.5)	96 (0.5)	78 (0.9)
Iceland	97 (1.0)	90 (1.2)	97 (1.0)	98 (0.4)	90 (1.6)
Iran, Islamic Rep.	97 (0.4)	98 (0.4)	96 (0.6)	87 (1.1)	95 (0.7)
Ireland	97 (0.3)	86 (1.1)	96 (0.4)	99 (0.2)	85 (0.8)
Israel	98 (0.5)	85 (1.0)	89 (1.5)	98 (0.5)	84 (1.3)
Japan	92 (0.4)	87 (0.6)	91 (0.5)	99 (0.1)	83 (0.7)
Korea	94 (0.5)	91 (0.6)	93 (0.6)	87 (0.8)	86 (0.8)
Kuwait	96 (0.6)	96 (0.6)	96 (0.5)	85 (2.0)	81 (1.2)
Latvia (LSS)	97 (0.4)	84 (1.0)	97 (0.3)	97 (0.4)	87 (0.8)
Lithuania	93 (0.6)	78 (1.1)	96 (0.4)	94 (0.6)	93 (0.5)
Netherlands	97 (0.6)	95 (0.7)	99 (0.3)	98 (0.6)	78 (1.2)
New Zealand	97 (0.3)	92 (0.6)	96 (0.5)	99 (0.3)	86 (0.7)
Norway	96 (0.5)	92 (0.6)	96 (0.5)	99 (0.1)	79 (0.9)
Portugal	97 (0.3)	97 (0.3)	99 (0.2)	93 (0.5)	94 (0.5)
Romania	88 (0.8)	86 (0.8)	88 (0.8)	86 (1.0)	80 (1.1)
Russian Federation	97 (0.4)	95 (0.6)	97 (0.5)	98 (0.4)	88 (0.9)
Scotland	98 (0.4)	92 (0.7)	98 (0.3)	98 (0.3)	82 (0.9)
Singapore	99 (0.2)	99 (0.2)	100 (0.1)	96 (0.3)	89 (0.6)
Slovak Republic	96 (0.4)	86 (0.8)	96 (0.4)	98 (0.2)	91 (0.5)
Slovenia	96 (0.5)	86 (0.9)	96 (0.4)	95 (0.5)	87 (0.7)
Spain	99 (0.2)	99 (0.2)	99 (0.2)	99 (0.1)	95 (0.3)
Sweden	92 (0.6)	84 (0.8)	90 (0.6)	99 (0.2)	84 (0.7)
Switzerland	96 (0.4)	68 (1.1)	94 (0.4)	95 (0.6)	78 (0.9)
Thailand	93 (0.5)	94 (0.5)	96 (0.4)	95 (0.3)	91 (0.5)
United States	97 (0.3)	96 (0.5)	96 (0.3)	99 (0.2)	88 (0.6)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.5

Students' Reports on Whether Their Mothers Agree or Strongly Agree That It Is Important to Do Various Activities - Mathematics - Upper Grade (Eighth Grade*)

Country	Percent of Students: Do Well in Mathematics	Do Well in Science	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	98 (0.2)	94 (0.4)	98 (0.2)	94 (0.4)	83 (0.7)
Austria	96 (0.4)	81 (1.0)	95 (0.5)	90 (0.7)	56 (1.1)
Belgium (Fl)	97 (0.4)	93 (0.8)	98 (0.4)	94 (0.5)	73 (1.2)
Belgium (Fr)	99 (0.3)	98 (0.3)	99 (0.3)	95 (0.6)	85 (0.7)
Canada	99 (0.1)	98 (0.3)	99 (0.1)	96 (0.4)	83 (0.7)
Colombia	99 (0.4)	99 (0.3)	99 (0.2)	93 (0.6)	94 (1.0)
Cyprus	95 (0.4)	89 (0.8)	95 (0.5)	91 (0.6)	80 (0.8)
Czech Republic	99 (0.2)	93 (0.8)	98 (0.3)	90 (0.7)	74 (1.1)
Denmark	99 (0.3)	95 (0.6)	99 (0.3)	98 (0.3)	81 (1.0)
England	99 (0.3)	96 (0.5)	99 (0.3)	94 (0.6)	74 (1.2)
France	98 (0.3)	88 (0.9)	99 (0.3)	91 (0.7)	74 (1.0)
Germany	94 (0.8)	71 (1.4)	93 (0.7)	88 (0.7)	48 (1.2)
Greece	96 (0.3)	94 (0.5)	96 (0.4)	89 (0.6)	83 (0.7)
Hong Kong	93 (0.6)	86 (0.7)	93 (0.6)	74 (0.9)	71 (1.3)
Hungary	96 (0.4)	85 (0.8)	96 (0.4)	96 (0.4)	73 (1.1)
Iceland	97 (0.8)	95 (1.3)	98 (0.5)	95 (0.7)	87 (1.6)
Iran, Islamic Rep.	96 (0.5)	96 (0.5)	95 (0.5)	79 (1.8)	90 (1.5)
Ireland	98 (0.3)	89 (1.0)	98 (0.2)	94 (0.5)	83 (0.8)
Israel	99 (0.4)	89 (0.9)	93 (0.6)	95 (0.7)	79 (1.4)
Japan	- -	- -	- -	- -	- -
Korea	96 (0.4)	92 (0.5)	94 (0.5)	58 (1.1)	72 (0.9)
Kuwait	91 (1.0)	r 91 (0.9)	r 91 (0.8)	r 63 (2.2)	r 69 (2.0)
Latvia (LSS)	97 (0.4)	85 (1.1)	97 (0.5)	90 (0.8)	82 (0.9)
Lithuania	91 (0.6)	77 (1.1)	95 (0.5)	86 (0.8)	87 (0.9)
Netherlands	96 (0.5)	94 (0.7)	97 (0.4)	96 (0.4)	63 (1.4)
New Zealand	98 (0.3)	95 (0.4)	97 (0.3)	95 (0.5)	86 (0.8)
Norway	97 (0.4)	95 (0.5)	97 (0.4)	97 (0.3)	71 (1.1)
Portugal	96 (0.4)	98 (0.3)	98 (0.3)	87 (0.7)	91 (0.6)
Romania	93 (0.5)	94 (0.6)	90 (0.7)	83 (1.0)	76 (1.0)
Russian Federation	96 (0.3)	95 (0.4)	97 (0.4)	92 (0.6)	84 (0.7)
Scotland	98 (0.3)	93 (0.6)	99 (0.2)	94 (0.5)	77 (1.0)
Singapore	99 (0.2)	99 (0.2)	99 (0.1)	79 (0.8)	84 (0.8)
Slovak Republic	99 (0.2)	94 (0.5)	99 (0.2)	95 (0.4)	88 (0.6)
Slovenia	91 (0.7)	85 (0.7)	92 (0.6)	88 (0.7)	81 (0.9)
Spain	99 (0.2)	99 (0.2)	99 (0.2)	96 (0.4)	93 (0.5)
Sweden	96 (0.4)	92 (0.5)	95 (0.4)	97 (0.3)	83 (0.7)
Switzerland	96 (0.3)	69 (1.0)	95 (0.4)	83 (0.9)	59 (1.1)
Thailand	94 (0.5)	95 (0.4)	96 (0.4)	84 (0.9)	90 (0.5)
United States	98 (0.2)	97 (0.2)	98 (0.2)	93 (0.4)	81 (0.8)

*Eighth grade in most countries: see Table 2 for more information about the grades tested in each country.

Data are reported as percent of students.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A dash (-) indicates data are not available.

An "r" indicates a 70-84% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.6

Students' Reports on Whether Their Friends Agree or Strongly Agree That It Is Important to Do Various Activities - Mathematics - Upper Grade (Eighth Grade*)

Country	Percent of Students				
	Do Well in Mathematics	Do Well in Science	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	78 (0.8)	64 (1.0)	76 (0.8)	98 (0.2)	83 (0.8)
Austria	77 (1.2)	45 (1.8)	74 (1.1)	97 (0.4)	79 (1.2)
Belgium (Fl)	84 (1.7)	70 (1.6)	83 (1.8)	98 (0.4)	76 (1.5)
Belgium (Fr)	86 (1.1)	78 (1.3)	87 (0.9)	97 (0.4)	84 (1.2)
Canada	80 (0.8)	68 (1.3)	78 (0.8)	99 (0.2)	87 (0.6)
Colombia	95 (0.5)	93 (0.6)	95 (0.5)	97 (0.4)	96 (0.4)
Cyprus	85 (0.8)	71 (1.1)	85 (0.9)	91 (0.6)	82 (1.0)
Czech Republic	84 (1.3)	61 (1.5)	84 (1.2)	98 (0.3)	82 (1.1)
Denmark	94 (0.6)	82 (1.0)	95 (0.6)	99 (0.2)	92 (0.7)
England	88 (0.9)	80 (1.1)	88 (0.9)	99 (0.3)	79 (1.2)
France	85 (1.3)	53 (1.5)	88 (1.1)	97 (0.4)	80 (1.0)
Germany	70 (1.3)	35 (1.4)	68 (1.3)	94 (0.5)	64 (1.3)
Greece	87 (0.7)	82 (0.8)	89 (0.6)	96 (0.3)	85 (0.8)
Hong Kong	86 (0.9)	74 (1.3)	87 (0.9)	93 (0.5)	76 (1.0)
Hungary	81 (0.9)	66 (1.2)	83 (0.8)	94 (0.5)	74 (1.1)
Iceland	85 (1.4)	65 (2.0)	85 (1.1)	98 (0.4)	89 (1.2)
Iran, Islamic Rep.	95 (0.5)	95 (0.9)	93 (0.6)	87 (1.3)	93 (0.9)
Ireland	80 (0.9)	59 (1.4)	78 (0.8)	99 (0.2)	85 (0.7)
Israel	93 (1.1)	56 (2.5)	75 (2.0)	98 (0.5)	79 (1.9)
Japan	90 (0.5)	83 (0.7)	88 (0.6)	99 (0.2)	81 (0.7)
Korea	86 (0.8)	79 (0.9)	81 (0.8)	88 (0.7)	78 (1.0)
Kuwait	90 (0.8)	90 (0.6)	86 (0.9)	77 (2.4)	78 (1.5)
Latvia (LSS)	86 (0.9)	53 (1.3)	87 (1.0)	97 (0.4)	87 (0.8)
Lithuania	83 (0.9)	55 (1.3)	88 (0.9)	95 (0.5)	90 (0.7)
Netherlands	87 (0.9)	82 (1.2)	90 (0.7)	97 (0.6)	66 (1.2)
New Zealand	77 (1.0)	66 (1.2)	76 (1.0)	98 (0.3)	87 (0.8)
Norway	84 (0.8)	72 (1.2)	83 (0.9)	99 (0.2)	83 (1.0)
Portugal	89 (0.7)	88 (0.8)	93 (0.4)	92 (0.6)	94 (0.5)
Romania	87 (0.8)	80 (1.0)	88 (0.8)	86 (1.0)	81 (1.0)
Russian Federation	88 (0.8)	81 (0.8)	88 (0.8)	97 (0.4)	84 (0.8)
Scotland	81 (1.2)	70 (1.3)	82 (1.0)	98 (0.3)	84 (0.8)
Singapore	97 (0.4)	96 (0.5)	98 (0.2)	96 (0.3)	86 (0.8)
Slovak Republic	83 (0.7)	60 (1.3)	84 (0.7)	98 (0.2)	92 (0.5)
Slovenia	77 (1.2)	56 (1.6)	78 (1.1)	95 (0.5)	81 (0.9)
Spain	91 (0.6)	89 (0.7)	91 (0.5)	99 (0.2)	94 (0.4)
Sweden	70 (1.2)	61 (1.4)	68 (1.2)	97 (0.3)	75 (0.8)
Switzerland	85 (0.8)	40 (1.4)	82 (1.0)	93 (0.8)	75 (1.1)
Thailand	93 (0.6)	94 (0.5)	95 (0.4)	95 (0.4)	91 (0.4)
United States	75 (1.0)	69 (1.2)	73 (0.9)	98 (0.2)	90 (0.7)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Data are reported as percent of students.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Do Students Spend Their Out-of-School Time During the School Week?

Even though education may be thought to be the dominant activity of school-aged children, young people actually spend much more of their time outside of school. Some of this out-of-school time is spent at furthering academic development – for example, in studying or doing homework in school subjects. Table 4.7 presents eighth-grade students' reports about the average number of hours per day they spend studying or doing homework in mathematics, science, and other subjects. Students in many countries reported spending roughly an hour per day studying mathematics. Eighth-graders in the Czech Republic, Denmark, Germany, the Netherlands, and Scotland were at the lower end of the range, reporting an average of about one-half hour per day (.5 to .6 of an hour). Those in Iran and Romania were at the top end, reporting about two hours mathematics homework per day (2.0 and 1.8 hours, respectively). On average, students in nearly all countries reported spending somewhat less time per day studying science.

Participating countries showed some variation in the amount of time students spent doing homework each day across all school subjects. The most common response about the amount of homework done, reported by eighth-graders in about half the countries, was an average of two to three hours per day, but there was a range. Students in Iran, Kuwait, and Romania reported spending the most time on homework, more than five hours per day. Students in the Czech Republic, Denmark, and Scotland reported spending the least amount of time per day on homework, less than two hours.

The students also were asked about a variety of other ways they could spend their time out of school. Eighth-graders were asked about watching television, playing computer games, playing or talking with friends, doing jobs at home, playing sports, and reading books for enjoyment. Their reports about the amount of time spent daily in each of these activities are shown in Table 4.8. Granted, some television programming and some computer games are targeted at developing children's academic abilities, and leisure reading also can be related to higher academic achievement. Still, much fare on television is not educationally related, and eighth-grade students in many countries reported spending nearly as much time each day watching television – an average of two to three hours per day – as they did doing homework. Eighth-graders in many countries also appear to spend several hours per day playing or talking with friends, and nearly two hours playing sports. The time spent on leisure activities is not additive, because students often do these activities simultaneously (e.g., talk with friends and watch television). Nevertheless, it does appear that in most countries at least as much time is spent in these largely non-academic activities as in studying and doing homework, and probably more time.

Table 4.9 shows the relationship between time spent doing homework in all subjects and students' average mathematics achievement. The relationship was curvilinear in many countries, with the highest achievement being associated with a moderate amount of homework per day (one to three hours). This pattern suggests that, compared to their higher-achieving counterparts, the lower-performing students may do less homework, either because they do not do it or because their teachers do not assign it, or more

Table 4.7

Students' Reports on How They Spend Their Daily Out-of School Study Time[1] Mathematics - Upper Grade (Eighth Grade*)

Country	Average Hours Each Day Studying Mathematics or Doing Mathematics Homework After School	Average Hours Each Day Studying Science or Doing Science Homework After School	Average Hours Each Day Studying or Doing Homework in Other School Subjects	Total Hours Each Day on Average
Australia	0.7 (0.02)	0.5 (0.01)	0.9 (0.02)	2.0 (0.04)
Austria	0.8 (0.02)	0.7 (0.03)	0.8 (0.02)	2.4 (0.07)
Belgium (Fl)	1.1 (0.03)	0.8 (0.02)	1.5 (0.03)	3.4 (0.07)
Belgium (Fr)	1.0 (0.02)	0.8 (0.02)	1.2 (0.03)	3.0 (0.07)
Canada	0.7 (0.02)	0.6 (0.02)	0.9 (0.03)	2.2 (0.07)
Colombia	1.3 (0.06)	1.2 (0.06)	2.0 (0.07)	4.6 (0.15)
Cyprus	1.2 (0.02)	0.9 (0.02)	1.5 (0.03)	3.6 (0.06)
Czech Republic	0.6 (0.02)	0.6 (0.02)	0.6 (0.02)	1.8 (0.05)
Denmark	0.5 (0.02)	0.3 (0.02)	0.5 (0.02)	1.4 (0.05)
England	- -	- -	- -	- -
France	0.9 (0.02)	0.6 (0.01)	1.2 (0.03)	2.7 (0.05)
Germany	0.6 (0.02)	0.6 (0.02)	0.8 (0.02)	2.0 (0.05)
Greece	1.2 (0.03)	1.2 (0.03)	2.0 (0.05)	4.4 (0.08)
Hong Kong	0.9 (0.02)	0.6 (0.02)	1.1 (0.03)	2.5 (0.06)
Hungary	0.8 (0.02)	1.1 (0.02)	1.2 (0.03)	3.1 (0.06)
Iceland	0.9 (0.03)	0.6 (0.03)	0.9 (0.03)	2.4 (0.07)
Iran, Islamic Rep.	2.0 (0.05)	1.9 (0.05)	2.5 (0.05)	6.4 (0.13)
Ireland	0.7 (0.02)	0.6 (0.01)	1.4 (0.03)	2.7 (0.05)
Israel	1.0 (0.04)	0.6 (0.03)	1.2 (0.05)	2.8 (0.10)
Japan	0.8 (0.01)	0.6 (0.01)	1.0 (0.02)	2.3 (0.04)
Korea	0.8 (0.02)	0.6 (0.02)	1.1 (0.02)	2.5 (0.05)
Kuwait	1.6 (0.04)	1.5 (0.05)	2.3 (0.07)	5.3 (0.12)
Latvia (LSS)	0.9 (0.02)	0.6 (0.02)	1.2 (0.03)	2.7 (0.05)
Lithuania	0.8 (0.02)	0.7 (0.02)	1.2 (0.04)	2.7 (0.06)
Netherlands	0.6 (0.01)	0.6 (0.01)	1.0 (0.03)	2.2 (0.04)
New Zealand	0.7 (0.02)	0.6 (0.01)	0.9 (0.02)	2.1 (0.05)
Norway	0.7 (0.02)	0.6 (0.01)	1.0 (0.02)	2.3 (0.04)
Portugal	1.0 (0.02)	0.9 (0.02)	1.1 (0.02)	3.0 (0.05)
Romania	1.8 (0.07)	1.6 (0.06)	1.6 (0.06)	5.0 (0.18)
Russian Federation	0.9 (0.02)	1.0 (0.02)	1.0 (0.02)	2.9 (0.05)
Scotland	0.6 (0.02)	0.5 (0.01)	0.7 (0.02)	1.8 (0.04)
Singapore	1.4 (0.02)	1.3 (0.02)	1.9 (0.03)	4.6 (0.04)
Slovak Republic	0.7 (0.01)	0.8 (0.02)	0.9 (0.02)	2.4 (0.04)
Slovenia	0.9 (0.02)	1.0 (0.02)	0.9 (0.02)	2.9 (0.05)
Spain	1.2 (0.02)	1.0 (0.02)	1.4 (0.03)	3.6 (0.06)
Sweden	0.7 (0.01)	0.7 (0.01)	0.9 (0.02)	2.3 (0.04)
Switzerland	0.9 (0.02)	0.7 (0.01)	1.0 (0.02)	2.7 (0.04)
Thailand	1.2 (0.03)	1.0 (0.02)	1.3 (0.02)	3.5 (0.06)
United States	0.8 (0.02)	0.6 (0.01)	0.9 (0.02)	2.3 (0.04)

[1]Average hours based on: No Time = 0; Less Than 1 Hour = .5; 1-2 Hours =1.5; 3-5 Hours = 4; More Than 5 Hours = 7.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.8

Students' Reports on How They Spend Their Daily Leisure Time[1] Mathematics - Upper Grade (Eighth Grade*)

Country	Average Hours Each Day Watching Television or Videos	Average Hours Each Day Playing Computer Games	Average Hours Each Day Playing or Talking with Friends	Average Hours Each Day Doing Jobs at Home	Average Hours Each Day Playing Sports	Average Hours Each Day Reading a Book for Enjoyment
Australia	2.4 (0.05)	0.6 (0.02)	1.4 (0.03)	0.9 (0.02)	1.6 (0.03)	0.6 (0.02)
Austria	1.9 (0.06)	0.6 (0.03)	2.9 (0.08)	0.8 (0.03)	1.9 (0.07)	0.8 (0.03)
Belgium (Fl)	2.0 (0.05)	0.5 (0.06)	1.6 (0.05)	1.1 (0.03)	1.8 (0.07)	0.7 (0.03)
Belgium (Fr)	1.9 (0.08)	0.7 (0.03)	1.7 (0.10)	0.8 (0.03)	1.8 (0.04)	0.8 (0.03)
Canada	2.3 (0.04)	0.5 (0.02)	2.2 (0.05)	1.0 (0.02)	1.9 (0.03)	0.8 (0.02)
Colombia	2.2 (0.07)	r 0.4 (0.06)	1.9 (0.06)	2.3 (0.07)	1.9 (0.06)	0.9 (0.05)
Cyprus	2.3 (0.04)	0.8 (0.03)	1.7 (0.04)	1.0 (0.03)	1.4 (0.04)	0.8 (0.02)
Czech Republic	2.6 (0.05)	0.6 (0.03)	2.9 (0.09)	1.3 (0.04)	1.9 (0.06)	1.0 (0.03)
Denmark	2.2 (0.06)	0.7 (0.03)	2.8 (0.07)	1.1 (0.04)	1.7 (0.06)	0.7 (0.03)
England	2.7 (0.07)	0.9 (0.05)	2.5 (0.06)	0.8 (0.03)	1.5 (0.05)	0.7 (0.03)
France	1.5 (0.04)	0.5 (0.02)	1.5 (0.05)	0.9 (0.03)	1.7 (0.04)	0.8 (0.03)
Germany	1.9 (0.04)	0.8 (0.04)	3.5 (0.07)	0.9 (0.02)	1.7 (0.04)	0.7 (0.02)
Greece	2.1 (0.04)	0.7 (0.03)	1.5 (0.04)	0.9 (0.03)	1.8 (0.04)	1.0 (0.03)
Hong Kong	2.6 (0.05)	0.8 (0.03)	1.2 (0.04)	0.7 (0.02)	0.9 (0.03)	0.9 (0.02)
Hungary	3.0 (0.06)	0.7 (0.03)	2.3 (0.05)	2.0 (0.04)	1.7 (0.04)	1.2 (0.04)
Iceland	2.2 (0.05)	0.7 (0.06)	3.1 (0.06)	0.8 (0.03)	1.8 (0.06)	0.9 (0.06)
Iran, Islamic Rep.	1.8 (0.06)	r 0.2 (0.02)	1.2 (0.04)	1.8 (0.06)	1.2 (0.09)	1.1 (0.04)
Ireland	2.1 (0.03)	0.5 (0.03)	1.5 (0.06)	0.9 (0.03)	1.4 (0.05)	0.6 (0.02)
Israel	3.3 (0.10)	0.9 (0.04)	2.4 (0.08)	1.2 (0.05)	1.9 (0.09)	1.0 (0.04)
Japan	2.6 (0.04)	0.6 (0.02)	1.9 (0.04)	0.6 (0.01)	1.3 (0.03)	0.9 (0.02)
Korea	2.0 (0.04)	0.3 (0.02)	0.9 (0.03)	0.5 (0.02)	0.5 (0.02)	0.8 (0.03)
Kuwait	1.9 (0.07)	0.7 (0.05)	1.5 (0.11)	1.2 (0.08)	1.5 (0.10)	1.0 (0.04)
Latvia (LSS)	2.6 (0.05)	0.7 (0.04)	2.1 (0.06)	1.5 (0.04)	1.2 (0.04)	1.1 (0.03)
Lithuania	2.8 (0.05)	0.9 (0.04)	2.7 (0.06)	1.2 (0.03)	1.2 (0.04)	1.0 (0.03)
Netherlands	2.5 (0.09)	0.7 (0.04)	2.8 (0.08)	0.9 (0.04)	1.8 (0.06)	0.6 (0.03)
New Zealand	2.5 (0.05)	0.7 (0.03)	1.5 (0.04)	0.9 (0.02)	1.5 (0.04)	0.8 (0.02)
Norway	2.5 (0.04)	0.8 (0.03)	3.2 (0.06)	1.1 (0.03)	1.9 (0.05)	0.7 (0.02)
Portugal	2.0 (0.04)	0.7 (0.03)	1.7 (0.05)	1.0 (0.04)	1.7 (0.04)	0.7 (0.02)
Romania	1.9 (0.06)	0.6 (0.05)	1.5 (0.06)	1.9 (0.08)	1.3 (0.05)	1.3 (0.07)
Russian Federation	2.9 (0.05)	1.0 (0.04)	2.9 (0.05)	1.5 (0.03)	1.0 (0.03)	1.3 (0.04)
Scotland	2.7 (0.05)	1.0 (0.04)	2.8 (0.08)	0.7 (0.02)	1.9 (0.05)	0.7 (0.02)
Singapore	2.7 (0.05)	0.6 (0.03)	1.5 (0.04)	1.0 (0.03)	0.7 (0.03)	1.1 (0.02)
Slovak Republic	2.7 (0.05)	0.6 (0.03)	2.9 (0.07)	1.5 (0.05)	1.8 (0.04)	1.0 (0.03)
Slovenia	2.0 (0.04)	0.6 (0.02)	1.7 (0.05)	1.6 (0.05)	1.6 (0.03)	0.9 (0.02)
Spain	1.8 (0.05)	0.3 (0.02)	1.8 (0.06)	1.1 (0.03)	1.7 (0.04)	0.6 (0.02)
Sweden	2.3 (0.04)	0.6 (0.02)	2.3 (0.05)	0.9 (0.02)	1.6 (0.04)	0.7 (0.02)
Switzerland	1.3 (0.03)	0.4 (0.02)	2.4 (0.05)	1.0 (0.03)	1.8 (0.03)	0.8 (0.02)
Thailand	2.1 (0.07)	0.3 (0.02)	1.2 (0.03)	1.6 (0.03)	1.1 (0.02)	1.0 (0.02)
United States	2.6 (0.07)	0.7 (0.03)	2.5 (0.06)	1.2 (0.04)	2.2 (0.05)	0.7 (0.02)

[1]Average hours based on: No Time = 0; Less Than 1 Hour = .5; 1-2 Hours = 1.5; 3-5 Hours = 4; More Than 5 Hours = 7.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70 - 84% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 4.9

Students' Reports on Total Amount of Daily Out-of-School Study Time[1] Mathematics - Upper Grade (Eighth Grade*)

Country	Less than 1 Hour		1 to < 2 Hours		2 to 3 Hours		More than 3 Hours	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	15 (0.9)	486 (5.7)	46 (1.0)	541 (4.4)	22 (0.6)	543 (5.2)	17 (0.7)	532 (4.8)
Austria	9 (0.8)	524 (6.7)	46 (1.3)	551 (4.1)	21 (0.9)	544 (4.5)	24 (1.2)	528 (5.3)
Belgium (Fl)	2 (0.4)	~ ~	25 (1.3)	552 (8.9)	28 (1.1)	592 (5.9)	45 (1.6)	560 (4.6)
Belgium (Fr)	7 (0.8)	466 (7.4)	32 (1.0)	543 (4.6)	21 (1.3)	544 (5.5)	40 (1.5)	519 (4.5)
Canada	14 (1.2)	514 (5.6)	47 (1.1)	538 (2.8)	18 (0.7)	534 (3.7)	21 (1.1)	511 (3.6)
Colombia	2 (0.4)	~ ~	17 (1.1)	394 (5.2)	20 (1.2)	389 (3.6)	61 (1.9)	390 (3.5)
Cyprus	9 (0.5)	442 (5.8)	19 (0.7)	475 (3.9)	26 (0.8)	491 (4.0)	46 (0.9)	475 (2.9)
Czech Republic	13 (1.1)	551 (7.1)	57 (1.1)	571 (5.1)	17 (0.9)	568 (8.2)	13 (0.8)	542 (7.6)
Denmark	39 (1.6)	517 (4.4)	39 (1.4)	508 (3.8)	13 (0.8)	479 (4.1)	9 (0.7)	468 (6.9)
England	- -	- -	- -	- -	- -	- -	- -	- -
France	8 (0.7)	505 (8.0)	33 (1.2)	545 (3.6)	28 (1.0)	547 (4.5)	31 (1.2)	537 (3.7)
Germany	14 (1.1)	476 (6.7)	51 (1.2)	521 (4.3)	18 (1.0)	524 (7.0)	17 (0.9)	498 (5.0)
Greece	6 (0.6)	450 (7.4)	14 (0.7)	483 (5.2)	21 (0.7)	485 (3.9)	59 (1.2)	491 (3.3)
Hong Kong	13 (1.0)	539 (9.3)	32 (0.9)	586 (6.6)	25 (0.9)	607 (6.1)	30 (1.1)	604 (7.2)
Hungary	4 (0.4)	483 (11.3)	33 (1.1)	536 (5.0)	22 (0.9)	541 (5.2)	41 (1.3)	545 (3.7)
Iceland	5 (1.0)	450 (12.0)	46 (1.7)	501 (5.1)	25 (1.3)	489 (5.4)	23 (1.4)	477 (7.3)
Iran, Islamic Rep.	1 (0.2)	~ ~	5 (0.5)	428 (5.6)	12 (1.0)	436 (4.8)	82 (1.3)	431 (2.4)
Ireland	5 (0.6)	465 (8.8)	29 (1.0)	517 (5.3)	40 (1.1)	547 (5.5)	26 (1.2)	533 (5.7)
Israel	5 (0.6)	539 (10.9)	36 (2.2)	546 (6.3)	26 (1.5)	521 (6.8)	33 (2.1)	502 (6.3)
Japan	13 (0.8)	578 (5.3)	39 (0.8)	607 (2.6)	20 (0.6)	609 (4.0)	28 (1.0)	612 (2.7)
Korea	15 (0.9)	582 (4.9)	32 (1.1)	604 (3.5)	25 (0.8)	607 (4.0)	29 (1.2)	628 (4.3)
Kuwait	3 (0.6)	358 (10.3)	13 (1.5)	401 (5.5)	19 (1.3)	397 (5.1)	65 (1.8)	392 (2.0)
Latvia (LSS)	4 (0.5)	467 (9.4)	35 (1.1)	507 (4.4)	32 (1.2)	497 (4.9)	29 (1.2)	487 (3.4)
Lithuania	5 (0.6)	453 (9.4)	39 (1.4)	487 (3.9)	28 (1.0)	481 (4.6)	28 (1.4)	474 (5.4)
Netherlands	3 (0.9)	492 (16.2)	54 (1.7)	539 (9.0)	27 (1.7)	562 (7.0)	16 (0.8)	524 (6.0)
New Zealand	12 (0.9)	472 (5.6)	51 (1.2)	519 (4.7)	21 (1.0)	518 (6.1)	17 (0.9)	495 (5.6)
Norway	6 (0.5)	481 (6.8)	50 (1.2)	514 (2.9)	24 (0.9)	510 (3.6)	21 (0.9)	483 (3.6)
Portugal	3 (0.3)	458 (8.1)	41 (1.1)	463 (3.1)	18 (0.7)	455 (3.3)	38 (1.2)	448 (3.0)
Romania	9 (0.7)	459 (10.4)	16 (1.0)	464 (7.0)	15 (0.7)	481 (5.4)	60 (1.6)	494 (4.2)
Russian Federation	4 (0.5)	493 (10.3)	33 (1.1)	538 (5.3)	25 (1.0)	538 (5.2)	38 (1.4)	544 (6.9)
Scotland	17 (1.4)	461 (4.8)	54 (1.2)	506 (5.7)	17 (1.0)	517 (8.6)	12 (0.8)	503 (7.4)
Singapore	2 (0.3)	~ ~	7 (0.4)	642 (8.0)	13 (0.6)	652 (6.6)	78 (0.9)	643 (4.9)
Slovak Republic	6 (0.5)	549 (8.3)	46 (0.9)	556 (3.9)	25 (0.7)	548 (4.4)	23 (1.0)	532 (4.1)
Slovenia	5 (0.5)	551 (9.8)	36 (1.0)	561 (4.1)	21 (0.8)	537 (4.8)	37 (1.1)	523 (3.4)
Spain	3 (0.4)	443 (5.5)	26 (1.0)	490 (3.1)	18 (0.9)	495 (3.3)	53 (1.3)	487 (2.4)
Sweden	7 (0.6)	496 (6.9)	55 (1.2)	528 (3.1)	17 (0.8)	525 (4.3)	21 (0.9)	503 (4.2)
Switzerland	4 (0.3)	523 (7.9)	44 (1.2)	556 (3.4)	19 (0.8)	548 (5.1)	33 (1.1)	536 (4.0)
Thailand	3 (0.3)	495 (11.9)	26 (1.0)	514 (5.4)	18 (0.7)	515 (5.7)	54 (1.5)	531 (6.6)
United States	17 (1.1)	471 (7.2)	42 (0.9)	514 (4.2)	17 (0.7)	507 (5.5)	24 (0.8)	498 (5.9)

[1]Sum of time reported spent studying or doing homework in mathematics, science, and other subjects.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

homework, perhaps because they need to spend the extra time to keep up academically. In some countries, students doing one hour a day of homework or more had higher average mathematics achievement than students doing less than one hour a day (e.g., Greece, Japan, the Russian Federation, and Spain), although in these countries there was little difference in achievement as the time spent increased from at least one hour to more than three hours. A direct positive relationship between time spent doing homework and mathematics achievement was found in other countries, such as Korea and Romania. The only inverse relationship was noted for Denmark. Clearly, different countries have different policies and practices about assigning homework.

The relationship between mathematics achievement and amount of time spent watching television each day was more consistent across countries than that with doing homework (see Table 4.10). In about half the TIMSS countries, the highest mathematics achievement was associated with watching from one to two hours of television per day. This was the most common response, reflecting from 33% to 54% of the students for all countries. That watching less than one hour of television per day generally was associated with lower average mathematics achievement than watching one to two hours in many countries most likely has little to do with the influence of television viewing on mathematics achievement. For these students, low television viewing may be a surrogate socio-economic indicator, suggesting something about children's access to television sets across countries. Because students with fewer socio-economic advantages generally perform less well than their counterparts academically, it may be that students who reported less than one hour watching television each day simply do not have television sets in their homes, or come from homes with only one television set where they have less opportunity to spend a lot of time watching their choice of programming.

In general, beyond one to two hours of television viewing per day, the more television eighth-graders reported watching, the lower their mathematics achievement, although there were several countries where students watching three to five hours of television did not have lower achievement than those watching one to two hours. In all countries, however, students watching more than five hours of television per day had the lowest average mathematics achievement. Countries where 10% or more of the students reported watching more than five hours of television each day included Colombia, England, Hong Kong, Hungary, Israel, Latvia (LSS), Lithuania, New Zealand, the Russian Federation, Scotland, the Slovak Republic, and the United States.

Table 4.10

Students' Reports on the Hours Spent Each Day Watching Television and Videos Mathematics - Upper Grade (Eighth Grade*)

Country	Less than 1 Hour		1 to 2 Hours		3 to 5 Hours		More than 5 Hours	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	24 (0.9)	539 (6.0)	41 (0.8)	539 (4.1)	27 (0.8)	528 (3.8)	9 (0.6)	487 (5.5)
Austria	25 (1.4)	540 (5.4)	53 (1.1)	546 (4.2)	17 (1.0)	539 (5.2)	5 (0.6)	497 (8.6)
Belgium (Fl)	24 (1.2)	580 (6.7)	52 (1.2)	575 (6.2)	19 (1.0)	535 (7.1)	5 (0.5)	514 (12.1)
Belgium (Fr)	33 (1.3)	536 (4.2)	44 (1.8)	536 (4.9)	17 (1.3)	522 (4.0)	6 (1.0)	445 (9.0)
Canada	22 (0.7)	522 (2.9)	46 (0.8)	534 (3.5)	25 (0.7)	532 (3.0)	7 (0.6)	504 (5.2)
Colombia	31 (1.5)	384 (4.9)	39 (1.2)	397 (3.3)	20 (1.2)	391 (5.2)	11 (1.0)	374 (5.3)
Cyprus	25 (1.1)	466 (4.4)	45 (1.1)	486 (2.7)	21 (0.8)	479 (3.7)	9 (0.7)	441 (5.7)
Czech Republic	15 (0.8)	556 (7.5)	45 (1.2)	575 (6.2)	31 (1.2)	562 (4.3)	9 (0.8)	531 (8.9)
Denmark	28 (1.1)	499 (3.9)	42 (1.2)	507 (4.0)	22 (1.0)	510 (4.5)	8 (0.7)	488 (6.0)
England	20 (1.3)	500 (8.1)	37 (1.2)	515 (3.9)	31 (1.2)	516 (3.7)	11 (0.9)	481 (6.1)
France	42 (1.3)	546 (3.9)	45 (1.1)	539 (2.9)	9 (0.7)	532 (5.5)	4 (0.5)	494 (10.8)
Germany	31 (1.0)	510 (6.2)	47 (1.1)	517 (4.5)	16 (0.8)	511 (5.9)	6 (0.6)	467 (7.4)
Greece	32 (0.9)	486 (3.5)	42 (0.7)	489 (3.7)	17 (0.7)	486 (4.9)	9 (0.5)	470 (5.7)
Hong Kong	22 (0.9)	582 (7.7)	39 (0.9)	599 (6.8)	28 (1.0)	599 (6.5)	11 (0.8)	556 (9.1)
Hungary	11 (0.7)	550 (6.2)	41 (1.1)	552 (4.0)	33 (0.9)	537 (3.9)	15 (1.0)	496 (5.2)
Iceland	24 (1.3)	475 (7.4)	47 (1.3)	494 (4.5)	22 (1.2)	498 (5.7)	7 (0.8)	473 (11.8)
Iran, Islamic Rep.	32 (1.3)	421 (3.1)	46 (0.9)	434 (2.9)	17 (0.9)	438 (4.1)	5 (0.6)	425 (7.9)
Ireland	20 (0.8)	517 (6.4)	51 (1.1)	539 (5.2)	23 (0.8)	531 (5.3)	5 (0.5)	486 (8.5)
Israel	9 (1.4)	506 (17.0)	33 (2.1)	536 (7.0)	44 (1.7)	525 (5.4)	14 (1.2)	505 (7.8)
Japan	9 (0.5)	606 (5.7)	53 (0.9)	615 (2.1)	30 (0.8)	596 (3.4)	9 (0.5)	569 (5.1)
Korea	32 (1.0)	612 (4.6)	40 (1.0)	618 (3.4)	20 (0.8)	595 (5.3)	7 (0.6)	570 (6.9)
Kuwait	39 (1.7)	386 (2.9)	38 (1.3)	398 (3.3)	14 (1.2)	400 (3.8)	9 (0.8)	384 (4.1)
Latvia (LSS)	16 (1.0)	474 (4.4)	44 (1.1)	500 (3.7)	29 (1.2)	509 (4.2)	10 (0.7)	475 (5.1)
Lithuania	12 (0.7)	469 (6.2)	44 (1.3)	480 (4.6)	32 (1.2)	483 (4.0)	12 (0.9)	472 (5.8)
Netherlands	17 (1.8)	544 (14.0)	47 (1.7)	556 (7.0)	27 (1.5)	529 (6.3)	9 (0.9)	496 (7.3)
New Zealand	24 (1.0)	506 (6.4)	38 (0.9)	521 (4.8)	26 (0.9)	510 (4.7)	12 (0.8)	474 (5.7)
Norway	15 (0.7)	508 (4.2)	48 (1.0)	509 (2.5)	30 (1.0)	503 (3.7)	7 (0.4)	470 (6.0)
Portugal	27 (1.0)	450 (3.3)	48 (0.9)	458 (2.9)	20 (0.8)	460 (3.3)	5 (0.5)	440 (5.3)
Romania	38 (1.4)	475 (5.6)	39 (1.2)	489 (5.5)	16 (0.9)	495 (5.6)	8 (0.7)	470 (7.7)
Russian Federation	12 (1.0)	515 (6.9)	42 (1.4)	538 (5.9)	32 (1.0)	547 (4.8)	14 (0.9)	535 (7.5)
Scotland	15 (0.7)	488 (7.2)	43 (1.0)	504 (6.9)	31 (1.0)	508 (5.9)	11 (0.7)	472 (4.8)
Singapore	7 (0.6)	657 (7.2)	50 (1.1)	650 (5.2)	37 (1.2)	636 (5.2)	6 (0.5)	619 (8.6)
Slovak Republic	14 (0.7)	561 (7.4)	47 (1.0)	550 (3.5)	28 (0.9)	547 (4.1)	11 (0.8)	523 (5.6)
Slovenia	23 (1.1)	546 (4.1)	54 (1.1)	541 (3.4)	19 (0.9)	540 (4.7)	4 (0.4)	518 (9.9)
Spain	33 (1.2)	481 (3.0)	46 (1.0)	494 (2.4)	17 (0.8)	489 (3.9)	4 (0.5)	464 (5.1)
Sweden	16 (0.7)	518 (4.9)	51 (0.9)	528 (3.3)	27 (0.8)	514 (3.7)	6 (0.5)	478 (5.5)
Switzerland	45 (1.5)	556 (4.1)	44 (1.3)	543 (3.2)	9 (0.7)	528 (6.6)	2 (0.2)	~ ~
Thailand	28 (1.4)	510 (4.7)	46 (1.0)	524 (6.4)	19 (1.1)	540 (7.3)	8 (0.7)	521 (6.9)
United States	22 (0.8)	504 (5.7)	40 (0.9)	513 (5.1)	25 (0.6)	501 (4.2)	13 (1.0)	461 (4.6)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Do Students Perceive Success in Mathematics?

Table 4.11 presents eighth-grade students' perceptions about doing well in mathematics. In all except four countries, the majority of students agreed or strongly agreed that they did well in mathematics. The four exceptions, where more than 50% of the students disagreed or strongly disagreed about doing well, were Hong Kong (62%), Japan (55%), Korea (62%), and Lithuania (51%). Notably, three of those countries were among the very highest performing countries. Countries where 80% or more of the eighth-graders felt they were usually good at mathematics represented a range in mathematics performance – Australia, Canada, Colombia, Denmark, England, Greece, Iceland, Iran, Israel, Kuwait, New Zealand, Scotland, Sweden, and the United States.

Figure 4.2 indicates that, internationally, eighth-grade girls had lower self-perceptions than boys about how well they usually do in mathematics. This figure and the distributions shown in Table 4.11 also show that, on average, both boys and girls in the participating countries tended to agree (or sometimes disagree) about usually doing well in mathematics rather than report the extremes of strongly agreeing or disagreeing. For most countries both boys and girls tended to indicate that they did well in mathematics – a perception that did not always coincide with their achievement on the TIMSS mathematics test.

Table 4.11

Students' Self-Perceptions About Usually Doing Well in Mathematics Upper Grade (Eighth Grade*)

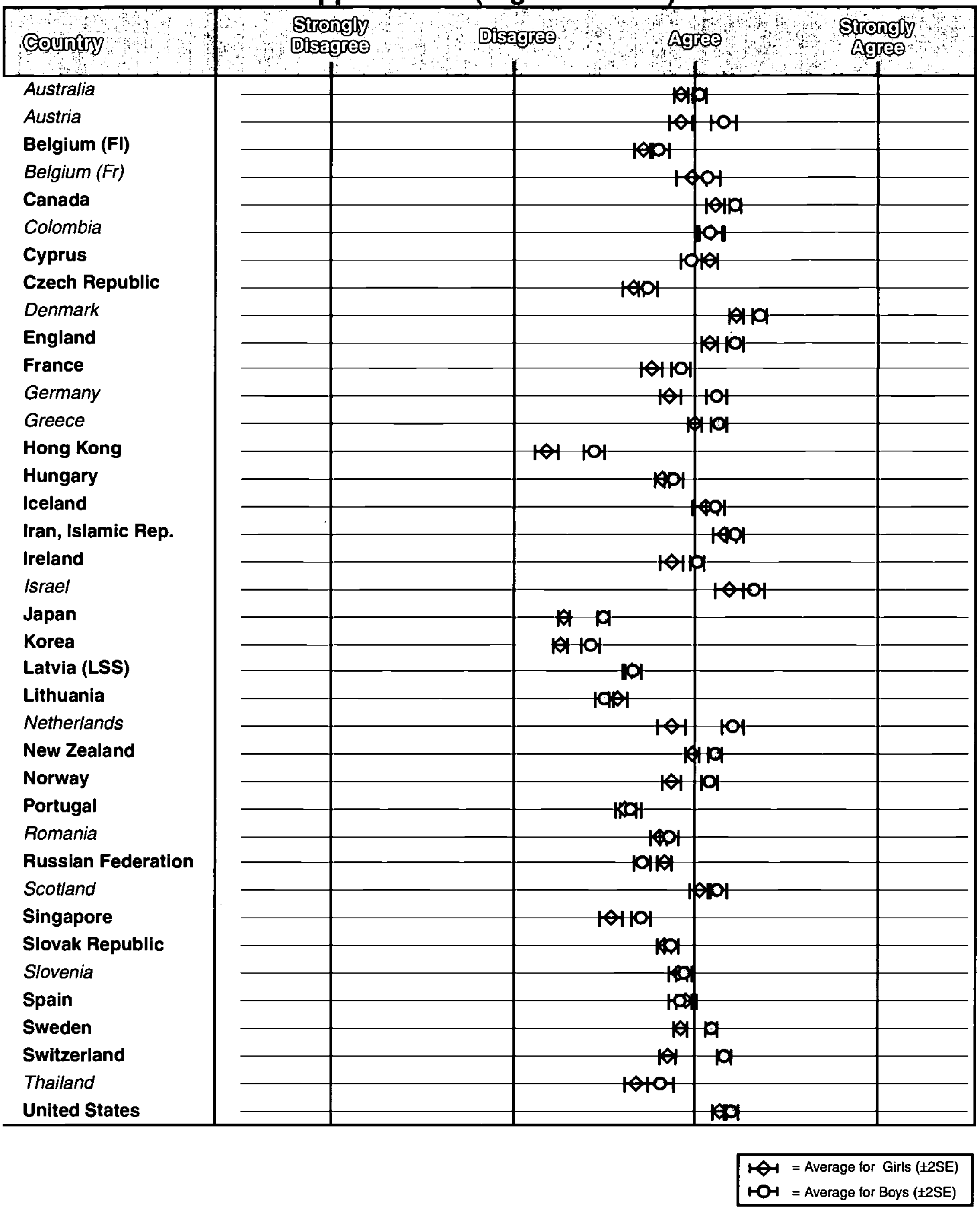
Country	Strongly Disagree		Disagree		Agree		Strongly Agree	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	3 (0.3)	457 (7.9)	17 (0.7)	487 (5.6)	60 (0.8)	530 (3.9)	20 (0.9)	586 (4.7)
Austria	3 (0.4)	512 (10.1)	21 (1.1)	508 (5.4)	45 (1.2)	535 (4.0)	31 (1.4)	572 (4.3)
Belgium (Fl)	5 (0.4)	512 (6.7)	29 (1.0)	548 (5.9)	48 (1.1)	567 (6.4)	17 (0.9)	609 (7.2)
Belgium (Fr)	3 (0.4)	467 (7.8)	19 (1.3)	505 (5.4)	48 (1.3)	528 (3.8)	29 (1.5)	550 (5.0)
Canada	3 (0.3)	480 (9.0)	13 (0.6)	480 (4.9)	49 (1.1)	514 (2.3)	35 (1.1)	570 (3.4)
Colombia	2 (0.4)	~ ~	17 (1.3)	373 (3.7)	51 (1.9)	385 (4.6)	30 (1.4)	398 (5.3)
Cyprus	5 (0.4)	411 (7.6)	18 (0.8)	432 (3.7)	46 (1.0)	469 (2.6)	31 (1.0)	521 (4.4)
Czech Republic	2 (0.3)	~ ~	37 (1.4)	516 (4.2)	48 (1.4)	584 (5.2)	13 (1.0)	640 (8.0)
Denmark	1 (0.2)	~ ~	8 (0.6)	431 (7.0)	53 (1.4)	492 (3.0)	38 (1.3)	537 (4.0)
England	1 (0.2)	~ ~	6 (0.6)	475 (8.3)	69 (1.0)	500 (3.0)	24 (1.0)	538 (5.8)
France	6 (0.7)	495 (6.1)	26 (1.1)	513 (4.0)	46 (1.0)	548 (3.4)	22 (0.8)	564 (5.1)
Germany	7 (0.5)	474 (7.1)	24 (1.0)	491 (5.2)	33 (1.1)	511 (5.1)	36 (1.1)	529 (5.3)
Greece	2 (0.3)	~ ~	16 (0.7)	454 (3.6)	55 (0.8)	481 (3.2)	27 (0.8)	515 (4.2)
Hong Kong	11 (0.9)	536 (9.5)	51 (1.2)	577 (6.7)	33 (1.2)	620 (6.7)	5 (0.5)	643 (8.2)
Hungary	3 (0.3)	469 (11.7)	25 (0.9)	490 (4.2)	57 (1.0)	545 (3.4)	15 (0.8)	608 (4.8)
Iceland	3 (0.6)	421 (10.1)	14 (1.4)	447 (4.9)	55 (1.6)	486 (4.5)	28 (1.8)	519 (9.5)
Iran, Islamic Rep.	1 (0.4)	~ ~	8 (0.7)	403 (4.3)	62 (1.4)	423 (2.6)	29 (1.4)	450 (3.7)
Ireland	3 (0.3)	475 (7.7)	18 (1.0)	492 (5.5)	61 (0.9)	530 (5.2)	18 (1.0)	572 (7.6)
Israel	2 (0.4)	~ ~	12 (1.3)	494 (10.1)	45 (1.9)	513 (6.2)	41 (1.9)	549 (8.3)
Japan	10 (0.5)	523 (3.7)	45 (0.7)	577 (2.3)	40 (0.7)	650 (2.5)	4 (0.3)	669 (7.8)
Korea	9 (0.5)	535 (5.7)	53 (1.0)	572 (3.0)	32 (0.9)	669 (3.0)	6 (0.6)	702 (5.7)
Kuwait	3 (0.7)	364 (11.3)	9 (0.9)	382 (3.6)	49 (1.7)	386 (2.4)	39 (2.1)	405 (3.9)
Latvia (LSS)	2 (0.3)	~ ~	43 (1.2)	471 (3.5)	43 (1.2)	505 (3.7)	12 (0.8)	542 (5.5)
Lithuania	5 (0.5)	446 (7.5)	46 (1.2)	454 (3.4)	38 (1.2)	492 (4.3)	11 (0.8)	544 (6.0)
Netherlands	4 (0.5)	487 (12.4)	21 (1.4)	504 (7.1)	43 (1.3)	537 (8.4)	32 (1.6)	580 (7.3)
New Zealand	2 (0.3)	~ ~	13 (0.8)	466 (6.1)	62 (0.9)	501 (4.5)	22 (0.8)	559 (5.5)
Norway	3 (0.3)	434 (7.4)	18 (0.9)	455 (3.2)	58 (1.0)	504 (2.2)	21 (0.8)	555 (4.4)
Portugal	7 (0.5)	419 (3.6)	37 (1.1)	435 (2.3)	42 (1.1)	463 (2.5)	14 (0.8)	502 (5.2)
Romania	6 (0.6)	455 (12.0)	25 (1.0)	459 (4.6)	49 (0.9)	488 (4.3)	20 (1.0)	505 (6.3)
Russian Federation	2 (0.3)	~ ~	37 (1.4)	501 (7.1)	43 (1.1)	547 (5.1)	18 (0.8)	590 (4.9)
Scotland	2 (0.3)	~ ~	10 (0.8)	455 (5.5)	66 (1.3)	491 (4.8)	22 (1.3)	553 (9.3)
Singapore	6 (0.4)	587 (9.0)	38 (1.2)	624 (5.2)	46 (1.1)	659 (4.9)	11 (0.6)	677 (6.2)
Slovak Republic	1 (0.2)	~ ~	28 (1.1)	496 (3.8)	55 (1.1)	555 (3.8)	15 (0.7)	619 (5.2)
Slovenia	2 (0.3)	~ ~	24 (1.1)	497 (4.0)	53 (1.0)	538 (3.6)	21 (0.9)	602 (4.2)
Spain	5 (0.5)	441 (4.6)	23 (1.0)	456 (2.6)	45 (1.1)	488 (2.6)	27 (1.0)	522 (3.4)
Sweden	2 (0.3)	~ ~	16 (0.7)	475 (3.4)	61 (0.9)	517 (3.0)	21 (0.8)	565 (3.8)
Switzerland	3 (0.4)	497 (10.1)	21 (0.9)	528 (4.0)	47 (0.9)	541 (3.0)	28 (1.1)	575 (3.3)
Thailand	2 (0.3)	~ ~	38 (1.5)	510 (5.1)	45 (1.1)	529 (6.6)	15 (0.9)	537 (7.4)
United States	3 (0.3)	430 (5.1)	11 (0.6)	462 (4.8)	52 (0.9)	491 (4.3)	34 (1.0)	534 (5.9)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.2

Gender Differences in Students' Self-Perceptions About Usually Doing Well in Mathematics - Upper Grade (Eighth Grade*)



*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background Data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Students were asked about the necessity of various attributes or activities to do well in mathematics (see Table 4.12). There was enormous variation from country to country in the percentage of eighth-grade students agreeing that natural talent or ability were important to do well in mathematics. Fewer than 50% of the students agreed in England, France, Iceland, the Netherlands, and Sweden compared to 90% or more in Colombia, Denmark, Hungary, and Iran. Internationally, relatively few students agreed that good luck was important to do well. The countries where more than 50% of the eighth-graders agreed that good luck was needed to do well in mathematics included Colombia, the Czech Republic, Hungary, Iran, Japan, Korea, Kuwait, Latvia (LSS), Lithuania, Romania, the Russian Federation, and the Slovak Republic.

Internationally, there was a high degree of agreement among students that lots of hard work studying at home was necessary in order to do well in mathematics. Percentages of agreement were in the 80s and 90s for most countries, and in the 70s for Austria, Germany, Hungary, Switzerland, and Thailand. The variation was substantial from country to country regarding students' agreement with the necessity of memorizing the textbook or notes. In Belgium (French), France, Iceland, Japan, Kuwait, and Thailand, 90% or more of the eighth-grade students agreed or strongly agreed that memorization was important to doing well in mathematics. In contrast, fewer than 40% so agreed in Austria, Latvia (LSS), Lithuania, Singapore, the Slovak Republic, Slovenia, Sweden, and Switzerland.

Table 4.12

Students' Reports on Things Necessary to Do Well in Mathematics Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Agree or Strongly Agree			
	Natural Talent/Ability	Good Luck	Lots of Hard Work Studying at Home	Memorize the Textbook or Notes
Australia	66 (0.8)	30 (0.8)	92 (0.5)	67 (0.8)
Austria	70 (1.4)	27 (1.2)	78 (1.2)	39 (1.2)
Belgium (Fl)	58 (1.7)	22 (2.0)	85 (1.1)	51 (1.8)
Belgium (Fr)	69 (1.3)	23 (1.3)	93 (0.8)	93 (0.5)
Canada	61 (1.0)	26 (0.9)	87 (0.7)	42 (0.9)
Colombia	91 (1.0)	62 (1.4)	97 (0.3)	74 (1.4)
Cyprus	51 (1.0)	34 (1.1)	92 (0.6)	71 (1.2)
Czech Republic	61 (1.0)	57 (1.2)	81 (1.0)	41 (1.8)
Denmark	90 (0.7)	28 (1.3)	87 (1.0)	61 (1.5)
England	45 (1.3)	23 (1.0)	93 (0.7)	49 (1.2)
France	40 (1.4)	21 (1.1)	90 (0.7)	95 (0.7)
Germany	59 (1.5)	25 (1.1)	76 (1.1)	47 (1.5)
Greece	54 (0.9)	26 (0.9)	95 (0.5)	84 (0.7)
Hong Kong	77 (1.0)	38 (1.0)	95 (0.6)	69 (1.5)
Hungary	95 (0.5)	56 (1.0)	79 (1.1)	47 (1.5)
Iceland	37 (1.8)	24 (1.5)	92 (0.8)	94 (1.0)
Iran, Islamic Rep.	95 (0.5)	51 (2.5)	96 (0.4)	89 (0.9)
Ireland	72 (1.0)	31 (1.2)	95 (0.5)	69 (1.1)
Israel	55 (2.1)	17 (1.6)	96 (0.6)	40 (2.1)
Japan	82 (0.6)	59 (1.0)	96 (0.3)	92 (0.6)
Korea	86 (0.7)	63 (1.0)	98 (0.2)	73 (0.7)
Kuwait	87 (1.3)	76 (1.7)	83 (1.4)	91 (0.8)
Latvia (LSS)	61 (1.1)	63 (1.4)	91 (0.7)	38 (1.3)
Lithuania	85 (1.0)	69 (1.1)	83 (0.9)	28 (1.5)
Netherlands	44 (1.5)	23 (1.5)	89 (0.9)	53 (1.7)
New Zealand	62 (1.1)	27 (1.2)	92 (0.5)	72 (1.2)
Norway	86 (0.6)	19 (0.8)	92 (0.6)	74 (1.1)
Portugal	72 (1.0)	39 (1.3)	97 (0.3)	56 (1.5)
Romania	66 (1.1)	59 (1.3)	88 (0.7)	73 (1.3)
Russian Federation	79 (1.0)	51 (1.4)	89 (0.8)	61 (1.9)
Scotland	- -	- -	- -	- -
Singapore	84 (0.7)	41 (1.0)	92 (0.7)	32 (1.6)
Slovak Republic	69 (1.1)	52 (1.1)	90 (0.6)	35 (1.1)
Slovenia	81 (1.0)	38 (1.3)	82 (1.0)	16 (1.0)
Spain	66 (1.2)	35 (1.0)	89 (0.8)	60 (1.4)
Sweden	48 (1.0)	24 (1.0)	83 (0.7)	33 (0.9)
Switzerland	60 (1.2)	22 (0.9)	71 (1.0)	36 (1.4)
Thailand	69 (1.2)	34 (1.1)	77 (0.9)	96 (0.4)
United States	50 (1.0)	32 (1.2)	90 (0.6)	59 (1.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Students also were asked about why they need to do well in mathematics. Students could agree with any or all of the three areas of possible motivation presented in Table 4.13, including getting their desired job, to please their parents, and to get into their desired secondary school or university. There were substantial differences from country to country in students' responses. In Colombia, Cyprus, Iran, Kuwait, and Scotland, 50% or more of the eighth-graders strongly agreed that they needed to do well in mathematics to get their desired job. The majority of students in nearly all countries either agreed or strongly agreed that getting their desired job was a motivating factor, except Korea, where 53% of the students disagreed or strongly disagreed.

In Iran, Kuwait, and Thailand, 50% or more of the students strongly agreed that they needed to do well in mathematics to please their parents. Even though in most countries the majority of the eighth-grade students agreed at some level that pleasing their parents was important, 50% or more disagreed or strongly disagreed in Denmark, Iceland, Japan, the Netherlands, Slovenia, and Sweden. Internationally, the reason most frequently cited by students for needing to do well in mathematics was to get into students' desired secondary school or university. With the exception of Austria, Belgium (Flemish), Germany, the Netherlands, and Switzerland, three-fourths or more of the students strongly agreed or agreed that this was a motivating factor for doing well in mathematics.

Table 4.13

Students' Reports on Why They Need to Do Well in Mathematics Upper Grade (Eighth Grade*)

Country	Percent of Students								
	Get Desired Job			Please Parents			Get into Desired Secondary School or University		
	Strongly Agree	Agree	Disagree/ Strongly Disagree	Strongly Agree	Agree	Disagree/ Strongly Disagree	Strongly Agree	Agree	Disagree/ Strongly Disagree
Australia	36 (0.9)	43 (0.8)	21 (0.7)	22 (0.7)	50 (0.7)	28 (0.6)	36 (0.9)	42 (0.8)	22 (1.0)
Austria	33 (1.3)	31 (0.8)	36 (1.5)	17 (1.0)	37 (1.2)	46 (1.3)	36 (1.4)	27 (1.3)	37 (1.6)
Belgium (Fl)	17 (0.9)	40 (1.1)	43 (1.5)	16 (0.8)	53 (1.2)	32 (1.2)	27 (1.1)	47 (0.9)	26 (1.0)
Belgium (Fr)	35 (1.3)	36 (1.4)	29 (1.2)	28 (1.6)	49 (1.2)	23 (1.2)	36 (1.2)	41 (1.3)	23 (1.1)
Canada	44 (0.9)	41 (1.0)	15 (0.6)	23 (0.7)	44 (0.9)	32 (1.1)	55 (1.4)	37 (1.2)	8 (0.5)
Colombia	50 (1.7)	35 (1.3)	15 (0.9)	41 (2.2)	36 (1.2)	23 (1.5)	63 (1.2)	31 (1.1)	6 (0.5)
Cyprus	53 (1.1)	34 (1.0)	13 (0.8)	34 (0.9)	37 (1.1)	30 (1.0)	50 (1.0)	32 (0.9)	18 (0.9)
Czech Republic	32 (1.3)	50 (1.1)	17 (1.2)	23 (1.1)	61 (1.0)	16 (0.8)	45 (1.0)	40 (1.2)	15 (0.9)
Denmark	32 (1.2)	39 (1.3)	29 (1.1)	13 (1.3)	28 (1.2)	59 (1.7)	40 (1.5)	45 (1.4)	14 (1.0)
England	37 (1.1)	43 (1.1)	20 (0.9)	20 (1.1)	43 (1.3)	36 (1.5)	41 (1.2)	45 (1.1)	14 (1.0)
France	35 (1.1)	36 (1.0)	29 (1.2)	17 (1.0)	42 (1.4)	41 (1.4)	42 (1.1)	42 (1.0)	17 (0.9)
Germany	39 (1.3)	31 (1.1)	30 (1.0)	25 (1.2)	32 (0.9)	43 (1.2)	32 (1.1)	33 (1.1)	35 (1.2)
Greece	45 (0.9)	37 (1.0)	17 (0.6)	37 (1.2)	39 (0.9)	25 (0.8)	51 (0.9)	34 (0.9)	15 (0.6)
Hong Kong	24 (1.0)	52 (0.9)	24 (0.8)	16 (0.7)	43 (0.9)	41 (1.1)	32 (0.9)	51 (0.9)	17 (0.8)
Hungary	22 (1.0)	55 (1.0)	23 (1.1)	10 (0.7)	53 (1.0)	36 (1.2)	32 (1.0)	43 (1.0)	25 (1.2)
Iceland	32 (1.8)	47 (2.0)	21 (1.2)	13 (1.4)	30 (1.3)	57 (2.1)	49 (1.5)	44 (1.9)	7 (0.8)
Iran, Islamic Rep.	62 (1.2)	28 (1.0)	10 (0.9)	69 (1.3)	25 (1.3)	5 (0.6)	73 (1.3)	22 (1.0)	5 (0.7)
Ireland	40 (1.1)	40 (1.1)	20 (0.9)	19 (0.9)	43 (0.8)	38 (1.0)	42 (1.1)	40 (1.1)	18 (1.2)
Israel	45 (1.8)	34 (1.5)	21 (1.1)	21 (1.4)	36 (2.0)	44 (2.0)	68 (1.8)	28 (1.6)	4 (0.6)
Japan	12 (0.5)	43 (0.7)	45 (0.8)	6 (0.4)	28 (0.7)	66 (0.9)	35 (0.7)	56 (0.8)	9 (0.9)
Korea	13 (0.8)	34 (0.8)	53 (1.1)	11 (0.7)	44 (1.2)	44 (1.3)	35 (1.2)	51 (1.0)	14 (0.8)
Kuwait	50 (2.4)	34 (1.7)	15 (1.2)	64 (2.2)	29 (1.7)	8 (0.8)	63 (1.5)	25 (1.1)	12 (1.1)
Latvia (LSS)	39 (1.2)	46 (1.0)	15 (1.0)	29 (1.4)	50 (1.3)	20 (1.0)	45 (1.3)	44 (1.1)	11 (0.7)
Lithuania	43 (1.4)	44 (1.3)	13 (0.9)	16 (0.9)	37 (1.3)	47 (1.3)	41 (1.2)	42 (1.3)	17 (1.0)
Netherlands	16 (1.1)	37 (1.4)	47 (1.3)	8 (1.0)	35 (1.4)	57 (1.7)	19 (1.1)	47 (1.2)	33 (1.3)
New Zealand	41 (1.0)	42 (0.9)	17 (0.7)	22 (0.8)	44 (1.0)	34 (1.0)	37 (1.0)	44 (0.9)	20 (0.7)
Norway	24 (0.9)	49 (0.9)	28 (0.9)	14 (0.8)	38 (0.9)	48 (1.0)	37 (1.0)	52 (1.0)	11 (0.7)
Portugal	37 (0.8)	39 (0.9)	23 (0.8)	22 (1.0)	44 (1.0)	34 (1.1)	43 (1.1)	40 (1.0)	17 (0.8)
Romania	40 (1.2)	38 (1.0)	22 (1.1)	33 (1.0)	43 (1.1)	24 (1.0)	46 (1.2)	36 (1.0)	18 (1.0)
Russian Federation	42 (0.9)	40 (0.9)	18 (0.9)	26 (1.0)	45 (1.2)	29 (1.2)	44 (1.1)	39 (1.1)	17 (0.7)
Scotland	51 (1.2)	36 (1.1)	12 (0.6)	22 (0.9)	43 (1.0)	34 (1.0)	51 (1.2)	33 (1.1)	16 (1.0)
Singapore	37 (0.8)	48 (0.6)	15 (0.7)	20 (0.6)	46 (0.8)	34 (1.0)	51 (1.0)	44 (1.0)	5 (0.3)
Slovak Republic	31 (0.9)	48 (1.0)	20 (0.9)	15 (0.7)	56 (1.0)	29 (1.1)	42 (0.9)	51 (0.9)	7 (0.5)
Slovenia	27 (1.1)	51 (1.1)	22 (1.0)	8 (0.6)	35 (1.3)	56 (1.5)	39 (1.1)	49 (1.1)	12 (0.7)
Spain	31 (1.0)	39 (0.9)	29 (0.8)	36 (1.0)	45 (0.9)	18 (0.9)	47 (1.0)	41 (0.9)	12 (0.5)
Sweden	24 (0.9)	47 (0.9)	29 (0.8)	11 (0.7)	35 (0.9)	54 (1.1)	29 (0.9)	53 (0.9)	18 (0.6)
Switzerland	30 (1.0)	36 (0.9)	34 (1.0)	18 (1.0)	39 (0.9)	43 (0.9)	32 (0.9)	39 (1.1)	28 (0.9)
Thailand	47 (1.1)	48 (1.0)	4 (0.4)	54 (1.1)	44 (1.1)	2 (0.3)	61 (1.1)	37 (1.0)	2 (0.3)
United States	47 (1.2)	39 (0.8)	15 (0.7)	35 (0.9)	45 (0.7)	20 (0.8)	64 (1.2)	32 (1.0)	4 (0.3)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are Students' Attitudes Towards Mathematics?

To collect information on eighth-grade students' perceptions of mathematics, TIMSS asked them a series of questions about its utility, importance, and enjoyability. Students' perceptions about the value of learning mathematics may be considered as both an input and outcome variable, because their attitudes towards the subject can be related to educational achievement in ways that reinforce higher or lower performance. That is, students who do well in mathematics generally have more positive attitudes towards the subject, and those who have more positive attitudes tend to perform better.

Table 4.14 provides students' responses to the question about how much they like or dislike mathematics in relation to their average mathematics achievement. As anticipated, within nearly every country, a clear positive relationship can be observed between a stronger liking of mathematics and higher achievement. Even though the majority of eighth-graders in nearly every country indicated they liked mathematics to some degree, clearly not all students feel positive about this subject area. In Austria, the Czech Republic, Germany, Hungary, Japan, Korea, Lithuania, and the Netherlands, more than 40% of the eighth-grade students reported disliking mathematics.

The data in Figure 4.3 reveal that, on average, eighth-graders of both genders were relatively neutral about liking mathematics. In no country did girls report a significantly stronger liking of the subject area than did boys. However, boys reported liking mathematics better than girls did in several countries, including Austria, France, Germany, Hong Kong, Japan, Norway, and Switzerland.

To gain some understanding about eighth-graders' view about the utility of mathematics and their enjoyment of it as a school subject, TIMSS asked students to state their level of agreement with the following four statements: 1) I would like a job that involved using mathematics, 2) Mathematics is important to everyone's life, 3) Mathematics is boring, and 4) I enjoy learning mathematics. The results for these four questions were averaged with students' responses to the question about liking mathematics to form an index of their overall attitudes towards mathematics based on all five questions.

The data for the index in Table 4.15 reveal that eighth-grade students generally had positive attitudes towards mathematics, and that those students with more positive attitudes had higher average mathematics achievement. On average, across the five questions comprising the mathematics attitude index, the majority of students in each TIMSS country expressed positive or strongly positive attitudes about mathematics. Very few students (usually only 2% to 3%) consistently had strongly negative opinions about all aspects of the subject. Since these results seem slightly more supportive than students' liking of the subject alone, it may be that students understand the utility of mathematics to a greater extent than they actually like doing it.

Gender differences for the index of overall attitudes are portrayed in Figure 4.4. In many countries, girls and boys reported similar overall attitudes about mathematics. The countries where boys' attitudes were significantly more positive than those of girls included Austria, France, Germany, Greece, Hong Kong, Japan, the Netherlands, Norway, Sweden, and Switzerland. Interestingly, the index of overall attitudes towards mathematics showed gender differences in a somewhat different set of countries than the single question about liking mathematics. For the countries showing a gender difference on the attitudes index but not on the liking question, it is possible that boys more than girls perceive the relevance of mathematics.

Table 4.14

Students' Reports on How Much They Like Mathematics Upper Grade (Eighth Grade*)

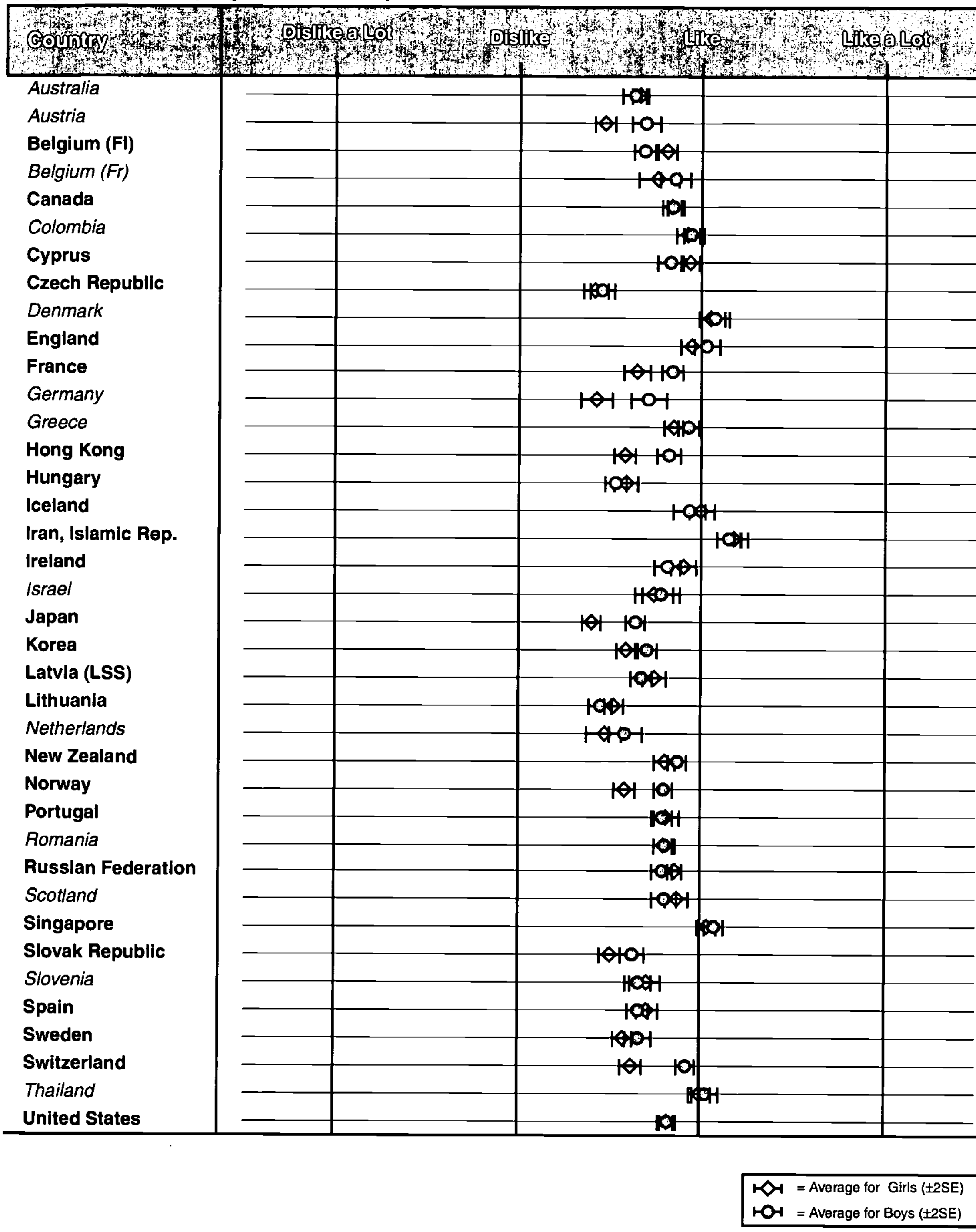
Country	Dislike a Lot		Dislike		Like		Like a Lot	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	12 (0.6)	480 (5.2)	24 (0.7)	523 (4.8)	51 (0.7)	541 (4.1)	13 (0.7)	563 (5.0)
Austria	16 (1.0)	517 (6.2)	26 (1.1)	529 (4.7)	41 (1.1)	548 (3.6)	17 (1.2)	558 (6.3)
Belgium (Fl)	11 (0.8)	520 (7.3)	21 (1.0)	558 (4.9)	49 (1.1)	566 (6.7)	18 (1.1)	602 (6.2)
Belgium (Fr)	11 (1.2)	489 (8.2)	19 (1.0)	514 (5.7)	48 (1.1)	529 (3.9)	22 (1.2)	557 (7.1)
Canada	10 (0.5)	498 (4.7)	16 (0.7)	521 (3.6)	54 (1.1)	527 (2.9)	20 (0.9)	553 (3.4)
Colombia	8 (0.6)	367 (6.9)	14 (1.1)	378 (3.9)	55 (1.3)	388 (3.1)	23 (1.4)	392 (6.6)
Cyprus	14 (0.9)	423 (3.5)	13 (0.5)	449 (4.3)	46 (1.0)	473 (2.7)	28 (1.0)	515 (3.4)
Czech Republic	14 (0.8)	533 (6.0)	36 (1.2)	550 (5.4)	41 (1.4)	578 (6.0)	8 (0.6)	606 (8.0)
Denmark	5 (0.6)	480 (7.9)	17 (1.1)	477 (4.3)	46 (1.2)	503 (4.0)	32 (1.5)	522 (3.9)
England	5 (0.5)	473 (8.5)	15 (1.0)	499 (6.5)	56 (1.2)	507 (3.2)	24 (1.1)	518 (4.6)
France	12 (1.0)	506 (5.7)	20 (1.1)	524 (4.6)	51 (1.3)	544 (3.3)	17 (1.0)	566 (5.5)
Germany	23 (1.2)	481 (4.8)	22 (1.1)	508 (6.8)	31 (1.1)	525 (5.0)	24 (1.1)	522 (5.7)
Greece	11 (0.6)	453 (5.0)	15 (0.6)	468 (4.3)	49 (1.0)	480 (3.4)	25 (1.0)	517 (3.6)
Hong Kong	12 (0.8)	545 (10.1)	23 (0.9)	569 (7.0)	48 (1.0)	598 (6.1)	17 (0.9)	629 (6.5)
Hungary	12 (0.8)	496 (7.4)	30 (1.2)	522 (4.3)	47 (1.1)	549 (3.8)	11 (0.7)	589 (6.1)
Iceland	6 (0.9)	447 (15.0)	15 (1.1)	480 (5.9)	56 (1.7)	488 (4.7)	23 (1.5)	503 (5.5)
Iran, Islamic Rep.	7 (0.6)	407 (5.2)	8 (0.7)	412 (5.2)	47 (1.5)	421 (2.8)	38 (1.5)	446 (2.8)
Ireland	9 (0.7)	492 (7.1)	18 (1.0)	520 (5.4)	53 (1.2)	531 (5.1)	21 (1.1)	549 (8.0)
Israel	10 (1.3)	513 (9.8)	24 (1.4)	523 (8.2)	45 (1.7)	522 (5.5)	21 (1.3)	536 (8.5)
Japan	11 (0.7)	550 (4.1)	36 (1.0)	585 (2.6)	43 (1.0)	625 (2.3)	10 (0.5)	649 (4.1)
Korea	6 (0.3)	536 (8.0)	36 (1.2)	569 (3.6)	44 (1.2)	628 (3.3)	14 (0.8)	676 (5.0)
Kuwait	8 (1.5)	371 (6.2)	8 (0.9)	391 (5.1)	40 (1.9)	391 (3.0)	44 (2.5)	398 (3.5)
Latvia (LSS)	7 (0.7)	469 (6.2)	26 (1.2)	475 (4.2)	56 (1.3)	499 (3.6)	11 (0.8)	536 (5.8)
Lithuania	12 (0.8)	457 (6.1)	35 (1.3)	463 (4.1)	44 (1.4)	488 (4.1)	9 (0.7)	519 (8.7)
Netherlands	13 (1.8)	494 (17.1)	30 (1.3)	535 (7.5)	50 (1.8)	554 (6.2)	8 (0.8)	567 (9.2)
New Zealand	9 (0.6)	475 (6.0)	19 (0.8)	500 (4.9)	51 (0.9)	508 (5.0)	21 (0.9)	533 (6.1)
Norway	11 (0.7)	454 (3.9)	26 (0.9)	485 (3.3)	47 (1.0)	514 (2.9)	16 (0.7)	540 (4.2)
Portugal	10 (0.7)	421 (3.8)	19 (1.0)	439 (3.4)	53 (1.0)	456 (2.5)	18 (1.1)	485 (4.0)
Romania	11 (0.7)	458 (7.3)	18 (0.7)	460 (5.4)	52 (1.0)	483 (4.1)	19 (1.0)	516 (5.6)
Russian Federation	5 (0.5)	499 (8.9)	22 (1.0)	510 (7.2)	58 (1.2)	540 (5.4)	15 (0.8)	574 (5.1)
Scotland	7 (0.6)	458 (6.4)	19 (0.9)	493 (5.3)	57 (1.0)	498 (6.0)	17 (1.0)	529 (9.8)
Singapore	4 (0.4)	583 (8.8)	14 (0.7)	613 (6.4)	54 (0.9)	642 (4.8)	28 (1.1)	671 (5.5)
Slovak Republic	15 (0.6)	496 (4.4)	25 (1.0)	526 (4.2)	49 (1.1)	559 (3.7)	11 (0.7)	613 (4.5)
Slovenia	11 (1.0)	511 (6.7)	23 (1.1)	519 (4.5)	52 (1.5)	540 (3.5)	14 (0.8)	606 (4.7)
Spain	13 (0.8)	459 (3.6)	24 (0.8)	473 (3.0)	45 (0.9)	491 (2.5)	18 (0.8)	516 (3.6)
Sweden	11 (0.7)	479 (4.9)	29 (1.0)	510 (3.2)	48 (1.1)	526 (3.3)	13 (0.7)	547 (5.1)
Switzerland	10 (0.7)	508 (7.0)	22 (1.1)	543 (4.1)	48 (0.9)	549 (3.2)	20 (0.8)	563 (4.6)
Thailand	3 (0.4)	502 (11.6)	15 (1.1)	504 (5.8)	59 (1.3)	519 (5.5)	23 (1.5)	548 (7.9)
United States	12 (0.7)	463 (5.2)	17 (0.7)	492 (5.2)	47 (0.8)	504 (4.8)	23 (1.0)	519 (6.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.3

Gender Differences in Liking Mathematics
Upper Grade (Eighth Grade*)



*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 4.15

Students' Overall Attitudes[1] Towards Mathematics Upper Grade (Eighth Grade*)

Country	Strongly Negative		Negative		Positive		Strongly Positive	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	4 (0.3)	492 (8.3)	32 (0.9)	514 (4.5)	55 (0.8)	540 (4.3)	9 (0.6)	561 (5.9)
Austria	4 (0.5)	527 (11.1)	38 (1.1)	532 (4.1)	47 (0.9)	542 (3.5)	12 (0.9)	560 (7.4)
Belgium (Fl)	4 (0.5)	535 (10.7)	33 (1.1)	547 (5.2)	52 (1.2)	572 (6.4)	11 (0.9)	604 (8.8)
Belgium (Fr)	3 (0.5)	507 (10.0)	28 (1.3)	514 (5.4)	53 (1.4)	526 (4.0)	15 (0.9)	558 (5.4)
Canada	3 (0.3)	510 (9.1)	23 (0.8)	512 (3.5)	58 (0.7)	528 (2.7)	16 (0.7)	554 (3.3)
Colombia	1 (0.5)	~ ~	11 (1.2)	387 (8.2)	61 (1.5)	385 (3.7)	26 (1.2)	387 (5.9)
Cyprus	2 (0.4)	~ ~	19 (1.1)	435 (3.3)	53 (0.9)	471 (2.6)	26 (1.0)	513 (3.8)
Czech Republic	3 (0.3)	543 (10.4)	39 (1.4)	544 (6.1)	52 (1.4)	574 (5.6)	6 (0.6)	613 (10.1)
Denmark	1 (0.2)	~ ~	16 (1.1)	479 (4.8)	57 (1.3)	502 (3.5)	26 (1.4)	523 (4.7)
England	1 (0.3)	~ ~	17 (1.0)	497 (5.9)	64 (1.1)	509 (3.0)	18 (1.0)	514 (6.0)
France	3 (0.5)	520 (7.7)	27 (1.5)	518 (4.5)	54 (1.1)	543 (3.2)	16 (1.0)	564 (5.7)
Germany	5 (0.5)	498 (8.0)	38 (1.4)	498 (5.2)	43 (1.1)	518 (5.3)	13 (0.8)	521 (6.3)
Greece	2 (0.3)	~ ~	21 (0.8)	467 (3.9)	57 (0.9)	482 (3.7)	20 (0.8)	512 (3.7)
Hong Kong	3 (0.4)	530 (16.4)	31 (1.0)	561 (7.8)	57 (1.1)	601 (6.1)	9 (0.6)	640 (6.6)
Hungary	2 (0.3)	~ ~	38 (1.2)	518 (4.1)	53 (1.3)	547 (3.7)	7 (0.6)	592 (7.2)
Iceland	2 (0.5)	~ ~	24 (1.6)	478 (5.5)	59 (1.5)	489 (4.9)	14 (1.2)	499 (6.5)
Iran, Islamic Rep.	2 (0.3)	~ ~	15 (1.2)	409 (3.1)	54 (1.6)	426 (2.7)	30 (1.3)	446 (2.9)
Ireland	2 (0.3)	~ ~	26 (1.1)	515 (5.3)	59 (1.2)	530 (5.3)	13 (0.9)	551 (8.1)
Israel	2 (0.5)	~ ~	25 (1.9)	523 (7.9)	56 (1.7)	524 (6.4)	17 (1.4)	527 (8.8)
Japan	4 (0.4)	558 (7.1)	44 (1.2)	592 (2.7)	48 (1.3)	619 (2.0)	3 (0.2)	649 (8.7)
Korea	2 (0.2)	~ ~	48 (1.1)	581 (3.0)	46 (1.1)	630 (3.4)	5 (0.4)	680 (9.9)
Kuwait	3 (0.5)	372 (8.3)	15 (1.5)	385 (4.2)	48 (1.5)	390 (3.1)	34 (2.2)	400 (3.0)
Latvia (LSS)	1 (0.2)	~ ~	28 (1.3)	478 (4.1)	62 (1.3)	496 (3.7)	8 (0.7)	526 (5.9)
Lithuania	2 (0.4)	~ ~	38 (1.3)	467 (3.9)	53 (1.4)	480 (4.1)	7 (0.6)	513 (9.3)
Netherlands	4 (0.5)	506 (14.7)	40 (1.9)	526 (9.1)	50 (1.8)	554 (6.2)	6 (0.8)	570 (10.6)
New Zealand	2 (0.3)	~ ~	23 (0.9)	491 (4.4)	60 (0.9)	511 (5.0)	15 (0.8)	530 (6.4)
Norway	3 (0.3)	456 (8.3)	30 (0.9)	481 (2.9)	55 (0.8)	511 (2.7)	12 (0.7)	538 (4.6)
Portugal	2 (0.3)	~ ~	24 (1.2)	436 (3.0)	58 (1.0)	456 (2.5)	16 (1.1)	480 (3.9)
Romania	1 (0.1)	~ ~	25 (1.0)	465 (5.7)	60 (1.0)	480 (4.2)	15 (0.9)	520 (6.2)
Russian Federation	1 (0.2)	~ ~	24 (1.1)	512 (5.4)	63 (1.2)	538 (6.1)	12 (0.8)	570 (5.5)
Scotland	7 (0.6)	458 (6.4)	19 (0.9)	493 (5.3)	57 (1.0)	498 (6.0)	17 (1.0)	529 (9.8)
Singapore	1 (0.2)	~ ~	16 (0.8)	609 (6.2)	62 (0.9)	646 (4.9)	20 (1.0)	666 (5.7)
Slovak Republic	1 (0.3)	~ ~	30 (1.0)	516 (3.7)	60 (1.0)	556 (3.7)	9 (0.6)	601 (5.4)
Slovenia	3 (0.4)	535 (11.2)	33 (1.3)	519 (3.7)	57 (1.4)	546 (3.5)	8 (0.7)	601 (6.8)
Spain	3 (0.4)	459 (5.9)	33 (1.0)	474 (2.8)	52 (1.0)	491 (2.2)	13 (0.8)	513 (4.3)
Sweden	2 (0.3)	~ ~	33 (1.1)	503 (3.3)	55 (0.9)	523 (3.2)	10 (0.7)	553 (5.0)
Switzerland	3 (0.3)	532 (9.2)	28 (1.1)	540 (4.1)	53 (1.2)	549 (3.0)	16 (0.6)	554 (5.5)
Thailand	0 (0.1)	~ ~	12 (1.1)	503 (7.3)	72 (1.0)	520 (5.3)	16 (1.2)	551 (9.1)
United States	4 (0.3)	481 (7.5)	26 (0.9)	483 (5.0)	55 (1.0)	503 (4.8)	15 (0.7)	526 (6.8)

[1]Index of overall attitudes towards mathematics is based on average of responses to the following statements: 1) I would like a job that involved using mathematics; 2) Mathematics is important to everyone's life; 3) Mathematics is boring (reversed scale); 4) I enjoy learning mathematics; 5) I like mathematics.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

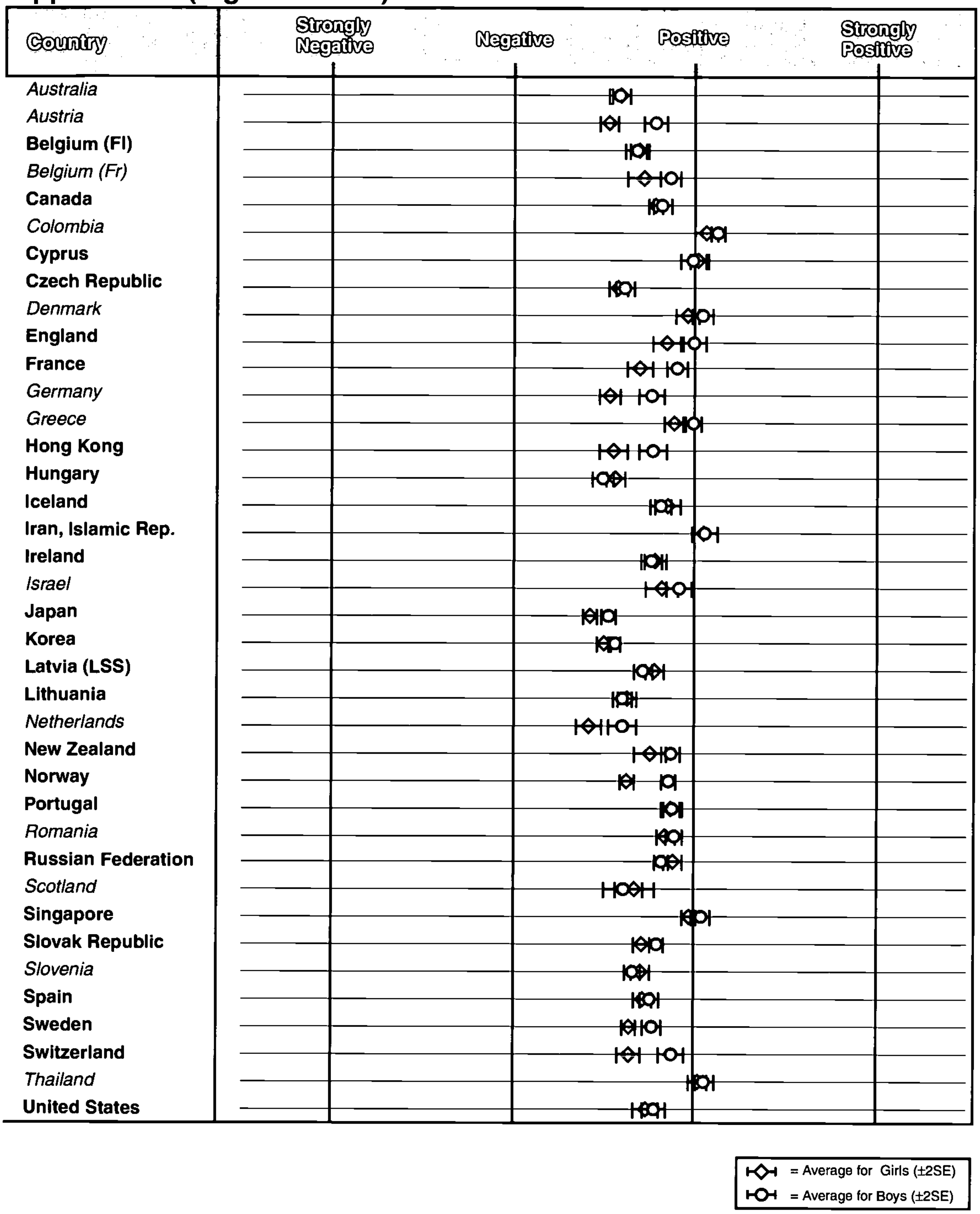
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.4

Gender Differences in Students' Overall Attitudes[1] Towards Mathematics Upper Grade (Eighth Grade*)



[1]Index of overall attitudes towards mathematics is based on average of responses to the following statements: 1) I would like a job that involved using mathematics; 2) Mathematics is important to everyone's life; 3) Mathematics is boring (reversed scale); 4) I enjoy learning mathematics; 5) I like mathematics.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Chapter 5

Teachers and Instruction

Teachers and the instructional approaches they use are fundamental in building students' mathematical understanding. Primary among their many duties and responsibilities, teachers structure and guide the pace of individual, small-group, and whole-class work to present new material, engage students in mathematical tasks, and help deepen students' grasp of the mathematics being studied. Teachers may help students use technology and tools to investigate mathematical ideas, analyze students' work for misconceptions, and promote positive attitudes about mathematics. They also may assign homework and conduct informal as well as formal assessments to monitor progress in student learning, make ongoing instructional decisions, and evaluate achievement outcomes.

Effective teaching is a complex endeavor requiring knowledge about the subject matter of mathematics, the ways students learn, and effective pedagogy in mathematics. It can be fostered through institutional support and adequate resources. Teachers also can support each other in planning instructional strategies, devising real-world applications of mathematical concepts, and developing sequences that move students from concrete tasks to the ability to think for themselves and explore mathematical theories.

TIMSS administered a background questionnaire to teachers to gather information about their backgrounds, training, and how they think about mathematics. The questionnaire also asked about how they spend their time related to their teaching tasks and the instructional approaches they use in their classrooms. Information was collected about the materials used in instruction, the activities students do in class, the use of calculators and computers in mathematics lessons, the role of homework, and the reliance on different types of assessment approaches.

This chapter presents the results of teachers' responses to some of these questions. Because the sampling for the teacher questionnaires was based on participating students, the responses to the mathematics teacher questionnaire do not necessarily represent all of the eighth-grade mathematics teachers in each of the TIMSS countries. Rather, they represent teachers of the representative samples of students assessed. It is important to note that in this report, the student is always the unit of analysis, even when information from the teachers' questionnaires is being reported. Using the student as the unit of analysis makes it possible to describe the instruction received by representative samples of students. Although this approach may provide a different perspective from that obtained by simply collecting information from teachers, it is consistent with the TIMSS goals of providing information about the educational contexts and performance of students.

Because countries were required to sample two classes (from adjacent grades), it was possible for an individual to be the mathematics or science teacher of both classes. In order to keep the response burden for teachers to a minimum, no teacher was asked to respond to more than one questionnaire, even where that teacher taught mathematics or science to more than one of the sampled classes. This, together with the fact that teachers sometimes did not complete the questionnaire assigned to them, meant that each country had some percentage of students for whom no teacher questionnaire information was available. The tables in this chapter contain special notation regarding the availability of teacher responses. For a country where teacher responses are available for 70% to 84% of the students, an "r" is included next to the data for that country. When teacher responses are available for 50% to 69% of the students, an "s" is included next to the data for that country. When teacher responses are available for less than 50% of the students, an "x" replaces the data.[1]

Who Delivers Mathematics Instruction?

This section provides information about the mathematics teaching force in each of the participating countries, in terms of certification, degrees, age, gender, and years of teaching experience.

Table 5.1 summarizes information gathered from each country about the requirements for certification held by the majority of the seventh- and eighth-grade teachers. In many countries, the type of education required for qualification includes a university degree. In other countries, study at a teacher training institution is required, or even both a university degree and study at a teacher training institution. The number of years of post secondary education required for a teaching qualification ranged from two years in Iran to as much as six years in Canada, although many countries reported four years. All of the countries except Colombia, Cyprus, Greece, and Lithuania reported that teaching practice was required. A large number of countries reported that an evaluation or examination was required for certification. Those countries not having such a requirement included Canada, Colombia, Cyprus, Greece, Iran, Israel, Korea, Portugal, and the United States.

Table 5.2 contains teachers' reports on their age and gender. If a constant supply of teachers were entering the teaching force, devoting their careers to the classroom, and then retiring, one might expect approximately equivalent percentages of students taught by teachers in their 20s, 30s, 40s, and 50s. However, this does not appear to hold for most countries. In most countries, the majority of the eighth-grade students were taught by teachers in their 30s or 40s. Very few countries seemed to have a comparatively younger teaching force, but those that did included Hong Kong, Iran, Kuwait, and Portugal. In these four countries, 40% or more of the students had mathematics teachers 29 years or younger and 70% had teachers in their 30s or younger. According to teachers' reports, the teaching force in eighth-grade mathematics was comparatively older in a number of countries. The TIMSS participants

[1] Similar to Chapter 4, background data are not available for Bulgaria and South Africa.

where 70% or more of the eighth-grade students had mathematics teachers in their 40s or older included the Czech Republic, Denmark, France, Germany, Norway, Romania, the Slovak Republic, and Spain.

In about one-fourth of the countries, approximately equivalent percentages of eighth-grade students were taught mathematics by male teachers and female teachers. However, at least 70% of the eighth-grade students had female mathematics teachers in the Czech Republic, Hungary, Israel, Latvia (LSS), Lithuania, the Russian Federation, the Slovak Republic, and Slovenia. In contrast, at least 70% of the students had male teachers in Greece, Japan, the Netherlands, and Switzerland.

As might be expected from the differences in teachers' ages from country to country, the TIMSS data indicate differences in teachers' longevity across countries (see Table 5.3). Those countries with younger teaching forces tended to have more students taught by less experienced teachers. At least half the eighth-grade students had mathematics teachers with 10 years or less of experience in Hong Kong, Iran, Korea, Kuwait, Portugal, and Thailand. In contrast, at least half the students had mathematics teachers with more than 20 years of experience in Belgium (French), the Czech Republic, France, Romania, the Slovak Republic, and Spain.

The relationship between years of teaching experience and mathematics achievement was not consistent across countries. In about one-fourth of the countries, the eighth-grade students with the most experienced teachers (more than 20 years) had higher mathematics achievement than did those with less experienced teachers (5 years or fewer). This may reflect the practice of giving teachers with more seniority the more advanced classes. However, in several countries, this pattern of higher student performance for the more experienced teachers was reversed. For another one-fourth of the countries or so, there was essentially no difference in student performance in relation to years of teaching experience. For the remaining countries, there were inconsistent patterns of performance differences in relation to years of teaching experience.

Table 5.1

Requirements for Certification Held by the Majority of Lower- and Upper-Grade (Seventh and Eighth Grade*) Teachers[1]

Country	Type of Education Required for Qualification	Number of Years of Post-Secondary Education Required	Teaching or Practice Experience Required	Evaluation or Examination Required
Australia	University or Teacher Training Institution	4	yes	yes
Austria	Teacher Training Institution: Teachers in the general secondary schools (70%) are required to have an education from a teacher training institution. Teachers in the academic secondary schools (30%) are required to have a university education.	3–5	yes	yes
Belgium (Fl)	Teacher Training Institution	3	yes	yes
Belgium (Fr)	Teacher Training Institution	3	yes	yes
Bulgaria	University	5	yes	yes
Canada	University	5–6	yes	no
Colombia	University	4	no	no
Cyprus	University	4	no	no
Czech Republic	University	4–5	yes	yes
Denmark	Teacher Training Institution	4	yes	yes
England	University or Higher Education Institution: Teachers of lower- and upper-grade students normally study their specialist subject area for their degree for 3 or 4 years. This is followed by a one-year post graduate course. However, some teachers study education and specialty concurrently. All teachers who qualified since 1975 are graduates. Some teachers who qualified before this date hold teacher certificates but are not graduates.	3–5	yes	yes
France	University and Teacher Training: As of 1991, teachers of lower- and upper-grade students are required to have a 3-year university diploma, followed by a competitive examination and professional training. The majority of teachers (more than 50%) meet the requirements (more in the public schools than in the private sector). Yet, there are still many teachers recruited before 1991 who do not have the same level of qualification.	4 or 5	yes	yes
Germany	University and Post-University Teacher Training Institution	3–5 +2 years	yes	yes
Greece	University	4	no	no
Hong Kong	University and one year Post-Graduate training	4	yes	yes
Hungary	Teacher Training Institution	4	yes	yes
Iceland	University	3	yes	yes
Iran	Teacher Training Institution	2	yes	no
Ireland	University with Post Graduate University Training	4–5	yes	yes
Israel	University	4	yes	no
Japan	University	4	yes	yes

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
[1]Certification pertains to the majority (more than 50%) of teachers of lower- and upper-grade students in each country.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Table 5.1 (Continued)

Requirements for Certification Held by the Majority of Lower- and Upper-Grade (Seventh and Eighth Grade*) Teachers[1]

Country	Type of Education Required for Qualification	Number of Years of Post-Secondary Education Required	Teaching or Practice Experience Required	Evaluation or Examination Required
Korea	University	4	yes	no
Kuwait	University	4	yes	yes
Latvia	Pedagogical Institution	4	yes	yes
Lithuania	University or Teacher Training Institution	5	no	yes
Netherlands	Teacher Training Institution	4	yes	yes
New Zealand	Teacher Training Institution or University with Teacher Training Institution: Teachers of students in the lower grade are required to attend a teacher training institution. Teachers in the upper grade are required to have a university and teacher training institution education.	3 (lower gr.) 4 (upper gr.)	yes	yes
Norway	Teacher Training Institution or University: Most teachers of students in the lower grade have a certificate from a teacher training institution. For teachers of students in the upper grade there is about an equal distribution between those who attended a teacher training institution and those who attended university.	3–4[2]	yes	yes
Philippines	Teacher Training Institution or University	4	yes	yes
Portugal	University	3–5	yes	no
Romania	University	4–5	yes	yes
Russian Federation	University or Teacher Training Institution or Post-Graduate University Training	4–5	yes	yes
Scotland	University or Teacher Training Institution	4	yes	yes
Singapore	Post-Graduate University Training	4–5	yes	yes
Slovak Republic	Teacher Training Institution or University	4–5[3]	yes	yes
Slovenia	University	4–5	yes	yes
South Africa	Teacher Training Institution	3	yes	yes
Spain	Teacher Training Institution or University	3	yes	yes
Sweden	Teacher Training Institution (lower grade) University (upper grade)	3-3.5 (lower gr.)[4] 4-4.5 (upper gr.)	yes	yes
Switzerland	University or Teacher Training Institution	2–4	yes	yes
Thailand	Teacher Training Institution or University	4	yes	yes
United States	University	4	yes	no

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
[1]Certification pertains to the majority (more than 50%) of teachers of lower- and upper-grade students in each country.
[2]Norway: Until 1965 2 years of post-secondary education were required. Between 1965 and 1995 3 years were required. As of 1996, new certified teachers are required to have completed 4 years of post-secondary education.
[3]Slovak Republic: In the past, 4 years of study at a teacher training institution were required. Currently, the requirement is 5 years at a teacher training institution or university.
[4]Sweden: Until 1988 3 years of post-secondary education were required for lower-grade teachers and 4 years for upper-grade teachers. Since 1988 3.5 years of post-secondary education are required for lower-grade teachers and 4-4.5 years are required for upper-grade teachers.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Table 5.2

Teachers' Reports on Their Age and Gender Mathematics - Upper Grade (Eighth Grade*)

Country		Percent of Students Taught by Teachers 29 Years or Under	30 - 39 Years	40 - 49 Years	50 Years or Older		Percent of Students Taught by Teachers Female	Male
Australia		22 (2.6)	27 (3.2)	41 (3.3)	10 (1.9)		44 (3.3)	56 (3.3)
Austria	r	9 (2.6)	38 (3.8)	42 (4.6)	10 (2.7)	r	48 (4.4)	52 (4.4)
Belgium (Fl)		13 (3.1)	28 (4.2)	30 (4.2)	29 (4.9)		66 (4.3)	34 (4.3)
Belgium (Fr)	s	5 (2.3)	26 (5.0)	46 (6.0)	23 (5.1)	s	51 (5.5)	49 (5.5)
Canada		15 (2.4)	21 (3.1)	39 (3.9)	26 (3.2)		38 (4.3)	62 (4.3)
Colombia		23 (4.4)	25 (4.1)	40 (4.5)	12 (2.9)		34 (4.2)	66 (4.2)
Cyprus		0 (0.0)	38 (4.7)	47 (5.2)	15 (3.5)	r	61 (5.6)	39 (5.6)
Czech Republic		8 (2.4)	20 (3.6)	41 (4.7)	31 (4.8)		82 (3.2)	18 (3.2)
Denmark		2 (1.4)	22 (4.0)	52 (4.7)	24 (4.0)		35 (4.5)	65 (4.5)
England	s	17 (2.5)	23 (3.1)	43 (2.8)	17 (2.4)	s	45 (3.6)	55 (3.6)
France		11 (2.7)	17 (3.7)	48 (5.0)	24 (3.8)		43 (4.5)	57 (4.5)
Germany	s	0 (0.0)	13 (3.5)	36 (5.2)	51 (5.3)	s	33 (4.9)	67 (4.9)
Greece		0 (0.4)	33 (4.4)	54 (4.2)	12 (4.2)		30 (3.8)	70 (3.8)
Hong Kong		48 (6.1)	29 (5.1)	11 (3.7)	12 (3.8)		40 (5.2)	60 (5.2)
Hungary		10 (2.5)	31 (4.4)	42 (4.4)	18 (3.1)		87 (3.1)	13 (3.1)
Iceland	r	12 (4.9)	39 (7.0)	29 (6.0)	20 (6.9)	r	39 (5.6)	61 (5.6)
Iran, Islamic Rep.		44 (4.8)	36 (5.1)	17 (3.0)	2 (1.6)		37 (4.8)	63 (4.8)
Ireland		17 (3.6)	34 (4.3)	35 (4.1)	14 (3.1)		58 (4.0)	42 (4.0)
Israel	r	12 (4.8)	27 (7.3)	41 (7.8)	20 (6.3)	r	95 (2.4)	5 (2.4)
Japan		22 (3.2)	43 (3.7)	25 (3.5)	10 (2.5)		28 (3.8)	72 (3.8)
Korea		26 (3.7)	43 (4.4)	12 (3.2)	19 (3.0)		45 (3.9)	55 (3.9)
Kuwait		40 (8.1)	40 (7.6)	16 (3.5)	3 (2.8)		51 (7.8)	49 (7.8)
Latvia (LSS)		15 (3.5)	41 (5.1)	20 (3.8)	24 (4.2)		90 (2.8)	10 (2.8)
Lithuania		8 (2.3)	36 (4.1)	22 (3.5)	34 (4.4)		87 (2.6)	13 (2.6)
Netherlands		6 (2.5)	33 (5.2)	50 (5.2)	11 (2.9)		22 (4.1)	78 (4.1)
New Zealand		12 (2.5)	38 (4.2)	35 (3.8)	15 (3.3)		42 (4.1)	58 (4.1)
Norway		7 (2.1)	23 (3.8)	39 (4.1)	31 (3.5)		32 (3.9)	68 (3.9)
Portugal		45 (4.5)	35 (4.1)	14 (2.2)	6 (2.2)		68 (3.8)	32 (3.8)
Romania		11 (2.4)	18 (3.1)	41 (4.3)	30 (4.0)		64 (4.0)	36 (4.0)
Russian Federation		18 (3.6)	29 (3.3)	33 (3.1)	21 (3.2)		97 (1.2)	3 (1.2)
Scotland		14 (3.3)	28 (4.4)	40 (4.9)	18 (3.2)		45 (4.6)	55 (4.6)
Singapore		26 (4.1)	18 (3.2)	33 (4.6)	23 (3.8)		60 (4.5)	40 (4.5)
Slovak Republic		7 (2.0)	22 (3.6)	50 (4.7)	22 (3.7)		79 (3.9)	21 (3.9)
Slovenia	r	9 (3.0)	59 (4.9)	22 (4.4)	10 (2.5)	r	87 (3.6)	13 (3.6)
Spain		0 (0.4)	24 (3.6)	48 (4.3)	28 (3.7)		37 (4.1)	63 (4.1)
Sweden		10 (2.2)	22 (3.5)	27 (3.2)	41 (4.3)		33 (3.3)	67 (3.3)
Switzerland		10 (3.5)	27 (3.9)	37 (4.4)	25 (3.9)		13 (2.3)	87 (2.3)
Thailand	r	25 (5.0)	43 (6.2)	29 (6.2)	3 (2.3)	r	61 (6.2)	39 (6.2)
United States		17 (3.0)	19 (3.2)	44 (4.4)	19 (2.9)		65 (4.0)	35 (4.0)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.3

Teachers' Reports on Their Years of Teaching Experience Mathematics - Upper Grade (Eighth Grade*)

Country		0 - 5 Years		6-10 Years		11-20 Years		More than 20 Years	
		Percent of Students	Mean Achieve-ment	Percent of Students	Mean Achieve-ment	Percent of Students	Mean Achieve-ment	Percent of Students	Mean Achieve-ment
Australia		18 (2.3)	517 (8.5)	19 (2.6)	528 (11.6)	35 (2.7)	540 (8.5)	28 (2.6)	533 (8.5)
Austria	r	7 (2.3)	516 (19.7)	13 (2.5)	546 (9.5)	51 (4.0)	554 (6.7)	28 (3.6)	549 (8.8)
Belgium (Fl)		10 (2.8)	556 (17.9)	9 (2.2)	590 (14.5)	32 (4.8)	554 (13.4)	49 (4.9)	575 (10.6)
Belgium (Fr)	s	8 (3.2)	536 (12.3)	8 (2.3)	528 (13.8)	31 (5.2)	558 (7.0)	54 (4.8)	543 (6.4)
Canada		17 (2.6)	527 (6.7)	15 (2.9)	527 (5.0)	22 (3.6)	526 (7.6)	46 (3.8)	528 (3.8)
Colombia		18 (3.0)	409 (7.7)	22 (5.0)	375 (11.7)	27 (4.3)	385 (6.0)	33 (4.2)	385 (5.0)
Cyprus	r	30 (4.6)	474 (4.6)	19 (4.3)	474 (7.6)	25 (5.0)	467 (6.4)	26 (4.7)	471 (5.5)
Czech Republic		12 (3.1)	566 (17.7)	9 (1.9)	538 (8.6)	17 (4.1)	584 (11.4)	62 (4.7)	562 (5.7)
Denmark		4 (1.9)	487 (2.6)	4 (2.0)	493 (14.4)	47 (4.9)	504 (3.3)	45 (4.8)	508 (4.4)
England	s	19 (2.5)	522 (10.8)	11 (2.1)	518 (13.5)	39 (3.5)	512 (8.1)	31 (3.0)	515 (11.3)
France		11 (2.5)	539 (8.1)	11 (3.1)	529 (10.2)	26 (4.6)	540 (8.8)	52 (4.3)	538 (5.4)
Germany	s	10 (2.2)	534 (14.5)	14 (4.3)	471 (12.1)	32 (5.1)	521 (10.6)	44 (5.5)	516 (9.3)
Greece		16 (3.1)	464 (7.2)	20 (3.4)	469 (5.3)	47 (4.3)	490 (3.5)	17 (4.4)	503 (11.9)
Hong Kong		53 (5.9)	585 (9.7)	14 (3.3)	606 (16.3)	18 (4.2)	574 (19.2)	15 (3.9)	596 (19.8)
Hungary		13 (2.9)	530 (12.7)	10 (2.8)	510 (7.4)	38 (4.1)	537 (5.6)	38 (4.1)	547 (5.2)
Iceland	r	19 (5.1)	478 (5.3)	14 (3.8)	480 (8.5)	33 (7.1)	492 (7.3)	35 (7.7)	496 (10.6)
Iran, Islamic Rep.		38 (4.5)	417 (3.7)	24 (4.8)	437 (3.8)	24 (4.3)	433 (3.2)	14 (3.0)	440 (4.8)
Ireland		13 (3.0)	513 (16.3)	18 (3.5)	512 (12.5)	42 (4.5)	535 (8.4)	28 (4.5)	523 (10.0)
Israel	r	16 (6.1)	490 (9.1)	12 (4.3)	555 (15.9)	45 (7.4)	510 (8.3)	27 (7.4)	548 (13.7)
Japan		19 (3.3)	606 (5.0)	25 (3.5)	607 (4.3)	36 (3.8)	598 (3.5)	19 (2.9)	614 (4.0)
Korea		28 (3.5)	610 (4.7)	29 (3.9)	622 (5.6)	23 (3.7)	597 (5.6)	20 (3.1)	606 (5.5)
Kuwait	r	30 (6.7)	397 (3.3)	33 (5.5)	388 (3.4)	31 (7.0)	388 (4.1)	6 (4.1)	418 (8.5)
Latvia (LSS)		12 (3.4)	496 (7.0)	16 (3.4)	482 (8.8)	38 (5.0)	496 (5.5)	34 (5.1)	490 (5.8)
Lithuania	r	5 (1.8)	455 (9.2)	15 (3.3)	465 (11.0)	33 (4.2)	482 (8.4)	47 (4.3)	481 (5.2)
Netherlands		13 (3.6)	530 (19.5)	21 (3.6)	525 (10.2)	42 (5.3)	548 (17.8)	24 (4.0)	556 (9.3)
New Zealand		17 (3.1)	497 (7.5)	28 (4.0)	515 (7.9)	34 (4.1)	517 (9.2)	20 (3.4)	487 (9.4)
Norway		12 (2.7)	499 (10.7)	10 (2.5)	500 (6.1)	35 (4.0)	508 (4.0)	43 (4.6)	503 (3.4)
Portugal		51 (4.7)	449 (3.0)	16 (3.1)	447 (5.4)	27 (3.9)	462 (4.3)	6 (2.3)	477 (8.6)
Romania		10 (2.3)	452 (14.2)	15 (3.1)	466 (9.9)	14 (3.1)	496 (12.8)	61 (4.2)	486 (5.7)
Russian Federation		16 (3.7)	541 (25.2)	14 (2.5)	532 (9.7)	29 (4.0)	526 (7.1)	41 (5.0)	538 (6.6)
Scotland		17 (3.4)	483 (9.2)	12 (3.2)	484 (14.3)	42 (4.4)	496 (8.5)	29 (4.3)	507 (12.3)
Singapore		30 (4.5)	617 (9.4)	11 (2.8)	658 (14.0)	11 (3.0)	664 (13.4)	48 (4.6)	652 (7.0)
Slovak Republic		6 (1.9)	556 (13.3)	15 (3.3)	531 (8.5)	21 (3.5)	539 (8.2)	58 (4.5)	553 (4.6)
Slovenia	r	4 (1.9)	537 (23.2)	19 (4.0)	533 (6.0)	55 (5.0)	542 (5.5)	22 (3.8)	550 (6.2)
Spain		3 (0.8)	472 (17.7)	8 (2.4)	487 (7.6)	39 (4.3)	488 (3.8)	50 (4.3)	488 (3.1)
Sweden		16 (2.4)	529 (7.1)	15 (2.8)	512 (9.5)	26 (3.1)	518 (6.2)	44 (4.1)	520 (4.4)
Switzerland		14 (3.3)	540 (10.1)	6 (1.8)	545 (19.0)	37 (4.6)	549 (8.4)	42 (4.9)	548 (7.4)
Thailand	s	48 (6.6)	517 (8.9)	12 (2.6)	499 (9.3)	35 (6.2)	540 (10.9)	5 (3.4)	615 (17.7)
United States		25 (3.4)	484 (6.3)	14 (2.7)	488 (9.8)	25 (3.2)	501 (7.3)	36 (3.3)	513 (7.5)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are Teachers' Perceptions About Mathematics?

Figure 5.1 depicts the percentages of eighth-grade students whose mathematics teachers reported certain beliefs about mathematics and the way mathematics should be taught. Teachers in many countries indicated a fairly practical view of mathematics, seeing it essentially as a way of modeling the real world. However, there was variation across countries in the amount of agreement with this view of the nature of mathematics. In Thailand and Iran, nearly all students had teachers who agreed or strongly agreed that mathematics is primarily a formal way of representing the real world, while in several of the Central or Eastern European countries (Slovenia, the Russian Federation, the Czech Republic, and Hungary), about 40% or fewer of the students' mathematics teachers agreed with this view.

There also appeared to be nearly uniform agreement by teachers across countries about the inherent nature of mathematical abilities. In most countries, 80% or more of the students had teachers who agreed that some students have a natural talent for mathematics.

Regarding perceptions about how to teach mathematics, teachers' opinions varied across countries concerning whether or not more practice during class is an effective approach to help students having difficulty. At least 80% of the eighth-grade students in the Czech Republic, Cyprus, Greece, Iran, the Slovak Republic, Thailand, Kuwait, Portugal, and Romania had teachers who agreed or strongly agreed with this approach. Conversely, fewer than 20% of the students in the Russian Federation and Norway had teachers who agreed with this approach.

There was nearly complete agreement by teachers across countries, however, that more than one representation should be used in teaching a mathematics topic. In only Hungary and Thailand did fewer than 80% of the eighth-grade students have teachers that agreed with this approach. This instructional approach is particularly useful in helping students with different learning styles understand key ideas. Also, using data in different formats reinforces the idea of mathematics as a network of interconnected concepts and procedures.

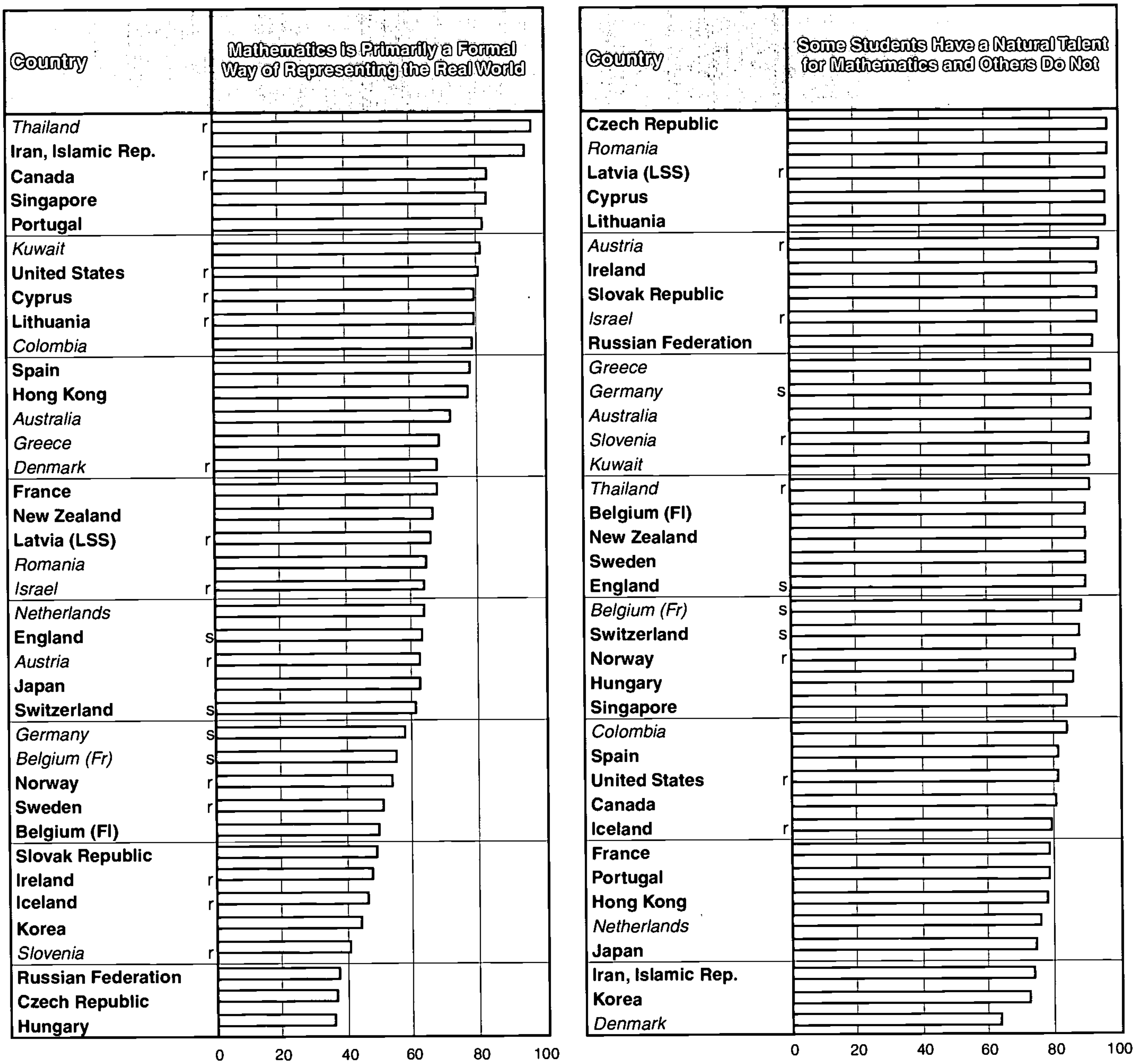
TIMSS also queried teachers about the cognitive demands of mathematics, asking them to rate the importance of various skills for success in the discipline. Figure 5.2 shows the percentages of students whose teachers rated each of four different skills as very important. Across the participating countries, the fewest students had teachers who felt the ability to remember formulas and procedures was very important. There was a range, however, with teachers of approximately 70% of the eighth-grade students in Kuwait and Ireland rating this ability as very important compared to those of fewer than 20% of the students in Slovenia, Sweden, Korea, Austria, Portugal, Israel, Denmark, the Czech Republic, and Switzerland.

Internationally, most mathematics teachers felt it was very important for students to be able to think creatively, to understand how mathematics is used in the real world, and to be able to provide reasons to support their solutions. However, there was some variation across countries. Fewer than 40% of the eighth-grade students in

Israel, Austria, Belgium (Flemish), Switzerland, Ireland, England, and France had teachers who felt it was very important to think creatively, and fewer than 40% in Latvia (LSS), Korea, Thailand, Belgium (Flemish), Hong Kong, France, Israel, the Netherlands, Switzerland, and Ireland had teachers who felt it was very important to understand how mathematics is used in the real world. With the current calls from business and industry for helping students improve their ability to apply mathematics and solve practical problems in job-related situations, it might be rather surprising that teachers in these countries do not place more importance on these latter two aspects of mathematics. In all countries except the Czech Republic, Switzerland, the Netherlands, and Austria, the majority of students had teachers who felt it was very important to be able to provide reasons to support mathematical solutions.

Figure 5.1

Percent of Students Whose Mathematics Teachers Agree or Strongly Agree with Statements About the Nature of Mathematics and Mathematics Teaching Upper Grade (Eighth Grade*)

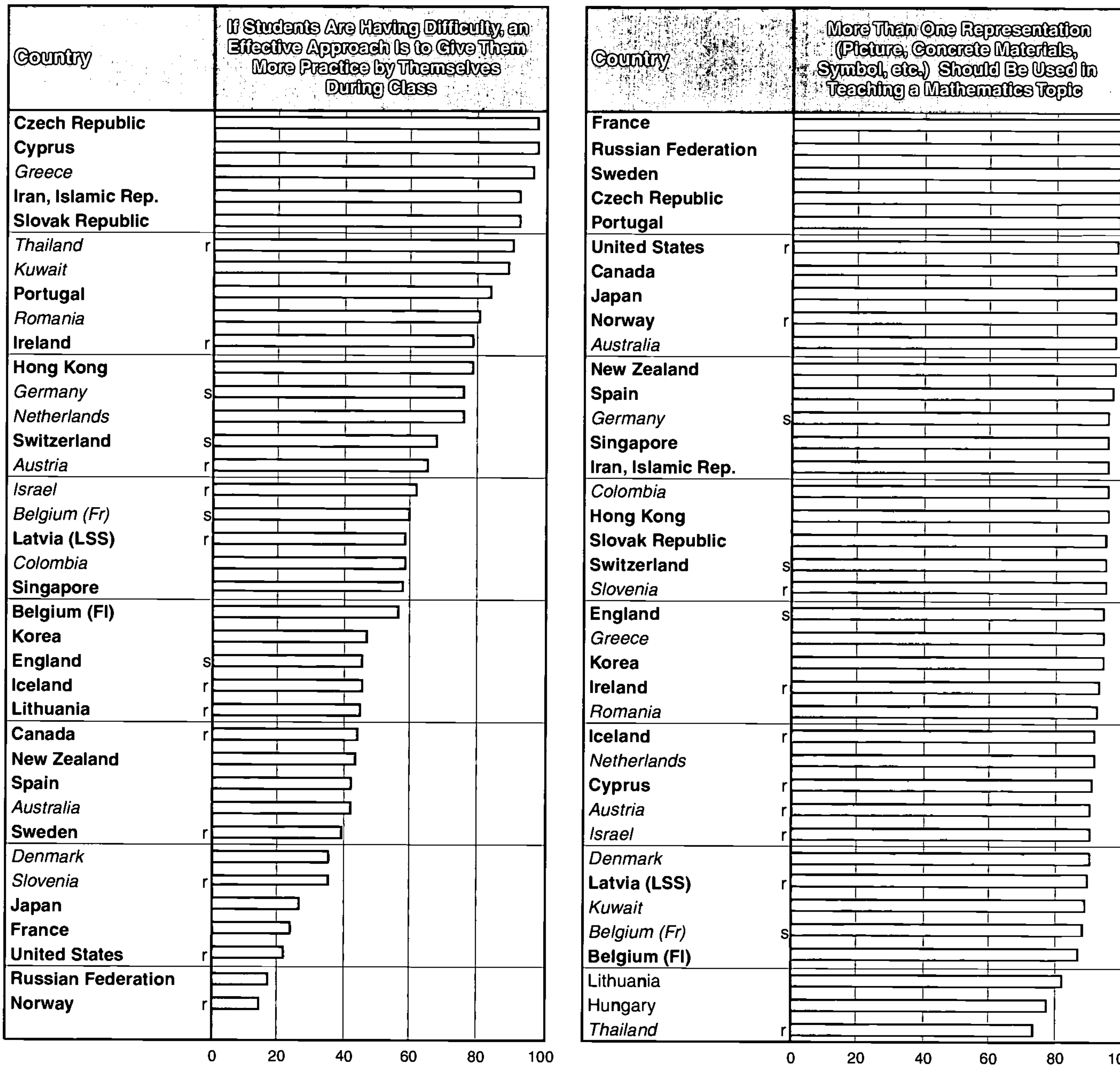


*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.1 (Continued)

Percent of Students Whose Mathematics Teachers Agree or Strongly Agree with Statements About the Nature of Mathematics and Mathematics Teaching Upper Grade (Eighth Grade*)

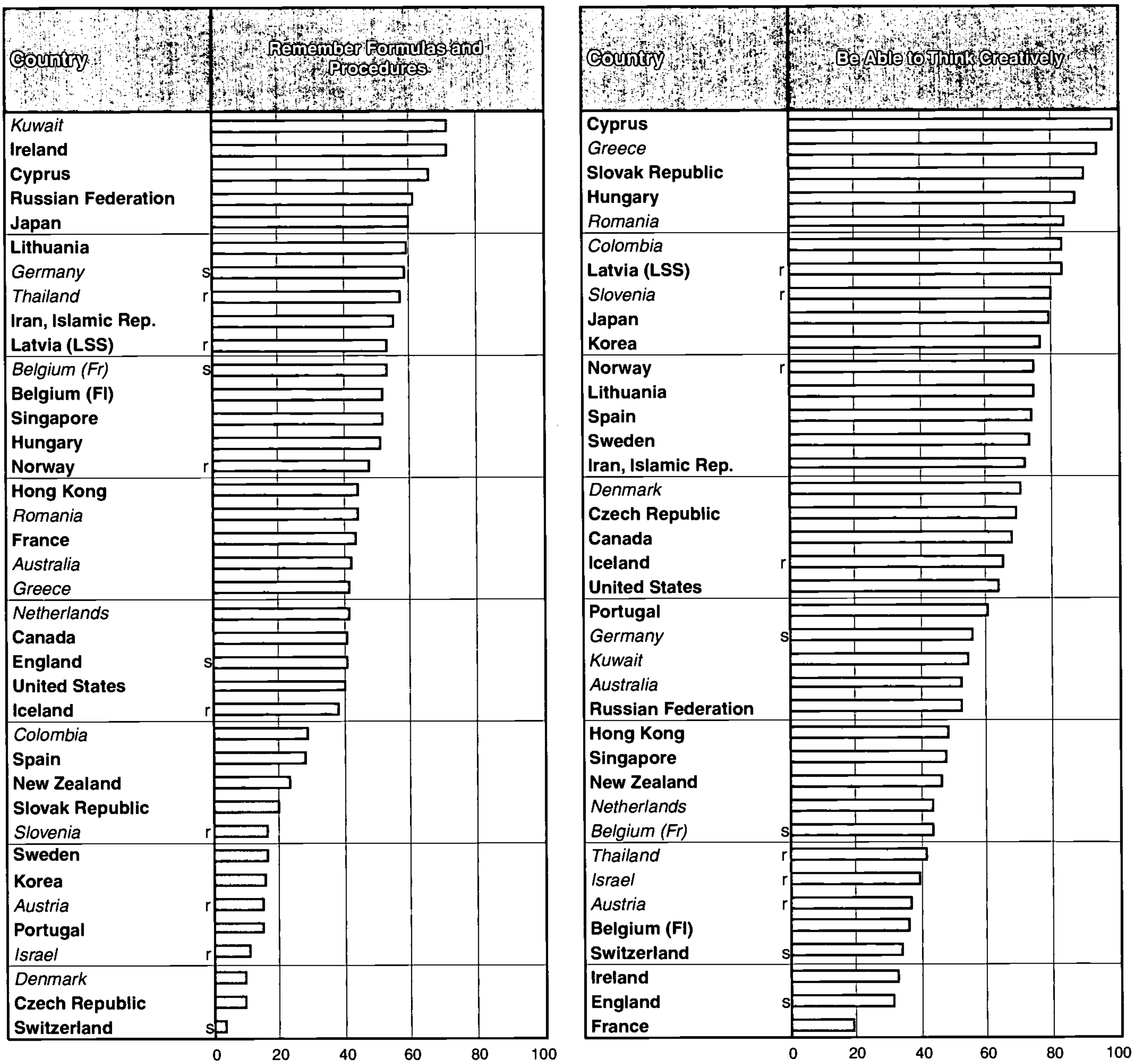


*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Scotland did not ask these questions. Hungary did not ask teachers their opinions about the effectiveness of more individual practice.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.2

Percent of Students Whose Mathematics Teachers Think Particular Abilities Are Very Important for Students' Success in Mathematics in School - Upper Grade (Eighth Grade*)

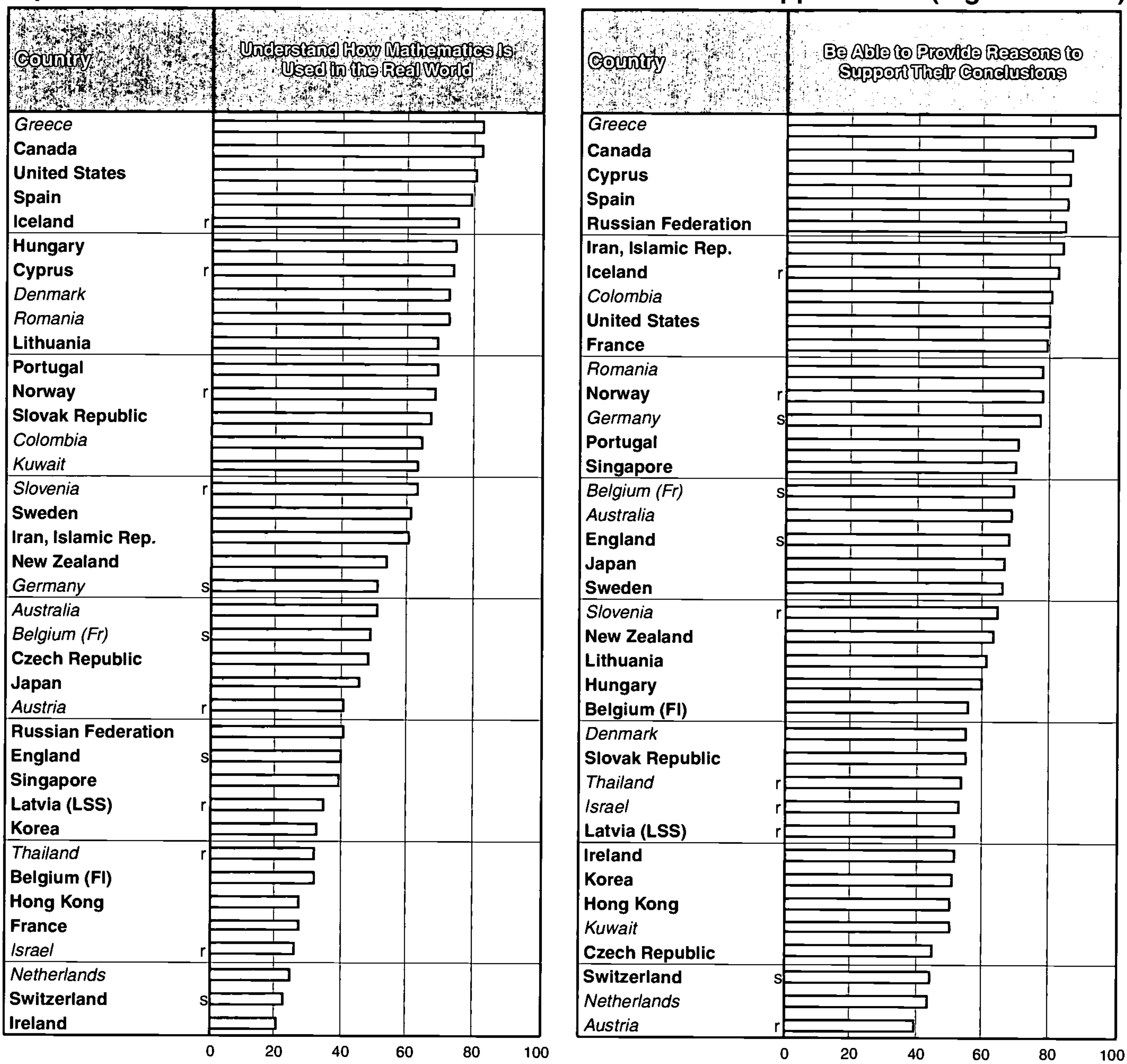


*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.2 (Continued)

Percent of Students Whose Mathematics Teachers Think Particular Abilities Are Very Important for Students' Success in Mathematics in School - Upper Grade (Eighth Grade*)



*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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How Do Mathematics Teachers Spend Their School-Related Time?

The data in Table 5.4 reveal that in a number of countries, eighth-grade mathematics teachers are specialists. In Belgium (Flemish), Belgium (French), Cyprus, England, France, Kuwait, Lithuania, the Netherlands, New Zealand, Portugal, the Russian Federation, Scotland, and Slovenia, the majority of eighth-grade students had teachers who spent at least 75% of their formally scheduled school time teaching mathematics.

For most participating countries, there was little difference in students' achievement according to whether they were taught by specialists. However, in some countries, such as Austria, England, France, Germany, Ireland, and Switzerland those students with specialists for teachers had higher average mathematics achievement. In Switzerland, this is at least partially because specialists teach the students in the higher tracks and generalists the students in lower tracks, and a similar situation may exist in the other countries displaying this relationship between achievement and degree of teaching specialization. Generally, it is important to keep in mind the complexity of the relationships between instruction and achievement. In tracked systems, many characteristics of instruction can be related to the track.

As shown in Table 5.5, teachers in most countries reported that mathematics classes typically meet for at least 2 hours per week, but less than 3.5 hours. However, from 3.5 up to nearly 5 hours of weekly class time was reported for 50% or more of the eighth-grade students in Belgium (Flemish), Belgium (French), Canada, Colombia, the Czech Republic, France, Hong Kong, Kuwait, Latvia (LSS), New Zealand, the Russian Federation, Scotland, the Slovak Republic, Spain, Switzerland, and the United States. The data reveal no clear pattern between the number of in-class instructional hours and mathematics achievement either across or between countries. Common sense and research both support the idea that increased time on task can yield commensurate increases in achievement, yet this time also can be spent outside of school on homework or in special tutoring. The ability to use straightforward analyses such as these to disentangle complicated relationships also is made difficult by the practice of providing additional in-school instruction for lower-performing students.

In addition to their formally scheduled duties, teachers were asked about the number of hours per week spent on selected school-related activities outside the regular school day. Table 5.6 presents the results. For example, on average, eighth-grade students in Australia had mathematics teachers who spent 2.3 hours per week preparing or grading tests, and another 1.8 hours per week reading and grading papers. Their teachers spent 2.6 hours per week on lesson planning and 1.7 hours combined on meetings with students and parents. They spent 0.9 hours on professional reading and development and 3 hours on record keeping and administrative tasks combined. Across countries, teachers reported that grading tests, grading student work, and lesson planning were the most time consuming activities, averaging as much as 10 hours per week in Singapore. In general, teachers also reported several hours per week spent on keeping students' records and other administrative tasks.

Opportunities to meet with colleagues to plan curriculum or teaching approaches enable teachers to expand their views of mathematics, their resources for teaching, and their repertoire of teaching and learning skills. Table 5.7 contains teachers' reports on how often they meet with other teachers in their subject area to discuss and plan curriculum or teaching approaches. Teachers of the majority of the students reported weekly or even daily planning meetings in Belgium (French), Colombia, Cyprus, the Czech Republic, England, Hungary, Israel, Kuwait, Latvia (LSS), Lithuania, Norway, Scotland, the Slovak Republic, Slovenia, and Sweden. In the remaining countries, however, most students had mathematics teachers who reported only limited opportunities to plan curriculum or teaching approaches with other teachers (monthly or even yearly meetings).

Table 5.4

Teachers' Reports on the Proportion of Their Formally Scheduled School Time Spent Teaching Mathematics[1] - Upper Grade (Eighth Grade*)

Country	Less Than 50 Percent		50-74 Percent		75-100 Percent	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	37 (3.1)	527 (5.4)	25 (3.2)	526 (8.2)	38 (3.6)	541 (8.8)
Austria	r 51 (3.3)	537 (6.3)	30 (3.1)	548 (7.8)	19 (3.2)	575 (13.8)
Belgium (Fl)	12 (3.0)	573 (16.9)	29 (4.4)	543 (14.0)	60 (4.4)	579 (9.2)
Belgium (Fr)	s 8 (3.0)	554 (9.6)	12 (4.0)	535 (14.1)	80 (4.9)	546 (4.5)
Canada	59 (3.3)	520 (3.2)	26 (3.2)	543 (7.7)	15 (2.2)	532 (7.2)
Colombia	34 (3.5)	381 (3.8)	36 (4.2)	402 (4.2)	30 (4.1)	384 (5.5)
Cyprus	r 3 (2.0)	472 (16.2)	6 (2.0)	472 (8.4)	91 (2.8)	471 (2.5)
Czech Republic	58 (4.7)	565 (7.0)	30 (4.5)	564 (9.7)	12 (3.3)	561 (7.8)
Denmark	65 (4.6)	505 (3.2)	27 (4.2)	499 (4.2)	8 (2.8)	519 (10.4)
England	s 10 (2.0)	495 (26.0)	21 (2.9)	499 (10.7)	69 (2.8)	524 (4.6)
France	6 (1.6)	496 (15.2)	9 (2.6)	529 (17.6)	85 (2.9)	542 (3.4)
Germany	s 49 (5.5)	499 (9.5)	35 (5.2)	518 (9.9)	17 (3.3)	552 (7.5)
Greece	- -	- -	- -	- -	- -	- -
Hong Kong	42 (6.1)	603 (10.0)	21 (5.1)	570 (15.1)	36 (4.8)	580 (11.7)
Hungary	- -	- -	- -	- -	- -	- -
Iceland	r 56 (6.6)	486 (4.9)	26 (8.2)	494 (8.7)	18 (6.5)	492 (18.8)
Iran, Islamic Rep.	23 (5.7)	430 (5.6)	32 (5.2)	431 (3.6)	45 (5.0)	430 (2.6)
Ireland	37 (4.3)	502 (9.5)	24 (3.6)	528 (10.7)	39 (4.7)	547 (8.9)
Israel	r 25 (6.7)	520 (15.9)	28 (7.8)	514 (14.0)	47 (8.4)	531 (9.8)
Japan	24 (3.3)	606 (6.0)	40 (4.0)	606 (4.5)	37 (3.5)	603 (4.3)
Korea	45 (4.5)	607 (4.1)	46 (4.5)	610 (4.1)	10 (2.6)	623 (8.3)
Kuwait	r 17 (5.8)	395 (5.5)	28 (6.9)	386 (3.9)	55 (8.0)	395 (4.3)
Latvia (LSS)	r 23 (4.2)	484 (6.5)	35 (4.5)	485 (6.4)	43 (4.9)	498 (4.5)
Lithuania	8 (1.9)	498 (7.3)	8 (2.1)	451 (9.4)	84 (2.9)	478 (4.4)
Netherlands	4 (2.0)	526 (44.0)	18 (4.5)	494 (25.9)	79 (4.9)	555 (6.8)
New Zealand	28 (3.5)	493 (8.2)	18 (3.4)	526 (12.6)	54 (4.0)	511 (6.1)
Norway	49 (4.4)	504 (3.5)	39 (4.5)	503 (3.6)	12 (2.5)	506 (3.9)
Portugal	5 (2.0)	452 (7.0)	15 (3.1)	447 (6.9)	80 (3.6)	456 (2.9)
Romania	73 (4.2)	485 (5.2)	20 (3.7)	480 (9.2)	6 (2.2)	437 (8.2)
Russian Federation	0 (0.2)	~ ~	2 (1.2)	~ ~	98 (1.2)	536 (5.4)
Scotland	r 2 (1.3)	~ ~	6 (2.4)	479 (36.5)	92 (2.7)	495 (6.4)
Singapore	22 (3.4)	626 (9.6)	53 (5.1)	658 (7.2)	25 (4.5)	630 (7.5)
Slovak Republic	61 (4.0)	547 (3.8)	26 (3.6)	544 (7.3)	13 (3.3)	553 (10.7)
Slovenia	r 14 (3.6)	550 (8.6)	22 (3.8)	531 (6.4)	63 (4.4)	543 (4.6)
Spain	69 (4.1)	487 (2.6)	26 (4.0)	486 (5.0)	5 (2.0)	499 (17.3)
Sweden	89 (2.3)	519 (3.2)	10 (2.1)	524 (10.2)	1 (0.8)	~ ~
Switzerland	52 (4.0)	532 (5.2)	30 (3.9)	552 (9.7)	18 (2.2)	579 (7.3)
Thailand	r 26 (5.6)	521 (14.6)	30 (5.0)	525 (11.8)	44 (5.9)	533 (9.7)
United States	38 (3.7)	494 (5.4)	31 (4.0)	506 (8.9)	31 (3.7)	501 (6.8)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
[1]Formally scheduled school time included time scheduled for teaching all subjects, as well as student supervision, student counseling/appraisal, administrative duties, individual curriculum planning, cooperative curriculum planning, and other non-student contact time.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.5

Teachers' Reports on Average Number of Hours Mathematics Is Taught Weekly to Their Mathematics Classes - Upper Grade (Eighth Grade*)

Country		Less Than 2 Hours		2 Hours to < 3.5		3.5 Hours to < 5		5 Hours or More	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r	5 (1.7)	528 (19.5)	50 (3.7)	518 (6.2)	44 (3.7)	552 (7.6)	1 (0.7)	~ ~
Austria	r	0 (0.0)	~ ~	99 (0.1)	549 (4.1)	1 (0.1)	~ ~	0 (0.0)	~ ~
Belgium (Fl)	s	0 (0.0)	~ ~	50 (4.4)	572 (5.6)	50 (4.4)	603 (5.4)	0 (0.0)	~ ~
Belgium (Fr)	s	0 (0.0)	~ ~	3 (1.8)	486 (12.9)	83 (4.2)	544 (4.7)	14 (3.8)	564 (10.0)
Canada		3 (1.2)	528 (11.8)	31 (3.8)	521 (5.0)	50 (3.6)	537 (4.3)	17 (3.1)	520 (10.2)
Colombia	r	4 (2.0)	389 (8.2)	25 (5.5)	367 (8.8)	58 (5.4)	397 (3.9)	13 (3.3)	390 (8.2)
Cyprus		x x	x x	x x	x x	x x	x x	x x	x x
Czech Republic		1 (0.9)	~ ~	6 (2.0)	587 (17.2)	90 (2.7)	561 (5.1)	3 (1.6)	535 (10.2)
Denmark		- -	- -	- -	- -	- -	- -	- -	- -
England		- -	- -	- -	- -	- -	- -	- -	- -
France	r	2 (1.4)	~ ~	10 (3.2)	532 (13.4)	87 (3.3)	539 (3.9)	2 (1.3)	~ ~
Germany	s	2 (1.5)	~ ~	85 (3.1)	523 (5.3)	12 (2.9)	463 (13.3)	1 (0.9)	~ ~
Greece		4 (1.7)	459 (10.8)	88 (2.8)	486 (3.5)	3 (1.6)	459 (12.3)	4 (1.6)	480 (8.9)
Hong Kong		5 (2.4)	612 (47.4)	26 (5.2)	590 (19.5)	63 (5.8)	590 (7.6)	6 (2.9)	567 (30.1)
Hungary		0 (0.0)	~ ~	75 (3.6)	538 (3.9)	23 (3.6)	536 (7.0)	1 (1.0)	~ ~
Iceland	r	0 (0.0)	~ ~	90 (2.9)	492 (5.3)	8 (2.9)	467 (3.5)	1 (0.2)	~ ~
Iran, Islamic Rep.		- -	- -	- -	- -	- -	- -	- -	- -
Ireland	r	1 (0.7)	~ ~	86 (3.7)	524 (6.4)	12 (3.4)	555 (15.2)	1 (1.1)	~ ~
Israel	r	6 (4.1)	523 (13.7)	41 (8.0)	520 (12.7)	47 (8.1)	514 (9.2)	6 (3.7)	579 (22.6)
Japan		4 (1.8)	607 (24.3)	91 (2.3)	602 (2.7)	4 (1.4)	649 (18.5)	0 (0.5)	~ ~
Korea		1 (0.7)	~ ~	90 (3.0)	610 (2.8)	5 (1.8)	608 (13.8)	5 (2.3)	604 (19.5)
Kuwait		2 (1.6)	~ ~	21 (6.5)	396 (6.8)	76 (6.6)	391 (2.3)	1 (1.0)	~ ~
Latvia (LSS)		1 (0.5)	~ ~	30 (4.8)	491 (5.8)	62 (5.3)	492 (4.3)	8 (2.6)	489 (15.0)
Lithuania		1 (0.8)	~ ~	61 (4.1)	482 (5.0)	29 (3.9)	481 (7.5)	9 (2.3)	448 (13.8)
Netherlands		3 (1.9)	529 (54.2)	97 (1.9)	542 (8.1)	0 (0.0)	~ ~	0 (0.0)	~ ~
New Zealand		5 (1.8)	484 (11.6)	42 (4.3)	514 (7.1)	50 (4.3)	507 (6.4)	3 (1.5)	503 (27.3)
Norway	r	7 (2.6)	502 (5.0)	80 (3.9)	508 (3.1)	8 (2.8)	502 (7.7)	5 (2.1)	513 (7.7)
Portugal		1 (0.8)	~ ~	89 (2.9)	455 (2.7)	10 (2.8)	452 (7.8)	0 (0.0)	~ ~
Romania		8 (2.6)	497 (17.6)	80 (3.4)	481 (5.0)	9 (2.5)	482 (12.4)	2 (0.6)	~ ~
Russian Federation		0 (0.0)	~ ~	17 (3.6)	519 (8.6)	70 (5.6)	533 (5.1)	14 (4.8)	567 (18.0)
Scotland		5 (2.0)	473 (14.7)	35 (4.4)	500 (11.6)	60 (4.6)	494 (7.1)	0 (0.0)	~ ~
Singapore		0 (0.0)	~ ~	52 (4.7)	654 (6.9)	48 (4.7)	633 (7.6)	0 (0.0)	~ ~
Slovak Republic		0 (0.0)	~ ~	2 (1.3)	~ ~	86 (3.0)	544 (3.2)	11 (2.9)	561 (11.0)
Slovenia	r	0 (0.0)	~ ~	87 (3.4)	542 (4.0)	12 (3.3)	525 (9.5)	1 (0.8)	~ ~
Spain	r	2 (1.1)	~ ~	28 (4.0)	480 (5.5)	62 (4.7)	490 (3.6)	8 (2.6)	494 (9.2)
Sweden	r	3 (1.2)	506 (24.2)	97 (1.3)	520 (3.2)	0 (0.4)	~ ~	0 (0.3)	~ ~
Switzerland	s	2 (1.4)	~ ~	14 (3.4)	520 (17.8)	71 (3.5)	557 (6.5)	13 (3.0)	566 (12.4)
Thailand		x x	x x	x x	x x	x x	x x	x x	x x
United States	s	8 (1.4)	492 (26.2)	24 (3.4)	501 (9.9)	58 (4.4)	507 (5.4)	11 (2.8)	498 (10.0)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.6

Average Number of Hours[1] Students' Teachers Spend on Various School-Related Activities Outside the Formal School Day During the School Week Mathematics - Upper Grade (Eighth Grade*)

Country	Preparing or Grading Tests	Reading and Grading Student Work	Planning Lessons by Self	Meeting with Students Outside Classroom Time	Meeting with Parents	Professional Reading and Development	Keeping Students' Records	Adminis-trative Tasks
Australia	2.3 (0.1)	1.8 (0.1)	2.6 (0.1)	1.3 (0.1)	0.4 (0.0)	0.9 (0.1)	1.0 (0.1)	2.0 (0.1)
Austria	r 2.3 (0.1)	r 2.5 (0.1)	r 3.6 (0.1)	r 0.4 (0.1)	r 0.6 (0.0)	r 1.5 (0.1)	r 0.9 (0.1)	r 1.1 (0.1)
Belgium (Fl)	3.8 (0.1)	2.3 (0.1)	2.9 (0.2)	0.8 (0.1)	0.6 (0.1)	0.6 (0.1)	0.5 (0.0)	1.2 (0.1)
Belgium (Fr)	s 3.4 (0.2)	s 1.6 (0.1)	s 2.8 (0.2)	s 0.7 (0.1)	s 0.5 (0.1)	s 0.9 (0.1)	s 0.7 (0.1)	s 1.2 (0.1)
Canada	2.3 (0.1)	2.4 (0.1)	2.6 (0.1)	1.4 (0.1)	0.5 (0.0)	0.8 (0.1)	1.1 (0.0)	1.7 (0.1)
Colombia	2.8 (0.1)	r 1.8 (0.1)	3.1 (0.1)	1.2 (0.1)	0.8 (0.1)	1.9 (0.2)	r 0.8 (0.1)	1.1 (0.1)
Cyprus	3.4 (0.1)	r 1.3 (0.2)	r 3.2 (0.2)	r 0.3 (0.1)	r 1.1 (0.1)	r 0.9 (0.1)	r 0.5 (0.0)	r 1.0 (0.1)
Czech Republic	3.4 (0.1)	1.6 (0.1)	4.0 (0.1)	1.2 (0.1)	0.5 (0.0)	0.8 (0.1)	0.9 (0.1)	1.3 (0.1)
Denmark	- -	- -	- -	- -	- -	- -	- -	- -
England	s 2.1 (0.1)	s 3.7 (0.1)	s 2.6 (0.1)	s 1.4 (0.1)	s 0.6 (0.0)	s 0.9 (0.1)	s 0.7 (0.1)	s 2.2 (0.1)
France	4.0 (0.1)	r 1.1 (0.1)	3.4 (0.2)	0.7 (0.1)	0.6 (0.0)	r 1.2 (0.1)	0.7 (0.0)	1.0 (0.1)
Germany	s 3.1 (0.1)	s 2.2 (0.2)	s 4.2 (0.1)	s 0.8 (0.1)	s 0.8 (0.1)	s 1.8 (0.2)	s 1.1 (0.1)	s 1.7 (0.1)
Greece	2.4 (0.1)	1.0 (0.1)	2.0 (0.2)	0.4 (0.1)	0.9 (0.1)	2.1 (0.1)	r 0.5 (0.1)	1.2 (0.1)
Hong Kong	2.4 (0.2)	3.1 (0.2)	2.2 (0.2)	1.7 (0.2)	0.4 (0.1)	1.0 (0.2)	0.7 (0.1)	1.2 (0.1)
Hungary	3.0 (0.1)	2.5 (0.1)	4.0 (0.1)	1.9 (0.1)	0.8 (0.1)	1.8 (0.1)	0.8 (0.1)	2.3 (0.1)
Iceland	r 2.0 (0.2)	r 2.3 (0.3)	r 3.0 (0.2)	r 0.9 (0.1)	r 0.8 (0.1)	r 0.9 (0.1)	r 1.3 (0.2)	r 2.2 (0.2)
Iran, Islamic Rep.	2.6 (0.2)	1.9 (0.2)	2.1 (0.1)	1.0 (0.1)	0.8 (0.1)	0.5 (0.1)	2.0 (0.1)	1.1 (0.2)
Ireland	2.3 (0.1)	1.6 (0.1)	2.3 (0.1)	0.8 (0.1)	0.3 (0.0)	0.5 (0.1)	0.7 (0.0)	1.3 (0.1)
Israel	r 3.6 (0.2)	r 1.7 (0.2)	r 2.9 (0.3)	r 1.5 (0.2)	r 0.9 (0.1)	r 2.8 (0.3)	r 1.1 (0.2)	r 1.9 (0.2)
Japan	2.0 (0.1)	1.8 (0.1)	2.9 (0.1)	1.8 (0.1)	0.4 (0.0)	1.8 (0.1)	1.4 (0.1)	2.6 (0.2)
Korea	1.7 (0.1)	1.5 (0.1)	2.1 (0.1)	1.6 (0.1)	0.4 (0.0)	1.2 (0.1)	0.9 (0.1)	2.0 (0.1)
Kuwait	2.4 (0.2)	2.1 (0.3)	2.7 (0.2)	0.4 (0.1)	0.6 (0.1)	1.0 (0.2)	0.9 (0.2)	0.9 (0.2)
Latvia (LSS)	3.0 (0.2)	r 2.8 (0.2)	3.3 (0.1)	r 1.8 (0.1)	r 0.7 (0.1)	r 1.1 (0.1)	r 0.4 (0.1)	r 1.0 (0.1)
Lithuania	1.5 (0.1)	2.7 (0.2)	3.1 (0.1)	1.6 (0.1)	0.8 (0.1)	1.9 (0.1)	0.8 (0.1)	r 0.6 (0.1)
Netherlands	3.7 (0.2)	0.7 (0.1)	2.5 (0.2)	1.0 (0.1)	0.6 (0.0)	1.1 (0.1)	0.4 (0.0)	1.1 (0.1)
New Zealand	2.3 (0.1)	1.7 (0.1)	3.0 (0.1)	1.3 (0.1)	0.4 (0.0)	1.0 (0.1)	0.8 (0.0)	2.3 (0.1)
Norway	2.4 (0.1)	1.6 (0.1)	3.6 (0.1)	0.8 (0.1)	0.7 (0.0)	0.6 (0.1)	0.9 (0.1)	1.8 (0.1)
Portugal	2.8 (0.1)	1.9 (0.1)	3.3 (0.1)	0.9 (0.1)	0.5 (0.1)	1.0 (0.1)	0.9 (0.1)	1.2 (0.1)
Romania	2.8 (0.1)	2.4 (0.1)	3.6 (0.1)	2.0 (0.1)	1.0 (0.1)	1.3 (0.1)	1.6 (0.1)	2.2 (0.1)
Russian Federation	2.6 (0.1)	3.4 (0.1)	3.5 (0.2)	2.4 (0.1)	1.2 (0.1)	2.3 (0.1)	1.0 (0.1)	2.1 (0.1)
Scotland	1.5 (0.1)	r 2.0 (0.1)	1.8 (0.1)	1.0 (0.1)	0.5 (0.1)	0.8 (0.1)	1.0 (0.1)	1.5 (0.1)
Singapore	3.4 (0.1)	4.1 (0.1)	2.7 (0.1)	1.6 (0.1)	0.4 (0.0)	1.1 (0.1)	1.1 (0.1)	2.0 (0.1)
Slovak Republic	2.9 (0.1)	1.9 (0.1)	3.6 (0.1)	1.3 (0.1)	0.7 (0.0)	0.9 (0.1)	1.1 (0.1)	1.1 (0.1)
Slovenia	r 2.6 (0.1)	r 1.0 (0.1)	r 3.7 (0.1)	r 1.2 (0.1)	r 1.2 (0.1)	r 1.7 (0.1)	r 0.6 (0.0)	r 1.8 (0.1)
Spain	2.1 (0.1)	1.4 (0.1)	1.8 (0.1)	0.9 (0.1)	1.1 (0.0)	1.6 (0.1)	0.8 (0.0)	1.7 (0.1)
Sweden	2.2 (0.1)	1.6 (0.1)	4.0 (0.1)	0.7 (0.0)	0.8 (0.0)	1.3 (0.1)	0.9 (0.0)	2.3 (0.1)
Switzerland	3.0 (0.1)	r 2.0 (0.1)	r 3.9 (0.1)	r 0.9 (0.1)	r 0.8 (0.1)	r 1.8 (0.1)	r 0.7 (0.0)	r 2.2 (0.1)
Thailand	s 2.6 (0.2)	s 1.9 (0.2)	r 1.8 (0.2)	s 1.5 (0.2)	s 0.5 (0.1)	s 1.3 (0.2)	s 1.1 (0.1)	s 1.5 (0.2)
United States	2.7 (0.1)	r 2.7 (0.2)	2.4 (0.1)	2.0 (0.1)	0.7 (0.0)	0.9 (0.1)	1.6 (0.1)	2.0 (0.1)

[1]Average hours based on: No time=0, Less Than 1 Hour=.5, 1-2 Hours=1.5; 3-4 Hours=3.5; More Than 4 Hours=5.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.7

Teachers' Reports on How Often They Meet with Other Teachers in Their Subject Area to Discuss and Plan Curriculum or Teaching Approaches Mathematics - Upper Grade (Eighth Grade*)

Country		Percent of Students Taught by Teachers			
		Meeting Never or Once/Twice a Year	Meeting Monthly or Every Other Month	Meeting Once, Twice, or Three Times a Week	Meeting Almost Every Day
Australia		12 (2.2)	52 (3.3)	24 (2.8)	12 (2.4)
Austria	r	17 (2.9)	37 (4.0)	36 (3.7)	9 (3.0)
Belgium (Fl)		52 (4.8)	29 (4.1)	15 (3.3)	4 (1.7)
Belgium (Fr)	s	19 (4.0)	29 (4.9)	41 (5.4)	11 (3.6)
Canada		29 (3.0)	33 (3.2)	30 (3.7)	8 (2.5)
Colombia		17 (3.6)	32 (4.3)	48 (4.6)	4 (1.7)
Cyprus		3 (1.8)	4 (1.6)	77 (3.8)	17 (3.0)
Czech Republic		12 (2.7)	30 (4.8)	37 (5.3)	21 (3.9)
Denmark		- -	- -	- -	- -
England	s	7 (1.7)	33 (3.3)	52 (3.8)	9 (1.4)
France		35 (5.2)	32 (4.9)	30 (4.5)	3 (1.9)
Germany	s	42 (5.8)	33 (4.8)	15 (3.9)	10 (3.1)
Greece		41 (4.1)	28 (4.9)	22 (3.9)	9 (2.5)
Hong Kong		30 (5.2)	53 (5.8)	16 (4.1)	1 (1.2)
Hungary		2 (1.3)	10 (2.7)	41 (4.4)	46 (4.2)
Iceland	r	23 (4.3)	31 (6.0)	41 (7.2)	4 (3.7)
Iran, Islamic Rep.		21 (5.3)	38 (5.3)	35 (4.3)	6 (2.3)
Ireland		62 (4.4)	24 (4.0)	12 (3.1)	2 (1.2)
Israel	r	5 (3.5)	20 (6.8)	53 (8.0)	21 (5.0)
Japan		23 (3.6)	28 (3.8)	46 (4.3)	3 (1.3)
Korea		23 (3.6)	37 (4.1)	37 (4.4)	3 (1.8)
Kuwait		2 (1.6)	2 (2.2)	67 (6.2)	29 (5.7)
Latvia (LSS)	r	19 (3.7)	31 (3.8)	28 (4.1)	22 (3.8)
Lithuania		14 (2.6)	29 (4.3)	26 (3.5)	31 (3.8)
Netherlands		12 (3.6)	65 (5.6)	21 (4.2)	1 (1.4)
New Zealand		10 (2.5)	43 (4.0)	45 (4.0)	2 (1.0)
Norway		6 (2.1)	17 (3.4)	71 (3.8)	6 (2.0)
Portugal		7 (1.9)	72 (3.9)	18 (3.2)	3 (1.7)
Romania		7 (2.1)	45 (4.0)	24 (3.4)	24 (3.4)
Russian Federation		8 (3.0)	55 (4.3)	25 (3.8)	12 (3.3)
Scotland		5 (2.2)	20 (3.9)	69 (4.2)	6 (2.3)
Singapore		10 (3.1)	68 (4.5)	16 (3.4)	6 (2.4)
Slovak Republic		3 (1.4)	23 (3.6)	30 (4.1)	44 (4.3)
Slovenia	r	2 (1.4)	26 (4.5)	26 (4.2)	46 (4.4)
Spain		16 (3.0)	43 (4.4)	39 (4.6)	2 (1.2)
Sweden		9 (2.3)	17 (2.7)	49 (3.9)	24 (3.2)
Switzerland	r	38 (3.8)	33 (3.8)	26 (3.5)	3 (1.4)
Thailand	r	53 (6.2)	31 (5.7)	12 (4.1)	4 (2.6)
United States		29 (3.7)	37 (3.9)	26 (3.7)	8 (2.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

HOW ARE MATHEMATICS CLASSES ORGANIZED?

Table 5.8 presents teachers' reports about the size of eighth-grade mathematics classes for the TIMSS countries. The data reveal rather large variations from country to country. According to teachers, mathematics classes were relatively small in a number of countries. For example, 90% or more of the students were in mathematics classes of 30 or fewer students in Belgium (Flemish), Belgium (French), the Czech Republic, Denmark, France, Germany, Hungary, Iceland, Latvia (LSS), Lithuania, the Netherlands, Norway, Portugal, the Russian Federation, Scotland, Slovenia, Sweden, and Switzerland. At the other end of the spectrum, 93% of the students in Korea and 48% in Colombia were in mathematics classes with more than 40 students. In Hong Kong, Japan, and Singapore, 90% of the students were in classes with more than 30 students. Extensive research about class size in relation to achievement indicates that the existence of such a relationship is dependent on the situation. Dramatic reductions in class size can be related to gains in achievement, but the chief effects of smaller classes often are in relation to teacher attitudes and instructional behaviors. The TIMSS data support the complexity of this issue. Across countries, the four highest-performing countries at the eighth grade – Singapore, Korea, Japan, and Hong Kong – are among those with the largest mathematics classes. Within countries, several show little or no relationship between achievement and class size, often because students are mostly all in classes of similar size. Within other countries, there appears to be a curvilinear relationship, or those students with higher achievement appear to be in larger classes. In some countries, larger classes may represent the more usual situation for mathematics teaching, with smaller classes used primarily for students needing remediation or for those students in the less-advanced tracks.

Teachers can adopt a variety of organizational and interactive approaches in mathematics class. Whole-class instruction can be very efficient, because it requires less time on management functions and provides more time for developing mathematics concepts. Teachers can make presentations, conduct discussions, or demonstrate procedures and applications to all students simultaneously. Both whole-class and independent work have been standard features of mathematics classrooms. Students also can benefit from the type of cooperative learning that occurs with effective use of small-group work. Because they can help each other, students in groups can often handle challenging situations beyond their individual capabilities. Further, the positive affective impact of working together mirrors the use of mathematics in the workplace.

Table 5.8

Teachers' Reports on Average Size of Mathematics Class Upper Grade (Eighth Grade*)

Country	1 - 20 Students		21 - 30 Students		31 - 40 Students		41 or More Students	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r 13 (2.4)	497 (14.6)	71 (3.3)	528 (5.4)	16 (2.6)	583 (9.7)	1 (0.5)	~ ~
Austria	x x	x x	x x	x x	x x	x x	x x	x x
Belgium (Fl)	49 (3.6)	552 (8.2)	51 (3.6)	596 (4.4)	0 (0.0)	~ ~	0 (0.0)	~ ~
Belgium (Fr)	s 43 (5.3)	535 (6.2)	57 (5.3)	551 (6.1)	0 (0.0)	~ ~	0 (0.0)	~ ~
Canada	r 11 (2.1)	524 (10.3)	65 (4.0)	527 (3.4)	23 (3.6)	534 (11.7)	1 (0.5)	~ ~
Colombia	r 16 (4.2)	400 (24.3)	6 (2.2)	361 (4.1)	29 (4.0)	394 (6.5)	48 (4.6)	384 (3.9)
Cyprus	r 1 (0.0)	~ ~	37 (3.9)	467 (4.3)	62 (3.9)	474 (3.2)	0 (0.0)	~ ~
Czech Republic	13 (3.3)	534 (6.2)	77 (5.3)	564 (6.2)	11 (4.5)	591 (13.7)	0 (0.0)	~ ~
Denmark	r 49 (4.8)	504 (3.8)	51 (4.8)	506 (3.7)	0 (0.0)	~ ~	0 (0.0)	~ ~
England	s 18 (3.1)	482 (12.2)	62 (3.7)	511 (5.9)	20 (3.4)	554 (7.9)	0 (0.0)	~ ~
France	11 (2.6)	512 (8.8)	86 (2.9)	543 (3.9)	3 (1.8)	519 (8.7)	0 (0.0)	~ ~
Germany	s 25 (4.4)	493 (15.6)	72 (4.5)	522 (5.6)	3 (1.8)	558 (40.8)	0 (0.0)	~ ~
Greece	9 (2.3)	462 (9.7)	64 (4.4)	489 (3.3)	27 (3.9)	481 (7.2)	0 (0.0)	~ ~
Hong Kong	3 (1.9)	501 (63.7)	4 (2.2)	605 (35.3)	56 (5.7)	584 (10.7)	37 (5.9)	606 (10.1)
Hungary	37 (4.0)	528 (5.2)	57 (4.1)	541 (4.9)	6 (2.2)	551 (17.8)	0 (0.0)	~ ~
Iceland	r 36 (5.9)	478 (4.8)	64 (5.9)	497 (7.1)	0 (0.0)	~ ~	0 (0.0)	~ ~
Iran, Islamic Rep.	r 1 (0.9)	~ ~	26 (4.5)	428 (6.3)	54 (5.3)	431 (2.3)	19 (4.4)	424 (7.7)
Ireland	r 12 (2.7)	454 (8.5)	68 (4.5)	526 (6.7)	20 (3.9)	575 (9.5)	0 (0.0)	~ ~
Israel	r 14 (5.1)	495 (13.2)	36 (7.4)	524 (10.2)	49 (9.1)	529 (13.8)	2 (1.6)	~ ~
Japan	0 (0.2)	~ ~	4 (1.4)	598 (8.5)	88 (2.0)	600 (2.2)	8 (1.5)	667 (10.1)
Korea	2 (1.2)	~ ~	1 (1.0)	~ ~	4 (1.5)	562 (6.6)	93 (2.0)	611 (2.6)
Kuwait	0 (0.0)	~ ~	49 (6.5)	395 (2.9)	49 (6.3)	390 (4.3)	2 (1.9)	~ ~
Latvia (LSS)	r 41 (4.0)	482 (5.1)	51 (3.8)	501 (4.3)	4 (2.1)	502 (23.4)	4 (2.0)	469 (11.4)
Lithuania	r 43 (3.8)	461 (4.8)	54 (3.7)	491 (5.7)	3 (1.6)	502 (21.1)	0 (0.0)	~ ~
Netherlands	16 (4.7)	467 (21.0)	77 (5.6)	549 (6.5)	7 (3.6)	631 (18.1)	0 (0.0)	~ ~
New Zealand	11 (2.2)	460 (6.8)	68 (3.8)	508 (5.8)	21 (3.1)	536 (9.0)	0 (0.0)	~ ~
Norway	r 20 (3.5)	499 (6.2)	79 (3.7)	510 (2.9)	1 (0.5)	~ ~	1 (0.8)	~ ~
Portugal	12 (2.8)	440 (4.4)	80 (3.7)	456 (3.1)	7 (2.6)	469 (12.1)	0 (0.0)	~ ~
Romania	23 (2.7)	462 (7.9)	51 (4.3)	470 (5.3)	24 (4.1)	516 (9.0)	2 (1.2)	~ ~
Russian Federation	15 (2.7)	514 (12.1)	75 (3.6)	539 (5.8)	9 (2.3)	544 (8.6)	0 (0.0)	~ ~
Scotland	r 12 (2.8)	455 (11.6)	80 (3.8)	496 (6.9)	8 (2.7)	543 (18.4)	0 (0.0)	~ ~
Singapore	1 (0.7)	~ ~	10 (2.5)	645 (13.2)	72 (4.3)	640 (6.2)	18 (4.0)	656 (8.8)
Slovak Republic	15 (2.8)	526 (8.5)	67 (4.2)	546 (4.1)	19 (3.6)	556 (8.5)	0 (0.0)	~ ~
Slovenia	r 15 (3.1)	513 (6.8)	80 (3.6)	545 (4.0)	5 (1.8)	554 (18.5)	0 (0.0)	~ ~
Spain	r 13 (2.8)	470 (5.9)	48 (4.0)	484 (4.5)	36 (4.2)	497 (4.6)	4 (1.7)	476 (10.9)
Sweden	r 36 (3.9)	492 (5.8)	61 (4.0)	534 (3.9)	2 (1.2)	~ ~	0 (0.0)	~ ~
Switzerland	s 56 (4.5)	543 (8.1)	44 (4.5)	565 (6.6)	0 (0.0)	~ ~	0 (0.0)	~ ~
Thailand	x x	x x	x x	x x	x x	x x	x x	x x
United States	s 24 (3.0)	504 (9.6)	59 (3.9)	507 (5.7)	12 (2.2)	506 (17.0)	4 (1.8)	490 (22.3)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.3 provides a pictorial view of the emphasis on individual, small-group, and whole-class work as reported by the mathematics teachers in the TIMSS countries. Because learning may be enhanced with teacher guidance and monitoring individual and small-group activities, the frequency of lessons using each of these organizational approaches is shown both with and without assistance of the teacher. Internationally, teachers reported that students working together as a class with the teacher teaching the whole class is a frequently used instructional approach. In most countries, approximately 50% or even more of the eighth-grade students were taught this way during most or every lesson. In contrast, students working together as a class and responding to each other appeared to be a much less common approach, used for a third or fewer of the students on a frequent basis (except in Israel).

Equally as popular as having students working together as a class with the teacher teaching the whole class, was having students work individually with assistance from the teacher. Group work was reported to be the least frequent approach, but when such an approach was indicated, it was more often with than without the assistance of the teacher. In general, having students work without the assistance of the teacher, either individually or in groups, was not common in most countries, except Israel and possibly Latvia (LSS).

Figure 5.3

Teachers' Reports About Classroom Organization During Mathematics Lessons Upper Grade (Eighth Grade*)

Country	Percent of Students Whose Teachers Report Using Each Organizational Approach "Most or Every Lesson": Work Together as a Class with Students Responding to One Another	Work Together as a Class with Teacher Teaching the Whole Class	Work Individually with Assistance from Teacher	Work Individually without Assistance from Teacher	Work in Pairs or Small Groups with Assistance from Teacher	Work in Pairs or Small Groups without Assistance from Teacher
Australia	r 14	r 46	r 64	r 27	r 25	r 9
Austria	r 6	r 52	r 51	r 23	r 19	r 7
Belgium (Fl)	10	59	57	36	6	5
Belgium (Fr)	s 7	s 38	s 55	s 29	s 11	s 5
Canada	r 12	37	57	r 25	r 28	r 14
Colombia	25	41	55	r 19	44	r 22
Cyprus	r 13	r 61	r 73	r 23	r 26	r 9
Czech Republic	5	47	72	42	13	8
Denmark	5	41	74	16	18	4
England	s 19	s 46	s 57	s 25	s 14	s 8
France	11	48	56	26	17	4
Germany	s 23	s 70	s 54	s 15	s 20	s 9
Greece	4	58	60	18	14	3
Hong Kong	11	37	62	17	9	4
Hungary	11	60	65	22	7	1
Iceland	r 2	r 39	r 82	r 38	r 32	r 17
Iran, Islamic Rep.	33	66	55	8	42	10
Ireland	r 7	67	47	37	r 9	r 6
Israel	r 70	r 65	r 35	r 68	r 51	r 62
Japan	22	78	27	15	7	1

Percent for "Most or Every Lesson" →

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.3 (Continued)

Teachers' Reports About Classroom Organization During Mathematics Lessons Upper Grade (Eighth Grade*)

Country	Percent of Students Whose Teachers Report Using Each Organizational Approach "Most or Every Lesson"					
	Work Together as a Class with Students Responding to One Another	Work Together as a Class with Teacher Teaching the Whole Class	Work Individually with Assistance from Teacher	Work Individually without Assistance from Teacher	Work in Pairs or Small Groups with Assistance from Teacher	Work in Pairs or Small Groups without Assistance from Teacher
Korea	39	89	41	30	12	11
Kuwait	3	34	48	14	7	5
Latvia (LSS)	24	86	90	r 55	28	r 11
Lithuania	10	55	72	25	32	10
Netherlands	7	56	65	38	49	34
New Zealand	19	52	63	28	25	14
Norway	r 17	r 58	r 71	s 4	r 36	s 6
Portugal	10	67	69	5	50	4
Romania	12	86	56	19	18	3
Russian Federation	6	66	65	37	22	13
Scotland	r 5	r 34	r 62	r 28	r 7	r 3
Singapore	15	61	48	27	20	6
Slovak Republic	35	47	50	31	8	7
Slovenia	r 11	r 60	r 87	r 34	r 40	r 11
Spain	r 15	r 68	r 58	r 24	r 15	r 10
Sweden	r 24	r 50	r 72	r 1	r 43	r 5
Switzerland	s 4	s 48	s 61	s 25	s 35	s 20
Thailand	r 19	s 58	r 41	r 18	r 22	r 5
United States	r 22	r 49	r 50	r 19	r 26	r 12

Percent for "Most or Every Lesson"

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Activities Do Students Do in Their Mathematics Lessons?

As shown in Table 5.9, mathematics teachers in the participating countries generally reported heavier reliance on curriculum guides than textbooks or examination specifications in deciding which topics to teach. Only Japan, Korea, the Netherlands, Sweden, and Thailand used textbooks more for this purpose than both other sources of information. In contrast, in almost all countries, the textbook was the major written source mathematics teachers used in deciding how to present a topic to their classes. Internationally, the textbook appears to play a role in mathematics classrooms in many countries. For nearly all students in all countries, teachers reported using a textbook in their mathematics classes (see Figure 5.4).

The types of activities teachers asked eighth-grade students to do, however, varied from country to country. Teachers were asked how often they asked students to practice computational skills, and the responses are shown in Table 5.10. It appears that in most countries, the majority of the students practice computation in most or every lesson.

The data in Table 5.11 reveal that the majority of students in most countries were asked to do some type of mathematics reasoning tasks in most or every lesson. The activities TIMSS asked about included explaining the reasoning behind an idea, using tables, charts, or graphs to represent and analyze relationships, working on problems for which there is no immediately obvious solution, and/or writing equations to represent relationships. In Cyprus, Romania, and the Russian Federation, 55% or more of the students were asked to do at least one of these types of reasoning tasks in every lesson.

Teachers were not asked about the emphasis placed on using things from everyday life in solving mathematics problems, but students were (see Table 5.12). According to eighth-grade students, only a moderate emphasis is placed on doing these types of problems in mathematics class. Only in Canada, Cyprus, England, Greece, Iran, Latvia(LSS), New Zealand, Spain, and the United States did more than 50% of the students report being asked to do such problems on a frequent basis (pretty often or almost always).

Table 5.9

Teachers' Reports on Their Main Sources of Written Information When Deciding Which Topics to Teach and How to Present a Topic Mathematics - Upper Grade (Eighth Grade*)[1]

Country	Percent of Students Taught by Teachers: Deciding Which Topics to Teach			Deciding How to Present a Topic		
	Curriculum Guide	Textbook	Examination Specifications	Curriculum Guide	Textbook	Examination Specifications
Australia	r 91 (2.0)	9 (2.0)	- -	r 13 (2.4)	87 (2.4)	- -
Austria	r 75 (4.2)	25 (4.2)	0 (0.2)	r 28 (3.9)	72 (3.8)	0 (0.2)
Belgium (Fl)	92 (2.7)	8 (2.7)	- -	r 8 (2.3)	92 (2.3)	- -
Belgium (Fr)	s 87 (4.6)	13 (4.6)	- -	s 2 (1.4)	98 (1.4)	- -
Canada	- -	- -	- -	- -	- -	- -
Colombia	r 63 (5.2)	35 (5.1)	3 (1.3)	r 43 (5.9)	56 (5.8)	1 (0.7)
Cyprus	r 67 (5.7)	33 (5.7)	0 (0.0)	r 17 (4.3)	83 (4.3)	0 (0.0)
Czech Republic	79 (4.6)	21 (4.6)	- -	9 (3.4)	91 (3.4)	- -
Denmark	- -	- -	- -	- -	- -	- -
England	- -	- -	- -	- -	- -	- -
France	89 (2.6)	10 (2.4)	1 (0.9)	r 13 (2.9)	87 (2.9)	0 (0.0)
Germany	s 80 (4.1)	20 (4.1)	- -	s 25 (5.4)	75 (5.4)	- -
Greece	53 (4.1)	47 (4.1)	- -	5 (1.9)	95 (1.9)	- -
Hong Kong	61 (6.3)	30 (6.0)	9 (2.2)	15 (4.5)	85 (4.5)	0 (0.0)
Hungary	79 (3.1)	19 (3.1)	2 (1.3)	18 (3.2)	81 (3.1)	1 (0.8)
Iceland	s 63 (8.1)	36 (8.1)	1 (0.1)	s 12 (3.9)	87 (4.0)	1 (0.1)
Iran, Islamic Rep.	r 64 (4.9)	31 (4.7)	5 (2.1)	r 55 (5.9)	36 (5.6)	9 (2.7)
Ireland	r 65 (4.8)	35 (4.8)	- -	r 14 (3.6)	86 (3.6)	- -
Israel	r 91 (4.9)	5 (3.1)	5 (3.6)	r 28 (6.5)	69 (7.2)	3 (3.3)
Japan	24 (3.4)	74 (3.5)	1 (1.1)	11 (2.4)	87 (2.8)	2 (1.4)
Korea	22 (3.4)	76 (3.6)	2 (1.1)	22 (3.2)	74 (3.5)	4 (1.7)
Kuwait	- -	- -	- -	- -	- -	- -
Latvia (LSS)	r 81 (4.0)	16 (3.7)	3 (1.5)	r 17 (3.2)	80 (3.8)	4 (1.8)
Lithuania	r 88 (3.1)	10 (2.8)	2 (1.3)	r 6 (2.3)	93 (2.2)	1 (0.9)
Netherlands	2 (1.3)	87 (4.0)	12 (3.8)	1 (0.8)	94 (2.8)	5 (2.7)
New Zealand	91 (2.6)	5 (1.9)	4 (1.7)	47 (4.3)	53 (4.3)	0 (0.0)
Norway	r 53 (4.8)	47 (4.8)	- -	s 9 (2.9)	91 (2.9)	- -
Portugal	86 (3.1)	14 (3.1)	- -	64 (4.9)	36 (4.9)	- -
Romania	94 (2.2)	3 (1.5)	3 (1.6)	28 (3.7)	67 (3.8)	5 (2.1)
Russian Federation	76 (4.4)	13 (2.8)	11 (3.2)	7 (2.5)	86 (3.6)	6 (2.7)
Scotland	s 79 (4.3)	10 (3.5)	11 (3.6)	s 28 (4.7)	68 (5.1)	4 (2.9)
Singapore	82 (3.5)	18 (3.5)	0 (0.2)	10 (2.8)	89 (2.8)	1 (0.4)
Slovak Republic	83 (3.6)	17 (3.6)	0 (0.0)	16 (3.0)	83 (3.1)	1 (0.8)
Slovenia	r 87 (3.7)	9 (3.1)	4 (2.0)	r 27 (4.5)	71 (4.8)	2 (1.6)
Spain	- -	- -	- -	- -	- -	- -
Sweden	r 46 (3.8)	54 (3.8)	- -	r 6 (1.7)	94 (1.7)	- -
Switzerland	s 69 (4.6)	30 (4.6)	1 (0.6)	x x	x x	x x
Thailand	s 44 (6.3)	50 (6.4)	6 (3.3)	r 17 (4.5)	83 (4.5)	0 (0.0)
United States	s 64 (3.7)	30 (3.3)	6 (1.3)	s 9 (2.3)	88 (2.4)	3 (1.2)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1]Curriculum Guides include national, regional, and school curriculum guides; Textbooks include teacher and student editions, as well as other resource books; and Examination Specifications include national and regional levels.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.4

Teachers' Reports About Using a Textbook in Teaching Mathematics Upper Grade (Eighth Grade*)

Countries are classified by percentage of students whose teachers reported that they use a textbook in teaching their mathematics class.

100%

[r]*Austria*
[r]Cyprus
Czech Republic
[s]England
Hong Kong
Hungary
[r]Iceland
[r]*Israel*
Japan
Korea
[r]Latvia (LSS)
Netherlands
[r]Norway
Romania
Russian Federation
Singapore
[r]Sweden

95-99%

Canada
Denmark
France
[s]*Germany*
Greece
Iran, Islamic Rep.
Ireland
Kuwait
Lithuania
Portugal
[r]*Scotland*
[r]*Slovenia*
[s]Switzerland
[s]*Thailand*
[r]United States

85-94%

[r]*Australia*
[r]Belgium(Fl)
New Zealand
[r]Spain

Note: Seventy percent of students in Colombia, and 49 percent in [s]Belgium (French) had teachers who reported using a textbook in their mathematics class.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
The Slovak Republic did not ask this question.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.10

Teachers' Reports on How Often They Ask Students to Practice Computational Skills Mathematics - Upper Grade (Eighth Grade*)

Country		Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r	10 (2.2)	527 (16.0)	40 (3.4)	544 (7.0)	38 (3.5)	529 (7.0)	13 (2.2)	507 (14.1)
Austria	r	3 (1.7)	607 (12.8)	27 (3.6)	568 (7.3)	49 (3.7)	546 (7.0)	21 (2.7)	517 (10.3)
Belgium (Fl)		0 (0.0)	~ ~	33 (3.8)	603 (6.6)	49 (4.7)	574 (7.9)	18 (3.8)	524 (17.4)
Belgium (Fr)	s	4 (4.0)	553 (0.0)	28 (5.2)	530 (8.4)	52 (6.0)	548 (6.6)	16 (4.4)	551 (15.3)
Canada		4 (1.7)	529 (5.1)	36 (4.0)	527 (6.2)	42 (4.1)	531 (5.6)	18 (2.8)	525 (11.2)
Colombia		2 (1.2)	~ ~	13 (2.9)	391 (8.7)	50 (5.0)	383 (3.9)	35 (5.0)	391 (9.1)
Cyprus	r	5 (1.3)	490 (24.7)	38 (5.3)	464 (4.8)	43 (5.3)	469 (3.8)	15 (4.1)	477 (11.2)
Czech Republic		0 (0.0)	~ ~	23 (4.8)	558 (7.6)	37 (4.6)	567 (8.3)	40 (5.2)	559 (8.2)
Denmark		2 (1.4)	~ ~	51 (4.1)	507 (4.1)	42 (4.3)	500 (3.6)	6 (2.1)	497 (14.9)
England	s	7 (1.6)	542 (20.8)	52 (2.6)	515 (6.0)	34 (2.8)	506 (8.0)	8 (1.9)	539 (17.3)
France		6 (2.1)	534 (10.2)	44 (4.8)	549 (4.5)	44 (4.2)	536 (5.4)	7 (2.1)	517 (15.7)
Germany	s	17 (3.3)	479 (12.1)	51 (5.0)	522 (8.4)	25 (4.4)	525 (11.2)	7 (2.8)	501 (26.4)
Greece		7 (2.0)	456 (9.6)	52 (4.3)	482 (4.8)	33 (3.8)	491 (4.5)	8 (2.1)	491 (11.8)
Hong Kong		21 (5.3)	591 (16.1)	23 (4.9)	598 (16.9)	35 (5.1)	575 (13.2)	21 (4.4)	595 (15.4)
Hungary		0 (0.0)	~ ~	13 (3.1)	543 (10.8)	51 (4.3)	536 (5.1)	35 (4.3)	537 (5.5)
Iceland	r	0 (0.0)	~ ~	12 (4.4)	489 (6.5)	40 (6.1)	479 (6.9)	49 (6.7)	498 (7.7)
Iran, Islamic Rep.		7 (2.8)	416 (14.3)	51 (5.6)	431 (2.3)	29 (5.3)	432 (3.8)	13 (3.3)	432 (6.9)
Ireland		19 (3.9)	524 (14.8)	29 (4.2)	527 (10.7)	37 (4.5)	527 (9.7)	15 (3.1)	531 (19.1)
Israel	r	18 (5.9)	518 (18.9)	36 (7.4)	520 (11.2)	41 (6.3)	522 (12.8)	4 (2.6)	545 (44.6)
Japan		- -	- -	- -	- -	- -	- -	- -	- -
Korea		19 (3.4)	610 (5.9)	53 (4.3)	609 (3.7)	24 (4.0)	613 (5.3)	4 (1.3)	603 (10.8)
Kuwait		1 (0.6)	~ ~	28 (7.3)	390 (3.6)	51 (8.1)	391 (2.9)	20 (5.3)	393 (5.9)
Latvia (LSS)		- -	- -	- -	- -	- -	- -	- -	- -
Lithuania		0 (0.0)	~ ~	2 (1.0)	~ ~	30 (3.7)	482 (7.5)	68 (3.9)	476 (4.7)
Netherlands		- -	- -	- -	- -	- -	- -	- -	- -
New Zealand		7 (2.3)	519 (17.9)	45 (3.8)	509 (6.2)	40 (3.6)	505 (6.4)	7 (2.2)	509 (21.2)
Norway	r	5 (2.0)	506 (7.9)	59 (4.4)	505 (3.4)	34 (4.4)	509 (4.5)	2 (1.2)	~ ~
Portugal		- -	- -	- -	- -	- -	- -	- -	- -
Romania		0 (0.0)	~ ~	12 (2.6)	476 (15.0)	35 (4.1)	482 (8.4)	53 (4.4)	483 (6.2)
Russian Federation		0 (0.4)	~ ~	13 (2.3)	517 (12.4)	43 (3.6)	545 (9.0)	44 (3.5)	530 (7.9)
Scotland		- -	- -	- -	- -	- -	- -	- -	- -
Singapore		20 (3.7)	645 (11.6)	30 (4.2)	644 (9.4)	36 (4.4)	639 (7.4)	13 (3.3)	652 (15.2)
Slovak Republic		3 (1.3)	533 (16.2)	35 (4.6)	545 (6.3)	36 (4.2)	550 (5.7)	27 (4.1)	541 (5.8)
Slovenia	r	0 (0.0)	~ ~	21 (4.3)	535 (8.2)	36 (5.5)	551 (6.0)	43 (5.4)	533 (4.8)
Spain	r	30 (4.1)	481 (4.8)	42 (4.8)	490 (4.3)	23 (4.3)	491 (7.3)	4 (2.4)	477 (7.0)
Sweden	r	2 (0.9)	~ ~	18 (2.6)	512 (6.8)	51 (3.7)	523 (4.5)	29 (3.6)	515 (6.6)
Switzerland	s	4 (1.9)	545 (30.8)	21 (4.0)	560 (18.4)	59 (5.0)	552 (5.9)	16 (3.7)	548 (12.4)
Thailand	r	0 (0.0)	~ ~	13 (4.7)	547 (20.4)	42 (5.9)	519 (10.1)	45 (6.5)	529 (9.6)
United States	r	11 (1.9)	536 (12.9)	31 (3.4)	510 (9.2)	38 (4.4)	485 (6.2)	21 (3.9)	499 (10.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.11

Teachers' Reports on How Often They Ask Students to Do Reasoning Tasks[1] Mathematics - Upper Grade (Eighth Grade*)

Country	Never or Almost Never: Percent of Students	Never or Almost Never: Mean Achievement	Some Lessons: Percent of Students	Some Lessons: Mean Achievement	Most Lessons: Percent of Students	Most Lessons: Mean Achievement	Every Lesson: Percent of Students	Every Lesson: Mean Achievement
Australia	r 1 (0.9)	~ ~	38 (3.0)	520 (8.6)	48 (3.2)	538 (6.0)	13 (2.4)	547 (8.5)
Austria	r 0 (0.0)	~ ~	25 (3.4)	539 (10.2)	57 (4.5)	548 (6.4)	18 (3.4)	561 (10.3)
Belgium (Fl)	0 (0.3)	~ ~	25 (4.3)	549 (13.7)	56 (4.7)	577 (8.4)	19 (3.4)	604 (9.2)
Belgium (Fr)	s 0 (0.0)	~ ~	21 (4.3)	531 (8.7)	48 (6.1)	542 (6.1)	31 (5.7)	556 (9.3)
Canada	0 (0.0)	~ ~	19 (3.0)	527 (8.1)	62 (3.8)	529 (4.0)	19 (3.6)	529 (8.7)
Colombia	0 (0.0)	~ ~	18 (3.5)	377 (4.4)	56 (5.1)	392 (3.4)	26 (5.0)	382 (11.7)
Cyprus	r 0 (0.0)	~ ~	4 (2.2)	468 (41.8)	39 (4.8)	469 (5.6)	58 (5.2)	471 (2.8)
Czech Republic	0 (0.0)	~ ~	9 (3.4)	570 (20.6)	56 (5.5)	558 (7.3)	36 (5.1)	566 (8.0)
Denmark	4 (2.6)	477 (8.1)	59 (4.8)	507 (3.4)	31 (4.5)	504 (4.3)	5 (2.3)	500 (16.6)
England	s 0 (0.0)	~ ~	25 (2.7)	506 (9.5)	60 (3.0)	518 (5.4)	14 (2.1)	524 (12.3)
France	0 (0.0)	~ ~	32 (4.3)	528 (5.2)	48 (4.7)	550 (5.5)	20 (3.8)	537 (9.9)
Germany	s 1 (1.0)	~ ~	24 (4.4)	515 (13.5)	58 (4.8)	518 (7.6)	17 (3.9)	510 (11.4)
Greece	1 (0.6)	~ ~	15 (2.9)	475 (6.7)	47 (4.1)	485 (4.8)	37 (3.9)	488 (6.4)
Hong Kong	1 (1.2)	~ ~	33 (5.5)	595 (12.6)	58 (5.6)	585 (9.8)	8 (3.2)	578 (28.7)
Hungary	0 (0.0)	~ ~	8 (2.4)	502 (6.6)	54 (4.6)	538 (5.2)	38 (4.5)	543 (5.8)
Iceland	r 1 (1.3)	~ ~	72 (6.4)	489 (5.1)	22 (5.9)	497 (15.0)	5 (2.3)	468 (19.5)
Iran, Islamic Rep.	0 (0.0)	~ ~	30 (6.3)	427 (5.6)	47 (6.0)	429 (3.0)	23 (4.5)	434 (4.0)
Ireland	1 (0.6)	~ ~	55 (4.8)	525 (8.1)	33 (4.3)	520 (8.8)	12 (3.3)	562 (18.0)
Israel	r 3 (2.7)	474 (0.0)	9 (4.3)	532 (12.5)	68 (8.1)	528 (9.9)	20 (5.9)	502 (15.7)
Japan	0 (0.0)	~ ~	7 (2.2)	594 (5.1)	55 (4.4)	604 (2.9)	37 (4.3)	608 (4.4)
Korea	1 (0.7)	~ ~	3 (1.5)	640 (9.6)	72 (3.7)	608 (3.0)	24 (3.4)	612 (6.8)
Kuwait	2 (2.4)	~ ~	49 (6.5)	392 (3.5)	41 (6.1)	392 (2.9)	8 (4.1)	386 (3.3)
Latvia (LSS)	r 0 (0.0)	~ ~	16 (3.6)	482 (8.6)	60 (4.8)	490 (4.2)	24 (4.4)	499 (7.1)
Lithuania	0 (0.0)	~ ~	15 (2.8)	467 (10.6)	59 (4.4)	475 (5.5)	26 (4.0)	490 (6.4)
Netherlands	- -	- -	- -	- -	- -	- -	- -	- -
New Zealand	0 (0.0)	~ ~	35 (3.4)	493 (6.9)	53 (3.9)	514 (6.6)	12 (2.7)	525 (12.7)
Norway	r 0 (0.0)	~ ~	47 (4.4)	506 (4.0)	48 (4.3)	508 (3.6)	5 (2.2)	509 (13.0)
Portugal	0 (0.0)	~ ~	16 (3.1)	454 (5.7)	66 (4.0)	454 (3.1)	18 (3.5)	456 (6.5)
Romania	0 (0.0)	~ ~	5 (1.7)	444 (21.5)	22 (3.2)	476 (9.4)	74 (3.4)	486 (4.9)
Russian Federation	0 (0.0)	~ ~	6 (1.9)	508 (13.3)	39 (4.0)	525 (6.1)	55 (4.8)	545 (7.0)
Scotland	- -	- -	- -	- -	- -	- -	- -	- -
Singapore	0 (0.0)	~ ~	34 (4.1)	637 (9.5)	57 (4.5)	648 (6.2)	8 (2.3)	642 (20.7)
Slovak Republic	0 (0.0)	~ ~	5 (2.0)	531 (7.2)	66 (4.0)	545 (4.0)	29 (3.9)	548 (5.7)
Slovenia	r 0 (0.0)	~ ~	13 (3.4)	537 (7.0)	77 (4.6)	541 (4.2)	10 (3.2)	539 (6.9)
Spain	r 0 (0.0)	~ ~	15 (3.3)	469 (5.2)	67 (4.2)	488 (3.5)	18 (3.3)	497 (6.2)
Sweden	r 1 (0.5)	~ ~	35 (3.8)	515 (6.6)	46 (3.7)	520 (4.0)	18 (2.8)	523 (7.5)
Switzerland	s 2 (1.6)	~ ~	31 (4.7)	538 (12.0)	52 (5.0)	556 (7.3)	15 (3.2)	583 (8.9)
Thailand	r 0 (0.0)	~ ~	49 (6.7)	526 (11.5)	34 (6.2)	521 (10.7)	17 (4.7)	544 (11.3)
United States	r 0 (0.0)	~ ~	24 (3.4)	495 (0.0)	50 (3.5)	498 (5.9)	26 (3.3)	514 (10.2)

[1]Based on most frequent response for: explain reasoning behind an idea; represent and analyze relationships using tables, charts or graphs; work on problems for which there is no immediately obvious method of solution; and write equations to represent relationships.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.12

Students' Reports on Frequency of Using Things from Everyday Life in Solving Mathematics Problems - Upper Grade (Eighth Grade*)

Country	Never		Once in a While		Pretty Often		Almost Always	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	14 (0.6)	512 (5.4)	39 (0.9)	543 (3.9)	34 (0.8)	536 (4.7)	13 (0.6)	513 (5.5)
Austria	21 (1.1)	536 (4.6)	44 (1.2)	546 (4.1)	23 (0.8)	545 (4.8)	12 (0.8)	519 (6.3)
Belgium (Fl)	34 (1.5)	563 (5.0)	41 (1.4)	576 (7.8)	20 (1.0)	567 (5.6)	5 (0.5)	512 (10.2)
Belgium (Fr)	39 (1.5)	525 (4.4)	39 (1.4)	543 (4.1)	15 (1.0)	514 (7.7)	8 (0.7)	510 (11.8)
Canada	13 (1.0)	528 (6.9)	36 (0.8)	534 (2.3)	34 (1.0)	530 (3.3)	17 (0.6)	517 (3.9)
Colombia	20 (1.6)	386 (4.9)	32 (1.5)	392 (4.5)	23 (1.0)	392 (4.5)	25 (1.2)	382 (5.5)
Cyprus	18 (1.0)	464 (3.6)	28 (0.9)	483 (3.4)	38 (1.0)	481 (3.5)	16 (0.9)	462 (4.4)
Czech Republic	16 (0.8)	553 (5.6)	41 (1.1)	565 (5.8)	34 (1.3)	573 (5.5)	9 (0.6)	552 (8.3)
Denmark	28 (1.3)	494 (4.7)	51 (1.5)	510 (3.5)	16 (1.3)	508 (5.2)	5 (0.5)	485 (11.0)
England	11 (0.9)	509 (7.4)	36 (1.2)	508 (4.3)	41 (1.3)	512 (2.7)	12 (0.8)	487 (6.9)
France	24 (1.5)	526 (3.7)	38 (1.0)	543 (3.2)	26 (1.3)	549 (4.5)	12 (0.8)	536 (5.8)
Germany	26 (1.4)	505 (4.8)	45 (1.5)	519 (5.1)	19 (1.1)	511 (6.7)	10 (0.8)	488 (6.6)
Greece	16 (0.8)	467 (5.3)	28 (0.9)	482 (3.9)	36 (1.1)	496 (3.8)	20 (0.7)	484 (4.3)
Hong Kong	26 (1.3)	578 (7.8)	45 (1.1)	599 (6.7)	20 (0.9)	593 (7.2)	8 (0.6)	570 (10.7)
Hungary	29 (1.2)	537 (4.5)	48 (1.2)	545 (4.0)	18 (0.8)	534 (6.3)	6 (0.5)	508 (9.7)
Iceland	35 (2.6)	491 (6.4)	36 (2.4)	497 (4.8)	21 (1.3)	482 (6.9)	8 (1.2)	451 (10.6)
Iran, Islamic Rep.	15 (0.9)	424 (5.6)	24 (1.0)	429 (4.1)	28 (1.2)	432 (2.5)	33 (1.0)	432 (3.4)
Ireland	39 (1.3)	529 (5.0)	33 (0.9)	543 (5.6)	18 (0.9)	524 (7.2)	9 (0.7)	495 (7.5)
Israel	19 (1.9)	527 (10.7)	41 (1.5)	533 (8.6)	23 (1.5)	516 (6.3)	16 (1.1)	511 (6.7)
Japan	25 (1.1)	594 (3.8)	57 (0.9)	608 (2.1)	16 (0.8)	612 (3.4)	2 (0.2)	~ ~
Korea	31 (1.1)	604 (3.4)	50 (1.0)	613 (3.3)	13 (0.7)	613 (6.7)	5 (0.5)	571 (10.8)
Kuwait	22 (1.5)	399 (3.9)	35 (1.6)	396 (2.8)	23 (1.5)	390 (3.3)	21 (1.7)	381 (3.6)
Latvia (LSS)	8 (0.9)	494 (7.2)	18 (0.9)	498 (5.3)	29 (1.0)	495 (4.0)	45 (1.4)	492 (3.9)
Lithuania	20 (1.0)	479 (5.1)	39 (1.0)	481 (4.1)	27 (1.1)	480 (4.8)	14 (0.8)	466 (6.4)
Netherlands	27 (1.5)	522 (10.0)	48 (1.5)	549 (6.1)	17 (1.1)	558 (7.1)	8 (0.7)	545 (11.1)
New Zealand	8 (0.6)	488 (7.1)	38 (1.0)	516 (5.1)	39 (1.1)	512 (4.7)	15 (0.7)	495 (5.9)
Norway	31 (1.2)	493 (3.1)	46 (1.1)	508 (2.5)	18 (0.9)	522 (4.5)	6 (0.5)	487 (8.2)
Portugal	20 (0.9)	457 (3.5)	36 (1.0)	459 (3.1)	24 (0.9)	452 (3.4)	20 (0.9)	448 (3.2)
Romania	15 (0.8)	483 (5.9)	41 (1.2)	492 (4.9)	23 (0.8)	479 (5.2)	21 (0.9)	469 (5.2)
Russian Federation	17 (1.1)	532 (5.0)	52 (1.2)	542 (5.0)	21 (1.6)	541 (9.4)	9 (0.8)	502 (8.5)
Scotland	17 (1.0)	492 (6.2)	35 (1.1)	511 (6.1)	33 (1.1)	502 (6.6)	15 (0.9)	479 (8.4)
Singapore	20 (0.9)	633 (6.3)	41 (1.0)	652 (5.2)	30 (0.9)	645 (5.7)	10 (0.5)	627 (5.9)
Slovak Republic	36 (1.6)	531 (3.7)	43 (1.2)	560 (4.4)	16 (0.9)	557 (5.3)	5 (0.5)	527 (11.2)
Slovenia	15 (0.9)	536 (4.1)	55 (1.2)	543 (3.8)	21 (0.9)	546 (5.0)	8 (0.8)	522 (7.0)
Spain	15 (1.0)	469 (3.6)	31 (1.1)	492 (2.7)	26 (1.0)	495 (2.8)	27 (1.1)	486 (3.1)
Sweden	29 (1.1)	509 (3.8)	41 (0.9)	525 (3.6)	23 (0.8)	525 (3.9)	7 (0.6)	517 (5.8)
Switzerland	17 (1.0)	543 (5.1)	51 (1.1)	552 (3.0)	25 (1.2)	549 (4.3)	7 (0.6)	523 (8.9)
Thailand	19 (0.8)	513 (5.4)	44 (0.9)	524 (5.3)	26 (0.9)	530 (8.1)	11 (0.7)	518 (7.5)
United States	14 (0.8)	491 (6.3)	34 (1.1)	515 (4.7)	31 (1.0)	504 (5.0)	21 (0.9)	481 (5.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Are Calculators and Computers Used?

As shown in Table 5.13, nearly all eighth-grade students reported having a calculator in the home, except in Iran (61%), Romania (62%), and Thailand (68%). Internationally, fewer students reported a computer in the home, even though more than three-fourths did so in Denmark, England, Iceland, Ireland, Israel, the Netherlands, and Scotland. Between 50% and 75% so reported in Australia, Austria, Belgium (Flemish), Belgium (French), Canada, Germany, Kuwait, New Zealand, Norway, Sweden, Switzerland, and the United States. Fewer than 20% of the eighth-grade students reported home computers in Colombia, Iran, Latvia (LSS), Romania, and Thailand.

Table 5.14 provides teachers' reports about how often calculators are used in eighth-grade mathematics classes. Even though calculators appear to be widely available in most countries, teachers reported considerable variation from country to country in the frequency of calculator use in mathematics classrooms. Although using calculators can take the drudgery out of mathematics and free the learner to concentrate on higher-order problem-solving skills, another point of view is that permitting unrestricted use of calculators may damage students' mastery of basic skills in mathematics.

According to teachers in many of the TIMSS countries, three-fourths or more of the eighth-grade students use calculators almost every day in their mathematics classes. The exceptions to at least weekly usage for the majority of the students were Belgium (Flemish), Greece, Iran, Ireland, Japan, Korea, Romania, and Thailand. As revealed in Table 5.15, teachers reported that students use calculators for a variety of purposes. Across countries, no single use appears to predominate, although checking answers, routine computation, and solving complex problems are frequent purposes in many countries. Using calculators on tests and exams was often less frequent than other uses, ranging from 0% of the students in Japan and Thailand to 64% in Austria.

Students' reports about the frequency of calculator usage in mathematics classes are presented in Table 5.16. Because different response categories were used for the student and teacher versions of the question, a direct comparison is difficult. It does appear that fewer students than teachers indicated nearly always using calculators. However, combining the two most frequent categories for students (pretty often and almost always) and comparing those percentages of responses to the two most frequent response categories for teachers (almost every day and once or twice a week) yields a fair degree of agreement between teachers' and students' reports.

Table 5.17 contains teachers' reports about how often computers are used in mathematics class to solve exercises or problems, and Table 5.18 contains students' responses to a similar question. Internationally, substantial percentages of teachers and students agreed that the computer is almost never used in most students' mathematics lessons. Teachers and students agree on moderate use of computers (more than 20% of the students in some lessons) in Austria, Denmark, England, Sweden, and the United States.

Table 5.13

Students' Reports on Having a Calculator and Computer in the Home
Mathematics - Upper Grade (Eighth Grade*)

Country	Calculator				Computer			
	Yes		No		Yes		No	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	97 (0.3)	533 (4.0)	3 (0.3)	447 (11.1)	73 (1.2)	539 (4.3)	27 (1.2)	510 (4.5)
Austria	100 (0.1)	540 (3.2)	0 (0.1)	~ ~	59 (1.5)	546 (3.5)	41 (1.5)	532 (4.0)
Belgium (Fl)	97 (0.8)	569 (5.2)	3 (0.8)	465 (20.2)	67 (1.3)	573 (5.8)	33 (1.3)	551 (6.3)
Belgium (Fr)	98 (0.3)	528 (3.4)	2 (0.3)	~ ~	60 (1.4)	538 (3.2)	40 (1.4)	511 (4.7)
Canada	98 (0.2)	529 (2.3)	2 (0.2)	~ ~	61 (1.3)	537 (2.4)	39 (1.3)	512 (3.2)
Colombia	88 (1.5)	389 (3.0)	12 (1.5)	356 (8.6)	11 (1.2)	405 (8.7)	89 (1.2)	382 (3.4)
Cyprus	96 (0.4)	477 (2.0)	4 (0.4)	418 (7.3)	39 (0.9)	484 (2.9)	61 (0.9)	469 (2.4)
Czech Republic	99 (0.2)	564 (4.9)	1 (0.2)	~ ~	36 (1.2)	579 (5.3)	64 (1.2)	555 (5.1)
Denmark	99 (0.3)	504 (2.9)	1 (0.3)	~ ~	76 (1.2)	508 (2.9)	24 (1.2)	490 (4.9)
England	99 (0.2)	508 (2.7)	1 (0.2)	~ ~	89 (0.8)	506 (3.1)	11 (0.8)	512 (8.2)
France	99 (0.2)	540 (3.1)	1 (0.2)	~ ~	50 (1.3)	547 (3.6)	50 (1.3)	531 (3.6)
Germany	99 (0.2)	510 (4.4)	1 (0.2)	~ ~	71 (1.0)	512 (4.3)	29 (1.0)	504 (5.6)
Greece	87 (0.6)	491 (3.0)	13 (0.6)	437 (4.6)	29 (1.0)	500 (5.3)	71 (1.0)	478 (2.8)
Hong Kong	99 (0.1)	590 (6.4)	1 (0.1)	~ ~	39 (1.9)	606 (7.2)	61 (1.9)	580 (6.5)
Hungary	97 (0.4)	541 (3.1)	3 (0.4)	457 (12.9)	37 (1.2)	569 (3.7)	63 (1.2)	521 (3.4)
Iceland	100 (0.1)	488 (4.5)	0 (0.1)	~ ~	77 (1.4)	488 (4.7)	23 (1.4)	483 (5.7)
Iran, Islamic Rep.	61 (1.8)	437 (2.2)	39 (1.8)	417 (2.9)	4 (0.4)	440 (6.9)	96 (0.4)	429 (2.1)
Ireland	97 (0.3)	529 (5.0)	3 (0.3)	497 (13.3)	78 (1.1)	531 (5.3)	22 (1.1)	521 (6.4)
Israel	99 (0.3)	524 (6.1)	1 (0.3)	~ ~	76 (2.1)	534 (5.8)	24 (2.1)	496 (9.1)
Japan	- -	- -	- -	- -	- -	- -	- -	- -
Korea	91 (0.5)	610 (2.5)	9 (0.5)	578 (8.1)	39 (1.2)	632 (3.6)	61 (1.2)	592 (2.8)
Kuwait	84 (1.4)	395 (2.5)	16 (1.4)	380 (3.6)	53 (2.1)	394 (3.4)	47 (2.1)	390 (2.8)
Latvia (LSS)	94 (0.5)	495 (3.1)	6 (0.5)	473 (8.1)	13 (0.9)	492 (5.6)	87 (0.9)	495 (3.1)
Lithuania	90 (1.0)	482 (3.6)	10 (1.0)	443 (6.3)	42 (1.4)	478 (3.9)	58 (1.4)	477 (4.2)
Netherlands	100 (0.1)	542 (7.0)	0 (0.1)	~ ~	85 (1.2)	545 (8.1)	15 (1.2)	524 (7.7)
New Zealand	99 (0.2)	509 (4.5)	1 (0.2)	~ ~	60 (1.3)	520 (5.0)	40 (1.3)	491 (4.6)
Norway	99 (0.2)	504 (2.2)	1 (0.2)	~ ~	64 (1.1)	512 (2.7)	36 (1.1)	489 (3.1)
Portugal	99 (0.2)	455 (2.5)	1 (0.2)	~ ~	39 (1.8)	469 (3.4)	61 (1.8)	446 (2.2)
Romania	62 (1.5)	491 (4.7)	38 (1.5)	467 (5.1)	19 (1.2)	496 (7.3)	81 (1.2)	479 (4.0)
Russian Federation	92 (0.8)	539 (5.0)	8 (0.8)	498 (10.8)	35 (1.5)	537 (5.6)	65 (1.5)	535 (6.2)
Scotland	98 (0.4)	500 (5.7)	2 (0.4)	~ ~	90 (0.6)	499 (5.8)	10 (0.6)	504 (7.4)
Singapore	100 (0.1)	644 (4.9)	0 (0.1)	~ ~	49 (1.5)	657 (5.1)	51 (1.5)	630 (5.0)
Slovak Republic	99 (0.2)	548 (3.3)	1 (0.2)	~ ~	31 (1.2)	563 (4.4)	69 (1.2)	540 (3.6)
Slovenia	98 (0.3)	542 (3.0)	2 (0.3)	~ ~	47 (1.3)	560 (3.7)	53 (1.3)	524 (3.4)
Spain	99 (0.2)	488 (2.0)	1 (0.2)	~ ~	42 (1.2)	499 (2.9)	58 (1.2)	479 (2.1)
Sweden	99 (0.1)	519 (2.9)	1 (0.1)	~ ~	60 (1.3)	531 (2.8)	40 (1.3)	500 (3.6)
Switzerland	99 (0.2)	547 (2.8)	1 (0.2)	~ ~	66 (1.2)	554 (3.1)	34 (1.2)	531 (3.8)
Thailand	68 (2.2)	530 (7.1)	32 (2.2)	508 (4.1)	4 (0.9)	573 (14.2)	96 (0.9)	521 (5.4)
United States	98 (0.3)	502 (4.5)	2 (0.3)	~ ~	59 (1.7)	518 (4.8)	41 (1.7)	474 (4.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.14

Teachers' Reports on Frequency of Students' Use of Calculators in Mathematics Class[1]
Upper Grade (Eighth Grade*)

Country		Never or Hardly Ever		Once or Twice a Month		Once or Twice a Week		Almost Every Day	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r	6 (2.0)	512 (26.3)	1 (0.7)	~ ~	10 (1.7)	511 (14.7)	83 (2.6)	537 (5.0)
Austria	r	2 (1.3)	~ ~	3 (1.7)	470 (14.6)	7 (2.1)	560 (17.4)	87 (3.1)	550 (4.2)
Belgium (Fl)		39 (4.9)	577 (12.1)	23 (3.9)	572 (16.4)	14 (3.8)	584 (15.6)	24 (3.5)	571 (6.4)
Belgium (Fr)	s	18 (5.1)	553 (11.0)	25 (5.0)	551 (9.9)	27 (4.9)	537 (8.7)	30 (5.5)	543 (9.2)
Canada		5 (1.4)	489 (17.5)	3 (0.9)	515 (13.1)	12 (2.5)	518 (9.9)	80 (2.8)	533 (3.8)
Colombia		33 (4.6)	383 (4.0)	11 (2.7)	397 (8.9)	22 (4.7)	401 (17.5)	34 (4.7)	377 (3.5)
Cyprus	r	27 (4.6)	471 (6.4)	8 (2.5)	464 (4.3)	21 (4.1)	463 (6.9)	44 (5.2)	475 (4.3)
Czech Republic		3 (1.9)	523 (19.8)	6 (2.3)	552 (17.5)	17 (4.4)	566 (9.2)	74 (4.9)	563 (5.7)
Denmark		28 (4.9)	502 (5.6)	15 (3.6)	503 (7.6)	18 (3.7)	507 (6.2)	39 (4.9)	507 (4.1)
England	s	0 (0.0)	~ ~	2 (0.7)	~ ~	15 (2.2)	479 (9.8)	83 (2.2)	523 (4.5)
France		4 (2.0)	537 (21.7)	3 (1.6)	565 (23.3)	19 (3.4)	538 (6.0)	74 (4.2)	537 (4.1)
Germany	s	19 (3.8)	511 (9.8)	5 (2.4)	579 (25.4)	15 (3.2)	526 (19.4)	62 (4.5)	508 (7.0)
Greece		46 (4.1)	486 (3.8)	23 (4.1)	475 (7.3)	12 (2.4)	483 (9.1)	19 (3.6)	490 (6.0)
Hong Kong		8 (3.0)	558 (38.8)	7 (2.9)	581 (21.4)	18 (3.7)	555 (18.4)	67 (4.9)	601 (8.0)
Hungary		29 (3.8)	533 (7.5)	5 (1.9)	512 (18.3)	6 (1.9)	534 (16.8)	60 (4.2)	540 (4.9)
Iceland	r	0 (0.0)	~ ~	0 (0.0)	~ ~	4 (1.8)	476 (15.8)	96 (1.8)	490 (5.2)
Iran, Islamic Rep.		54 (5.9)	422 (3.4)	32 (5.9)	437 (2.3)	9 (2.6)	432 (8.7)	5 (2.0)	442 (5.8)
Ireland		68 (4.6)	535 (8.0)	7 (2.3)	490 (15.9)	13 (3.5)	515 (16.2)	11 (3.2)	521 (16.6)
Israel	r	11 (5.7)	501 (9.0)	5 (3.7)	588 (34.8)	11 (4.6)	517 (34.6)	73 (6.9)	518 (7.6)
Japan		79 (3.7)	603 (2.9)	16 (3.4)	609 (9.1)	4 (1.6)	620 (22.6)	2 (1.2)	~ ~
Korea		76 (4.1)	613 (2.9)	16 (3.5)	608 (7.3)	8 (2.7)	585 (6.8)	1 (0.6)	~ ~
Kuwait		23 (4.4)	400 (5.5)	11 (2.9)	396 (6.5)	23 (7.2)	390 (4.3)	43 (7.9)	388 (3.2)
Latvia (LSS)	r	13 (3.0)	499 (7.8)	13 (3.6)	479 (8.6)	27 (4.4)	492 (7.1)	46 (4.9)	492 (5.2)
Lithuania	r	12 (2.9)	453 (10.8)	6 (2.2)	496 (22.0)	20 (3.7)	461 (9.0)	62 (4.4)	485 (4.9)
Netherlands		0 (0.0)	~ ~	2 (1.5)	~ ~	17 (4.3)	535 (20.4)	81 (4.5)	545 (9.2)
New Zealand		7 (2.1)	536 (18.4)	5 (1.6)	507 (12.6)	21 (3.4)	510 (9.3)	66 (4.0)	505 (6.0)
Norway	r	2 (1.3)	~ ~	1 (1.0)	~ ~	15 (3.8)	504 (6.2)	82 (3.8)	507 (2.8)
Portugal		1 (0.9)	~ ~	4 (1.3)	452 (10.4)	21 (3.4)	454 (5.9)	74 (3.8)	455 (2.8)
Romania		63 (4.2)	470 (5.1)	7 (2.3)	494 (12.2)	10 (2.5)	521 (10.0)	19 (3.1)	490 (10.5)
Russian Federation		9 (2.1)	512 (11.0)	6 (2.1)	556 (21.4)	18 (3.0)	533 (7.9)	67 (3.9)	536 (7.4)
Scotland		- -	- -	- -	- -	- -	- -	- -	- -
Singapore		1 (0.8)	~ ~	5 (1.9)	617 (23.0)	12 (2.7)	636 (14.1)	82 (3.2)	647 (5.4)
Slovak Republic		2 (1.1)	~ ~	6 (2.0)	547 (11.6)	10 (2.5)	547 (12.2)	82 (3.1)	546 (3.6)
Slovenia	r	35 (4.7)	539 (5.2)	13 (3.3)	542 (10.3)	17 (4.0)	534 (8.9)	35 (4.7)	543 (6.1)
Spain	r	40 (4.4)	487 (4.7)	4 (1.9)	490 (12.2)	11 (2.6)	479 (7.0)	45 (4.7)	489 (4.3)
Sweden		7 (2.2)	495 (17.2)	21 (3.0)	523 (6.5)	37 (4.0)	520 (5.0)	35 (3.9)	521 (5.6)
Switzerland	s	36 (4.6)	545 (10.7)	8 (2.6)	547 (13.1)	24 (4.0)	545 (13.4)	32 (3.5)	567 (7.9)
Thailand	r	72 (5.8)	532 (9.3)	15 (4.9)	525 (12.0)	9 (3.6)	501 (4.7)	4 (1.8)	523 (13.1)
United States	r	8 (2.3)	489 (17.7)	10 (2.0)	460 (8.4)	20 (3.4)	492 (7.6)	62 (4.2)	513 (5.8)

[1]Based on most frequent response for: checking answers, test and exams, routine computations, solving complex problems, and exploring number concepts.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.15

Teachers' Reports on Ways in Which Calculators Are Used at Least Once or Twice a Week - Mathematics - Upper Grade (Eighth Grade*)

Country	Percent of Students by Type of Use: Never or Hardly Ever Use Calculators	Checking Answers	Tests and Exams	Routine Computations	Solving Complex Problems	Exploring Number Concepts
Australia	r 6 (2.0)	r 84 (3.0)	r 47 (3.5)	r 92 (2.1)	r 76 (3.1)	r 48 (3.9)
Austria	r 2 (1.3)	r 91 (2.9)	r 64 (4.2)	r 91 (2.2)	r 70 (4.6)	s 28 (3.7)
Belgium (Fl)	39 (4.9)	24 (3.4)	10 (2.5)	28 (4.3)	15 (3.2)	10 (2.3)
Belgium (Fr)	s 18 (5.1)	s 53 (6.3)	s 16 (4.3)	s 41 (5.8)	s 39 (5.7)	s 24 (5.5)
Canada	5 (1.4)	85 (2.4)	r 52 (4.4)	82 (2.5)	86 (2.7)	r 63 (4.2)
Colombia	33 (4.6)	33 (4.4)	18 (3.8)	34 (4.7)	32 (4.4)	30 (4.9)
Cyprus	r 27 (4.6)	r 57 (5.3)	r 4 (2.3)	r 51 (5.8)	r 35 (4.3)	r 21 (4.6)
Czech Republic	3 (1.9)	80 (4.2)	22 (5.1)	67 (5.2)	80 (4.0)	16 (5.2)
Denmark	28 (4.9)	52 (4.9)	r 5 (2.0)	48 (5.1)	33 (4.4)	25 (4.2)
England	s 0 (0.0)	s 86 (2.4)	s 42 (3.4)	s 96 (1.0)	s 73 (2.6)	s 55 (3.4)
France	4 (2.0)	r 91 (2.8)	r 57 (4.8)	82 (3.5)	50 (5.0)	r 39 (5.3)
Germany	s 19 (3.8)	s 67 (4.8)	s 39 (4.9)	s 72 (4.4)	s 64 (5.4)	s 27 (5.5)
Greece	46 (4.1)	24 (3.5)	2 (1.0)	21 (3.5)	21 (3.4)	8 (2.4)
Hong Kong	8 (3.0)	74 (5.0)	53 (6.1)	79 (5.1)	62 (5.8)	29 (5.4)
Hungary	29 (3.8)	r 56 (5.1)	r 14 (2.9)	r 43 (4.4)	r 53 (4.7)	r 53 (4.4)
Iceland	r 0 (0.0)	r 91 (3.8)	r 51 (8.4)	r 97 (2.1)	r 99 (0.1)	r 69 (6.2)
Iran, Islamic Rep.	54 (5.9)	4 (1.6)	2 (1.7)	8 (2.4)	8 (2.8)	6 (1.6)
Ireland	68 (4.6)	18 (4.0)	4 (2.0)	r 17 (3.9)	r 7 (2.5)	r 4 (1.8)
Israel	r 11 (5.7)	r 75 (6.4)	r 57 (7.9)	r 72 (6.3)	r 56 (7.4)	r 43 (8.5)
Japan	79 (3.7)	1 (0.6)	0 (0.0)	3 (1.5)	2 (0.7)	3 (1.4)
Korea	76 (4.1)	1 (0.9)	1 (0.6)	6 (2.5)	4 (1.6)	1 (0.8)
Kuwait	23 (4.4)	51 (8.0)	25 (6.6)	52 (7.7)	48 (6.3)	22 (6.4)
Latvia (LSS)	r 13 (3.0)	r 50 (4.9)	r 8 (2.8)	r 59 (4.2)	r 49 (5.2)	r 17 (3.9)
Lithuania	r 12 (2.9)	r 72 (4.1)	r 9 (2.9)	r 66 (4.1)	r 58 (4.5)	r 18 (3.7)
Netherlands	0 (0.0)	83 (4.5)	50 (6.1)	97 (1.8)	67 (4.9)	46 (5.3)
New Zealand	7 (2.1)	41 (4.3)	20 (3.1)	85 (3.0)	70 (4.0)	54 (4.5)
Norway	r 2 (1.3)	r 93 (2.4)	r 24 (4.0)	r 91 (2.8)	r 72 (4.7)	r 35 (4.8)
Portugal	1 (0.9)	86 (2.6)	31 (3.5)	76 (3.4)	67 (3.7)	55 (4.2)
Romania	63 (4.2)	20 (3.4)	1 (1.1)	25 (3.3)	11 (2.7)	9 (2.3)
Russian Federation	9 (2.1)	73 (4.5)	15 (2.8)	76 (3.9)	45 (5.2)	6 (1.7)
Scotland	- -	- -	- -	- -	- -	- -
Singapore	1 (0.8)	89 (2.7)	47 (4.7)	83 (3.4)	82 (3.7)	57 (4.4)
Slovak Republic	2 (1.1)	79 (3.7)	31 (4.1)	72 (4.6)	77 (3.8)	60 (4.3)
Slovenia	r 35 (4.7)	r 39 (5.2)	r 4 (2.1)	r 38 (5.3)	r 28 (4.6)	r 6 (2.5)
Spain	r 40 (4.4)	r 46 (4.6)	r 16 (3.4)	r 35 (4.4)	r 39 (4.8)	r 29 (4.2)
Sweden	7 (2.2)	r 42 (4.1)	r 13 (2.8)	r 57 (4.1)	r 60 (3.6)	r 25 (3.5)
Switzerland	s 36 (4.6)	s 47 (4.9)	s 16 (2.7)	s 48 (4.3)	s 35 (3.9)	s 17 (2.8)
Thailand	r 72 (5.8)	r 7 (3.0)	r 0 (0.0)	r 5 (2.4)	r 9 (3.1)	s 10 (3.6)
United States	r 8 (2.3)	r 71 (3.8)	r 47 (4.2)	r 68 (3.6)	r 76 (3.4)	r 58 (3.9)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.16

Students' Reports on Frequency of Using Calculators in Mathematics Class Upper Grade (Eighth Grade*)

Country	Never		Once in a While		Pretty Often		Almost Always	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	4 (1.1)	495 (28.4)	10 (0.9)	509 (7.5)	31 (1.1)	533 (4.4)	55 (1.9)	539 (4.6)
Austria	2 (0.7)	~ ~	7 (0.8)	515 (9.9)	17 (1.2)	542 (7.2)	74 (2.1)	542 (3.3)
Belgium (Fl)	34 (4.1)	571 (12.4)	36 (2.4)	577 (6.1)	20 (2.5)	556 (10.5)	10 (1.6)	530 (11.7)
Belgium (Fr)	37 (2.7)	526 (4.6)	41 (1.9)	543 (3.9)	14 (1.6)	516 (8.4)	9 (1.1)	491 (8.6)
Canada	6 (1.2)	493 (8.7)	22 (1.6)	523 (3.6)	33 (1.2)	532 (3.0)	38 (2.2)	534 (4.4)
Colombia	54 (2.5)	394 (3.2)	26 (1.3)	382 (4.4)	9 (0.9)	393 (6.9)	11 (1.1)	371 (4.1)
Cyprus	30 (2.0)	480 (3.5)	39 (1.4)	477 (3.1)	21 (1.0)	475 (4.2)	10 (0.9)	452 (4.5)
Czech Republic	5 (1.2)	552 (12.0)	33 (2.5)	553 (6.1)	37 (2.1)	578 (6.8)	24 (1.9)	560 (5.5)
Denmark	32 (3.7)	506 (4.0)	37 (2.6)	499 (4.2)	19 (1.7)	514 (6.3)	12 (1.7)	498 (5.0)
England	0 (0.1)	~ ~	9 (0.9)	467 (6.6)	46 (1.6)	507 (4.3)	45 (1.8)	517 (3.3)
France	2 (0.9)	~ ~	27 (1.5)	539 (4.0)	40 (1.3)	548 (3.4)	30 (1.4)	530 (5.1)
Germany	25 (2.8)	502 (7.1)	19 (1.7)	527 (9.1)	20 (1.5)	517 (7.6)	35 (2.0)	504 (6.2)
Greece	51 (2.6)	482 (3.9)	26 (1.3)	494 (4.0)	14 (1.1)	489 (5.6)	9 (1.0)	473 (6.0)
Hong Kong	8 (2.3)	572 (27.9)	9 (1.2)	567 (15.8)	33 (1.9)	593 (6.4)	49 (2.5)	595 (7.0)
Hungary	20 (2.2)	521 (6.2)	39 (1.9)	539 (4.0)	24 (1.3)	547 (5.9)	17 (1.3)	547 (5.7)
Iceland	1 (0.3)	~ ~	6 (0.9)	474 (10.9)	32 (2.0)	491 (5.5)	61 (2.3)	487 (4.8)
Iran, Islamic Rep.	79 (1.4)	432 (2.4)	13 (1.0)	435 (4.7)	4 (0.5)	415 (4.4)	4 (0.5)	400 (6.5)
Ireland	79 (1.7)	535 (5.3)	14 (1.0)	517 (7.0)	4 (0.6)	493 (9.4)	3 (0.5)	484 (11.7)
Israel	7 (1.8)	517 (12.5)	21 (2.2)	536 (7.6)	27 (1.6)	532 (8.6)	45 (3.4)	515 (6.2)
Japan	75 (2.3)	607 (2.1)	21 (1.9)	603 (3.4)	3 (0.7)	575 (7.0)	0 (0.1)	~ ~
Korea	93 (0.5)	613 (2.5)	5 (0.4)	570 (9.7)	1 (0.3)	~ ~	1 (0.2)	~ ~
Kuwait	27 (3.2)	394 (3.7)	35 (2.1)	395 (3.1)	23 (1.5)	391 (3.8)	14 (1.7)	387 (3.3)
Latvia (LSS)	14 (1.4)	502 (5.7)	27 (1.4)	499 (4.1)	35 (1.3)	492 (4.1)	24 (2.0)	487 (5.2)
Lithuania	17 (1.7)	476 (6.5)	34 (1.5)	472 (3.9)	24 (1.2)	484 (4.5)	25 (1.7)	482 (5.8)
Netherlands	1 (0.2)	~ ~	9 (1.3)	514 (16.9)	36 (1.7)	547 (7.2)	54 (2.1)	544 (7.4)
New Zealand	6 (1.1)	519 (13.3)	20 (1.7)	503 (6.9)	37 (1.3)	511 (5.3)	36 (2.0)	510 (6.1)
Norway	4 (1.0)	465 (9.6)	25 (1.7)	497 (3.3)	39 (1.2)	509 (3.1)	33 (1.9)	508 (3.1)
Portugal	3 (0.6)	455 (7.3)	27 (1.6)	457 (3.1)	34 (1.2)	454 (3.5)	35 (1.5)	454 (2.8)
Romania	57 (1.7)	484 (4.7)	25 (1.2)	490 (5.4)	9 (0.6)	475 (6.8)	9 (0.8)	465 (7.3)
Russian Federation	9 (1.4)	538 (11.3)	37 (2.3)	537 (7.2)	25 (1.6)	537 (5.3)	29 (1.6)	534 (5.7)
Scotland	2 (0.7)	~ ~	16 (1.5)	498 (7.0)	48 (1.5)	501 (5.3)	34 (2.0)	498 (8.8)
Singapore	1 (0.4)	~ ~	16 (1.5)	613 (6.0)	54 (1.2)	648 (5.0)	29 (1.7)	655 (5.6)
Slovak Republic	4 (0.7)	550 (13.7)	24 (1.7)	543 (4.9)	37 (1.3)	554 (4.3)	35 (1.7)	544 (4.5)
Slovenia	44 (3.0)	544 (4.1)	38 (2.2)	540 (4.2)	10 (1.0)	534 (7.9)	8 (0.8)	535 (8.5)
Spain	49 (3.3)	493 (2.9)	23 (1.9)	492 (3.4)	12 (1.1)	479 (5.3)	17 (2.0)	471 (4.3)
Sweden	4 (0.9)	482 (13.1)	42 (2.2)	520 (3.2)	36 (1.7)	527 (3.9)	18 (2.2)	511 (5.2)
Switzerland	45 (2.9)	538 (4.6)	22 (1.6)	552 (5.1)	16 (1.2)	553 (5.5)	16 (1.3)	561 (6.3)
Thailand	59 (2.2)	514 (4.7)	34 (1.7)	535 (8.0)	5 (0.8)	543 (16.3)	2 (0.3)	~ ~
United States	10 (1.6)	464 (9.4)	20 (1.6)	498 (5.8)	26 (1.2)	501 (5.3)	44 (2.7)	511 (5.6)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.17

Teachers' Reports on Frequency of Using Computers in Mathematics Class to Solve Exercises or Problems - Upper Grade (Eighth Grade*)

Country		Never or Almost Never: Percent of Students	Never or Almost Never: Mean Achievement	Some Lessons: Percent of Students	Some Lessons: Mean Achievement	Most or Every Lesson: Percent of Students	Most or Every Lesson: Mean Achievement
Australia	r	78 (3.2)	531 (5.3)	21 (3.2)	535 (9.6)	0 (0.2)	~ ~
Austria	r	69 (4.5)	551 (5.6)	29 (4.4)	543 (7.3)	1 (0.5)	~ ~
Belgium (Fl)		99 (0.7)	574 (4.6)	1 (0.7)	~ ~	0 (0.0)	~ ~
Belgium (Fr)	s	95 (2.4)	543 (4.4)	4 (2.2)	555 (25.7)	1 (1.0)	~ ~
Canada		82 (3.5)	533 (2.9)	18 (3.5)	511 (10.3)	1 (0.5)	~ ~
Colombia		94 (2.2)	387 (3.8)	5 (2.0)	391 (12.9)	1 (0.9)	~ ~
Cyprus	r	89 (3.3)	468 (2.9)	11 (3.3)	476 (11.4)	0 (0.0)	~ ~
Czech Republic		74 (5.4)	560 (6.4)	23 (5.1)	568 (8.8)	4 (2.8)	549 (0.7)
Denmark		38 (4.5)	500 (4.5)	62 (4.5)	507 (2.9)	0 (0.0)	~ ~
England	s	53 (3.9)	517 (5.9)	46 (3.7)	514 (6.9)	2 (1.0)	~ ~
France		86 (3.2)	541 (3.3)	14 (3.2)	536 (11.5)	0 (0.0)	~ ~
Germany	s	87 (3.1)	510 (5.8)	13 (3.1)	550 (12.3)	0 (0.0)	~ ~
Greece		85 (2.9)	481 (3.3)	12 (2.5)	500 (7.7)	2 (1.4)	~ ~
Hong Kong		90 (3.5)	590 (7.3)	9 (3.7)	576 (29.4)	1 (1.2)	~ ~
Hungary		- -	- -	- -	- -	- -	- -
Iceland		- -	- -	- -	- -	- -	- -
Iran, Islamic Rep.		93 (5.5)	430 (2.3)	6 (5.5)	435 (18.2)	1 (1.0)	~ ~
Ireland		99 (0.9)	528 (6.0)	1 (0.9)	~ ~	0 (0.0)	~ ~
Israel		- -	- -	- -	- -	- -	- -
Japan		90 (2.7)	604 (2.5)	9 (2.6)	612 (10.1)	1 (0.5)	~ ~
Korea		96 (1.6)	610 (2.5)	3 (1.3)	618 (21.6)	1 (1.0)	~ ~
Kuwait		73 (7.1)	393 (2.9)	21 (6.6)	387 (3.4)	6 (3.4)	389 (10.6)
Latvia (LSS)	r	97 (1.6)	490 (3.3)	3 (1.6)	494 (14.9)	0 (0.0)	~ ~
Lithuania		94 (1.8)	480 (4.1)	6 (1.8)	450 (12.3)	0 (0.0)	~ ~
Netherlands		- -	- -	- -	- -	- -	- -
New Zealand		86 (3.1)	506 (4.4)	14 (3.1)	526 (15.7)	0 (0.0)	~ ~
Norway	r	90 (2.6)	507 (2.7)	10 (2.6)	509 (5.1)	0 (0.0)	~ ~
Portugal		97 (1.5)	454 (2.6)	3 (1.5)	482 (23.2)	0 (0.0)	~ ~
Romania		96 (1.7)	481 (4.4)	4 (1.7)	512 (20.6)	0 (0.0)	~ ~
Russian Federation		78 (2.6)	533 (6.8)	15 (2.2)	537 (6.9)	6 (2.4)	566 (14.6)
Scotland		- -	- -	- -	- -	- -	- -
Singapore		92 (2.7)	643 (5.3)	8 (2.7)	652 (15.3)	0 (0.0)	~ ~
Slovak Republic		95 (1.5)	543 (3.3)	4 (1.3)	592 (13.5)	1 (0.8)	~ ~
Slovenia	r	69 (4.5)	539 (4.5)	27 (4.5)	545 (7.2)	4 (2.1)	527 (21.9)
Spain	r	89 (3.1)	488 (2.6)	11 (3.1)	472 (9.1)	0 (0.0)	~ ~
Sweden	r	74 (2.9)	519 (4.1)	25 (2.9)	515 (7.3)	0 (0.3)	~ ~
Switzerland	s	87 (3.2)	549 (5.6)	13 (3.3)	577 (13.0)	1 (0.8)	~ ~
Thailand	r	97 (2.0)	528 (7.5)	1 (1.5)	~ ~	2 (1.3)	~ ~
United States	r	76 (3.1)	502 (5.9)	21 (3.2)	497 (9.1)	3 (1.7)	506 (22.2)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.18

Students' Reports on Frequency of Using Computers in Mathematics Class Upper Grade (Eighth Grade*)

Country	Never		Once in a While		Always or Pretty Often	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	77 (2.1)	536 (4.4)	18 (1.7)	536 (7.6)	5 (0.9)	477 (11.4)
Austria	62 (2.6)	545 (3.8)	32 (2.2)	540 (5.4)	6 (0.8)	487 (7.9)
Belgium (Fl)	94 (1.1)	568 (5.7)	4 (0.9)	544 (15.7)	2 (0.6)	~ ~
Belgium (Fr)	94 (1.4)	532 (3.3)	3 (0.7)	531 (22.2)	4 (0.9)	437 (20.4)
Canada	82 (1.4)	532 (2.4)	13 (1.3)	528 (8.4)	5 (0.4)	476 (6.7)
Colombia	95 (0.5)	389 (2.9)	3 (0.4)	390 (6.9)	3 (0.3)	370 (5.9)
Cyprus	73 (0.9)	485 (1.8)	16 (0.9)	459 (4.9)	11 (0.8)	432 (4.3)
Czech Republic	88 (2.9)	564 (5.1)	8 (1.9)	560 (12.5)	4 (1.8)	570 (18.0)
Denmark	40 (3.6)	505 (4.0)	51 (3.0)	507 (3.6)	9 (1.3)	486 (8.4)
England	45 (2.6)	512 (4.9)	46 (2.3)	514 (4.3)	9 (1.2)	457 (6.8)
France	88 (2.4)	542 (3.3)	8 (2.0)	531 (10.8)	4 (0.8)	492 (9.6)
Germany	84 (2.1)	511 (4.6)	11 (1.9)	533 (9.3)	5 (0.7)	455 (7.7)
Greece	83 (1.0)	490 (2.9)	10 (0.7)	471 (6.4)	7 (0.6)	443 (6.2)
Hong Kong	91 (0.7)	592 (6.2)	6 (0.5)	580 (11.4)	3 (0.4)	559 (16.7)
Hungary	92 (0.8)	539 (3.2)	5 (0.8)	548 (12.3)	2 (0.4)	~ ~
Iceland	81 (2.4)	494 (4.4)	11 (1.3)	479 (5.1)	8 (1.6)	442 (9.8)
Iran, Islamic Rep.	92 (0.8)	432 (2.3)	3 (0.4)	416 (5.2)	4 (0.5)	399 (5.6)
Ireland	96 (1.1)	531 (5.0)	3 (0.9)	498 (30.4)	1 (0.3)	~ ~
Israel	76 (4.5)	530 (6.9)	12 (2.6)	523 (11.5)	11 (3.0)	489 (15.7)
Japan	77 (3.3)	604 (2.9)	19 (2.6)	611 (4.6)	4 (1.2)	604 (14.5)
Korea	93 (0.7)	611 (2.4)	5 (0.5)	587 (9.4)	2 (0.3)	~ ~
Kuwait	78 (2.0)	398 (2.5)	8 (0.9)	380 (7.6)	14 (1.7)	371 (2.8)
Latvia (LSS)	91 (1.1)	497 (3.1)	6 (0.9)	484 (8.5)	3 (0.4)	458 (12.9)
Lithuania	92 (1.0)	481 (3.4)	5 (0.8)	456 (8.8)	3 (0.5)	456 (13.2)
Netherlands	81 (3.4)	536 (7.8)	18 (3.3)	575 (13.8)	2 (0.4)	~ ~
New Zealand	79 (2.5)	512 (4.5)	17 (2.1)	514 (8.7)	4 (0.6)	442 (9.1)
Norway	88 (1.5)	508 (2.4)	10 (1.5)	487 (6.1)	2 (0.3)	~ ~
Portugal	97 (0.6)	455 (2.5)	2 (0.6)	~ ~	1 (0.2)	~ ~
Romania	78 (1.2)	487 (4.5)	8 (0.7)	471 (8.7)	14 (0.9)	468 (8.8)
Russian Federation	94 (0.8)	538 (5.7)	4 (0.6)	528 (6.8)	2 (0.3)	~ ~
Scotland	54 (3.1)	504 (6.9)	37 (2.5)	503 (6.1)	9 (1.3)	459 (4.7)
Singapore	90 (1.5)	644 (5.2)	8 (1.4)	653 (8.2)	2 (0.4)	~ ~
Slovak Republic	94 (1.0)	549 (3.5)	5 (1.0)	539 (9.6)	1 (0.2)	~ ~
Slovenia	89 (0.7)	547 (3.1)	7 (0.6)	494 (7.0)	3 (0.4)	492 (10.1)
Spain	93 (1.3)	490 (2.0)	4 (0.8)	466 (7.5)	3 (0.7)	452 (12.4)
Sweden	61 (3.2)	527 (3.5)	30 (2.7)	521 (3.8)	9 (1.1)	467 (5.6)
Switzerland	82 (2.1)	549 (3.2)	14 (1.8)	546 (6.0)	4 (0.6)	512 (16.9)
Thailand	91 (1.0)	522 (5.8)	6 (0.6)	535 (10.3)	3 (0.5)	510 (9.2)
United States	69 (2.5)	504 (4.6)	21 (1.8)	514 (6.8)	10 (1.5)	458 (7.5)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Much Homework Are Students Assigned?

Although teachers often give students time to begin or review homework assignments in class, homework is generally considered a method of extending the time spent on regular classroom lessons. Table 5.19 presents teachers' reports about how often they assigned homework and the typical lengths of such assignments. Internationally, most eighth-grade students are assigned homework at least three times a week. Most typically, for the majority of students the assignments were 30 minutes or less in length. Homework assignments were more than 30 minutes for the majority of students in Cyprus, Greece, Romania, the Russian Federation, Singapore, and Thailand. The majority of students were assigned mathematics homework less frequently than three times a week in Belgium (Flemish), the Czech Republic, England, Iran, Japan, Korea, Scotland, and Sweden, although teachers in England and Iran gave longer assignments for about half of their students.

Homework generally has its biggest impact when it is commented on and graded by teachers. Table 5.20 presents teachers' reports about their use of students' written mathematics homework. In most countries, for at least 70% of the students, teachers reported at least sometimes, if not always, correcting homework assignments and returning those assignments to students. The exceptions were France, Germany, Hungary, Iceland, Japan, the Netherlands, Portugal, the Slovak Republic, and Slovenia.

Many teachers do not count mathematics homework directly in determining grades, but use it more as a method to monitor students' understanding and to correct misconceptions. In general, for the TIMSS countries, teachers reported that mathematics homework assignments contributed only sometimes to students' grades or marks. In some countries, however, it had even less impact on grades. According to their teachers, homework never or only rarely contributed to the grades for the majority of the students in Austria, Belgium (Flemish), the Czech Republic, Denmark, France, Germany, Hungary, Ireland, Japan, Korea, Latvia (LSS), Lithuania, the Netherlands, Norway, Singapore, the Slovak Republic, Slovenia, Sweden, and Switzerland. At the other end of the continuum, teachers reported that homework always contributed to the grades for the majority of the students in Cyprus, England, Portugal, the Russian Federation, and the United States.

Table 5.19

Teachers' Reports About the Amount of Mathematics Homework Assigned Upper Grade (Eighth Grade*)

Country		Never Assigning Homework	Assigning Homework Less Than Once a Week: 30 Minutes or Less	Assigning Homework Less Than Once a Week: More Than 30 Minutes	Assigning Homework Once or Twice a Week: 30 Minutes or Less	Assigning Homework Once or Twice a Week: More Than 30 Minutes	Assigning Homework Three Times a Week or More Often: 30 Minutes or Less	Assigning Homework Three Times a Week or More Often: More Than 30 Minutes
		Percent of Students Taught by Teachers						
Australia	r	1 (0.8)	6 (1.6)	0 (0.2)	21 (2.6)	4 (1.9)	62 (3.4)	5 (1.7)
Austria	r	0 (0.0)	1 (0.5)	0 (0.0)	24 (4.4)	3 (1.4)	63 (5.0)	10 (2.1)
Belgium (Fl)		0 (0.0)	17 (3.5)	2 (1.1)	52 (4.8)	10 (2.6)	15 (2.9)	5 (2.1)
Belgium (Fr)		1 (1.2)	2 (1.4)	0 (0.0)	30 (5.1)	5 (2.2)	55 (5.5)	7 (2.8)
Canada	r	2 (1.1)	2 (0.9)	1 (0.7)	22 (3.4)	2 (0.9)	59 (3.7)	13 (2.7)
Colombia		0 (0.0)	1 (0.9)	1 (0.8)	17 (4.7)	13 (2.9)	29 (4.2)	39 (4.2)
Cyprus	r	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	50 (5.3)	50 (5.3)
Czech Republic		0 (0.4)	14 (4.5)	0 (0.0)	62 (5.2)	0 (0.3)	23 (3.5)	1 (0.6)
Denmark		0 (0.0)	4 (1.8)	0 (0.0)	42 (4.7)	3 (1.6)	49 (5.2)	2 (1.0)
England		0 (0.0)	3 (1.0)	1 (0.6)	44 (3.8)	47 (3.7)	3 (1.4)	2 (1.1)
France		0 (0.0)	0 (0.0)	2 (0.9)	7 (2.5)	4 (1.2)	77 (3.9)	10 (2.8)
Germany		1 (1.4)	1 (1.4)	0 (0.0)	22 (4.4)	0 (0.0)	73 (5.0)	3 (1.8)
Greece		0 (0.0)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.2)	31 (3.4)	67 (3.5)
Hong Kong		1 (1.4)	4 (2.2)	3 (1.8)	25 (4.7)	15 (4.1)	38 (6.0)	14 (4.1)
Hungary		0 (0.0)	1 (0.7)	0 (0.0)	2 (1.3)	0 (0.0)	82 (3.0)	15 (3.1)
Iceland		0 (0.0)	0 (0.0)	0 (0.0)	5 (2.0)	1 (1.0)	75 (5.5)	19 (5.5)
Iran, Islamic Rep.		0 (0.0)	1 (0.5)	3 (1.4)	10 (3.0)	59 (4.4)	2 (1.1)	26 (4.3)
Ireland		0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	94 (2.2)	5 (2.0)
Israel	r	0 (0.0)	1 (1.2)	0 (0.0)	3 (2.2)	0 (0.0)	48 (7.1)	48 (6.8)
Japan		0 (0.0)	27 (4.0)	4 (1.7)	37 (3.7)	10 (2.3)	16 (2.9)	6 (1.5)
Korea		0 (0.0)	5 (1.6)	8 (2.2)	27 (3.7)	21 (3.3)	21 (3.2)	18 (3.4)
Kuwait		0 (0.0)	0 (0.0)	0 (0.0)	19 (6.1)	2 (2.0)	60 (8.3)	18 (6.0)
Latvia (LSS)		0 (0.0)	0 (0.0)	0 (0.0)	8 (2.8)	1 (0.9)	83 (3.9)	9 (2.4)
Lithuania		0 (0.0)	0 (0.0)	0 (0.0)	2 (1.3)	0 (0.0)	76 (3.9)	22 (3.9)
Netherlands		1 (1.2)	1 (0.9)	0 (0.0)	12 (3.5)	2 (1.4)	81 (4.2)	4 (2.2)
New Zealand		0 (0.0)	5 (1.9)	2 (0.1)	34 (4.3)	4 (1.5)	54 (4.2)	2 (1.2)
Norway	r	0 (0.0)	0 (0.0)	0 (0.0)	7 (2.7)	8 (2.7)	67 (4.3)	18 (4.0)
Portugal		0 (0.0)	1 (0.9)	1 (0.5)	30 (4.0)	2 (1.1)	57 (4.1)	9 (2.4)
Romania		0 (0.0)	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.6)	11 (2.8)	87 (2.8)
Russian Federation		0 (0.0)	0 (0.0)	0 (0.0)	2 (0.9)	1 (0.8)	42 (3.5)	55 (3.4)
Scotland	r	0 (0.4)	20 (4.3)	4 (2.0)	46 (5.1)	6 (2.3)	24 (4.1)	0 (0.0)
Singapore		0 (0.0)	1 (0.9)	0 (0.0)	3 (1.5)	11 (3.1)	26 (4.1)	58 (4.5)
Slovak Republic		0 (0.0)	1 (0.9)	0 (0.0)	12 (2.8)	1 (0.7)	83 (3.4)	4 (1.7)
Slovenia	r	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.4)	0 (0.0)	74 (4.4)	24 (4.2)
Spain	r	0 (0.0)	4 (1.6)	0 (0.0)	18 (3.3)	9 (2.7)	47 (4.4)	22 (3.7)
Sweden	r	0 (0.4)	19 (3.0)	7 (1.9)	45 (4.0)	26 (3.3)	2 (1.2)	1 (1.2)
Switzerland		0 (0.0)	1 (0.4)	1 (0.3)	26 (4.2)	4 (1.5)	61 (4.4)	6 (2.3)
Thailand	r	0 (0.0)	0 (0.0)	0 (0.0)	6 (3.5)	20 (4.8)	16 (4.7)	58 (6.6)
United States	r	0 (0.1)	3 (1.3)	0 (0.0)	7 (1.8)	3 (0.9)	64 (2.9)	23 (3.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates teacher response data available for 70-84% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.20

Teachers' Reports on Their Use of Students' Written Mathematics Homework[1] Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers							
	Collecting, Correcting, and then Returning Assignments to Students				Using Homework to Contribute Towards Students' Grades or Marks			
	Never	Rarely	Sometimes	Always	Never	Rarely	Sometimes	Always
Australia	r 7 (1.9)	14 (2.5)	41 (3.7)	38 (3.6)	r 23 (3.1)	17 (2.6)	41 (3.4)	20 (2.8)
Austria	r 1 (0.5)	25 (3.4)	22 (3.2)	53 (3.8)	r 22 (3.8)	34 (4.0)	27 (3.4)	17 (3.6)
Belgium (Fl)	5 (1.6)	5 (2.9)	9 (2.3)	80 (3.7)	34 (4.9)	16 (3.0)	21 (3.9)	29 (3.9)
Belgium (Fr)	s 7 (3.2)	7 (2.9)	28 (5.2)	58 (6.0)	s 21 (4.6)	20 (4.0)	25 (4.9)	33 (5.7)
Canada	r 4 (1.6)	21 (2.9)	50 (4.2)	25 (3.3)	r 12 (2.7)	10 (2.7)	49 (4.3)	29 (3.4)
Colombia	0 (0.0)	9 (2.2)	11 (2.9)	80 (3.7)	1 (1.0)	10 (2.2)	49 (5.1)	40 (4.8)
Cyprus	r 8 (2.9)	18 (3.4)	56 (5.0)	17 (4.4)	r 0 (0.0)	2 (0.6)	37 (4.7)	62 (4.7)
Czech Republic	4 (2.8)	2 (1.3)	24 (3.9)	70 (4.7)	42 (4.9)	35 (5.2)	19 (4.5)	3 (1.5)
Denmark	10 (3.8)	17 (3.7)	45 (5.0)	27 (4.8)	44 (5.0)	29 (4.4)	17 (3.7)	10 (2.9)
England	s 2 (1.1)	3 (1.0)	42 (3.6)	53 (3.9)	s 4 (1.5)	7 (1.5)	39 (3.2)	50 (3.4)
France	11 (2.8)	43 (4.6)	26 (4.0)	19 (3.7)	44 (4.4)	33 (4.5)	14 (2.7)	9 (2.9)
Germany	s 13 (4.0)	34 (5.1)	47 (6.0)	7 (2.0)	s 32 (5.1)	33 (5.0)	28 (4.4)	6 (2.9)
Greece	9 (2.4)	20 (3.2)	49 (3.9)	22 (3.6)	3 (1.4)	7 (1.8)	43 (3.6)	46 (3.9)
Hong Kong	0 (0.0)	1 (1.1)	12 (3.5)	87 (3.6)	23 (4.4)	25 (4.9)	19 (4.3)	33 (5.3)
Hungary	9 (2.5)	35 (4.2)	49 (4.5)	7 (2.3)	20 (3.7)	40 (4.2)	28 (3.7)	11 (2.8)
Iceland	r 8 (3.7)	25 (7.1)	62 (7.5)	6 (1.8)	r 9 (3.9)	16 (4.3)	40 (6.4)	35 (7.6)
Iran, Islamic Rep.	10 (2.9)	14 (3.1)	40 (4.7)	37 (4.8)	11 (2.3)	27 (5.9)	41 (5.2)	21 (4.4)
Ireland	6 (2.4)	16 (3.8)	57 (5.1)	20 (4.2)	35 (5.2)	20 (4.1)	37 (4.5)	7 (2.4)
Israel	r 0 (0.0)	17 (5.2)	59 (8.1)	24 (8.3)	r 0 (0.0)	11 (5.3)	59 (8.4)	30 (8.5)
Japan	21 (3.4)	34 (4.3)	25 (3.9)	21 (3.6)	32 (3.6)	37 (4.5)	18 (4.0)	13 (3.1)
Korea	1 (1.0)	10 (2.4)	61 (3.9)	28 (3.7)	26 (3.2)	34 (4.0)	35 (4.0)	6 (1.7)
Kuwait	1 (0.8)	3 (2.6)	28 (6.9)	68 (6.6)	9 (3.9)	11 (4.6)	38 (8.0)	42 (7.6)
Latvia (LSS)	r 2 (1.6)	11 (3.0)	30 (4.1)	57 (4.7)	r 32 (4.0)	23 (3.4)	25 (3.4)	20 (3.6)
Lithuania	5 (1.7)	9 (2.6)	52 (4.4)	35 (4.5)	r 48 (5.0)	9 (2.7)	28 (4.2)	15 (3.2)
Netherlands	49 (5.2)	29 (5.0)	22 (3.9)	1 (0.8)	67 (5.2)	17 (4.6)	12 (3.8)	4 (1.9)
New Zealand	3 (1.7)	20 (3.1)	48 (4.2)	28 (3.7)	15 (2.9)	28 (3.8)	41 (4.3)	16 (3.2)
Norway	r 7 (2.4)	17 (3.6)	64 (4.6)	13 (3.5)	r 16 (3.5)	48 (5.0)	29 (4.6)	7 (2.6)
Portugal	9 (2.5)	23 (4.0)	43 (4.0)	26 (4.0)	2 (1.2)	13 (3.1)	34 (4.3)	51 (4.4)
Romania	4 (1.9)	11 (2.5)	49 (4.0)	37 (4.2)	8 (2.4)	16 (2.9)	44 (4.3)	32 (3.5)
Russian Federation	0 (0.1)	2 (1.1)	23 (3.7)	75 (4.0)	2 (0.9)	3 (1.3)	38 (5.5)	57 (5.1)
Scotland	- -	- -	- -	- -	- -	- -	- -	- -
Singapore	0 (0.0)	0 (0.0)	6 (2.2)	94 (2.2)	33 (4.6)	26 (4.2)	32 (4.0)	9 (2.5)
Slovak Republic	6 (2.6)	30 (3.8)	57 (4.7)	7 (2.2)	51 (4.7)	30 (4.3)	18 (3.0)	1 (0.6)
Slovenia	r 4 (2.0)	28 (4.9)	60 (5.1)	8 (2.8)	r 39 (4.1)	40 (5.0)	19 (4.2)	2 (1.6)
Spain	r 9 (2.9)	4 (1.8)	26 (4.6)	61 (4.8)	r 3 (1.6)	7 (2.5)	41 (4.8)	49 (4.8)
Sweden	r 6 (2.0)	8 (2.0)	24 (3.1)	62 (3.9)	r 27 (3.7)	23 (3.2)	32 (3.5)	18 (2.8)
Switzerland	s 5 (1.8)	23 (3.8)	56 (4.6)	16 (2.9)	s 42 (4.5)	42 (4.7)	15 (3.4)	0 (0.2)
Thailand	s 0 (0.0)	1 (0.6)	19 (4.9)	80 (4.9)	s 16 (4.8)	11 (3.1)	57 (5.8)	16 (4.7)
United States	r 5 (1.4)	15 (2.3)	42 (4.2)	38 (4.4)	r 1 (0.4)	4 (1.6)	27 (4.3)	68 (4.3)

[1]Based on those teachers who assign homework.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Assessment and Evaluation Procedures Do Teachers Use?

Teachers in participating countries were asked about the importance they place on different types of assessment and how they use assessment information. Their responses to these two questions are presented in Tables 5.21 and 5.22, respectively. The weight given to each type of assessment varied greatly from country to country. Internationally, the least weight reportedly was given to external standardized tests and teacher-made objective tests. Across all participating countries, fewer than 80% of the eighth-grade students had mathematics teachers who reported giving quite a lot or a great deal of weight to these types of assessments.

The Hungarian teachers reported the heaviest emphasis on projects or practical exercises. They reported relying on this type of assessment for 90% of the students, with the next highest countries being Colombia with 77%, Denmark with 74%, and Israel with 70%. However, the most heavily weighted types of assessment were teacher-made tests requiring explanations, observations of students, and students' responses in class. One or more of these assessment types was weighted heavily for 80% or more of the eighth-grade students in many European and Eastern European countries. In contrast, teachers were in less agreement about assessment approaches within Australia, Canada, England, Hong Kong, Israel, Japan, Korea, New Zealand, Singapore, Slovenia, Switzerland, Thailand, and the United States, where no type of assessment was weighted heavily for as many as 80% of the students.

As might be anticipated, mathematics teachers in most countries reported using assessment information to provide grades or marks, to provide student feedback, to diagnose learning problems, and to plan future lessons. Teachers in fewer countries reported considerable use of assessment information to report to parents or for the purpose of tracking or making program assignments.

As reported in Table 5.23, eighth-grade students reported substantial variation in the frequency of testing in mathematics classes. The majority of the students reported having quizzes and tests only once in a while or never in Austria, the Czech Republic, Denmark, England, Germany, Hungary, Iceland, Ireland, Japan, Korea, Latvia (LSS), Norway, Scotland, and the Slovak Republic. In contrast, one-third or more of the students reported almost always having quizzes or tests in Colombia, Hong Kong, Kuwait, Romania, Spain, and the United States. In a number of countries, there was a tendency for the reports of the most frequent testing to be associated with lower-achieving students. One could argue that these students can least afford time diverted from their ongoing instructional program. However, teachers may provide shorter lessons and follow-up quizzes for lower-achieving students to more closely monitor their grasp of the subject matter.

Table 5.21

Teachers' Reports on the Types of Assessment Given "Quite A Lot" or "A Great Deal" of Weight in Assessing Students' Work in Mathematics Class
Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers Relying on Different Types of Assessment						
	External Standardized Tests	Teacher-Made Tests Requiring Explanations	Teacher-Made Objective Tests	Homework Assignments	Projects or Practical Exercises	Observations of Students	Students' Responses in Class
Australia	r 8 (1.8)	r 42 (2.9)	r 24 (2.9)	r 26 (2.9)	r 29 (2.9)	r 37 (3.4)	r 34 (3.3)
Austria	r 4 (1.1)	r 29 (3.1)	r 1 (0.5)	r 47 (3.7)	s 23 (3.8)	r 97 (1.6)	r 81 (4.0)
Belgium (Fl)	10 (2.6)	94 (1.9)	11 (3.1)	15 (2.7)	16 (2.6)	50 (4.0)	55 (4.0)
Belgium (Fr)	s 6 (2.5)	s 85 (4.8)	s 16 (4.4)	s 35 (6.0)	s 6 (3.6)	s 47 (6.3)	s 58 (5.5)
Canada	r 16 (3.3)	r 49 (4.0)	r 18 (3.0)	r 44 (4.5)	r 32 (3.6)	r 43 (4.5)	r 41 (3.9)
Colombia	16 (3.7)	81 (4.0)	55 (4.7)	90 (2.5)	77 (3.9)	88 (3.2)	94 (2.0)
Cyprus	r 40 (3.7)	r 71 (4.9)	r 56 (4.7)	r 96 (2.0)	r 67 (4.7)	r 88 (3.1)	r 100 (0.0)
Czech Republic	r 43 (5.4)	100 (0.3)	r 19 (5.1)	14 (3.1)	r 29 (4.9)	74 (4.4)	96 (2.6)
Denmark	54 (5.2)	75 (4.8)	21 (4.0)	66 (5.2)	74 (4.2)	97 (1.8)	91 (2.9)
England	s 36 (3.2)	s 32 (3.0)	s 7 (1.8)	s 68 (3.3)	s 48 (3.5)	s 71 (2.9)	s 66 (3.4)
France	23 (3.7)	83 (3.7)	25 (3.9)	28 (4.8)	r 16 (3.6)	49 (4.6)	54 (4.9)
Germany	s 0 (0.0)	s 55 (5.1)	s 7 (2.9)	s 18 (4.6)	s 40 (4.7)	s 74 (5.2)	s 81 (4.3)
Greece	32 (4.9)	92 (2.2)	44 (4.3)	58 (4.7)	r 45 (4.3)	87 (3.0)	99 (0.6)
Hong Kong	32 (5.4)	40 (5.4)	40 (5.8)	74 (5.4)	12 (3.7)	68 (5.2)	74 (4.8)
Hungary	34 (4.1)	71 (3.5)	24 (3.6)	43 (4.6)	90 (2.7)	69 (4.2)	87 (2.9)
Iceland	r 45 (8.3)	s 42 (9.0)	s 9 (3.5)	r 92 (3.0)	r 53 (7.0)	r 73 (7.3)	r 68 (6.1)
Iran, Islamic Rep.	22 (3.6)	88 (5.2)	24 (4.0)	60 (5.2)	r 14 (3.3)	r 45 (5.3)	86 (3.8)
Ireland	r 35 (4.7)	r 26 (4.2)	25 (4.3)	75 (4.1)	r 37 (4.9)	r 76 (4.0)	86 (3.6)
Israel	r 77 (6.0)	r 29 (7.4)	r 64 (7.0)	r 61 (7.6)	r 70 (7.7)	r 54 (7.1)	r 46 (6.1)
Japan	16 (2.5)	54 (3.8)	20 (3.2)	44 (3.8)	34 (3.7)	68 (3.7)	71 (3.6)
Korea	36 (3.9)	54 (4.3)	32 (3.8)	24 (3.9)	20 (3.6)	31 (3.8)	62 (3.9)
Kuwait	30 (8.1)	78 (6.4)	77 (5.3)	62 (7.5)	32 (6.4)	61 (5.6)	88 (5.3)
Latvia (LSS)	r 52 (4.7)	r 61 (5.2)	r 33 (4.4)	r 79 (4.3)	r 62 (4.9)	r 83 (3.6)	r 100 (0.0)
Lithuania	r 10 (3.0)	r 31 (4.0)	s 11 (3.1)	r 34 (4.8)	s 16 (3.3)	s 24 (4.5)	r 83 (3.3)
Netherlands	29 (5.8)	99 (1.1)	31 (6.2)	30 (5.4)	14 (4.1)	36 (5.1)	42 (5.6)
New Zealand	14 (2.9)	52 (4.5)	20 (3.3)	34 (4.0)	36 (4.5)	52 (4.3)	46 (4.3)
Norway	r 27 (4.0)	r 100 (0.0)	r 3 (1.6)	r 25 (3.9)	r 15 (3.6)	r 55 (4.6)	r 59 (4.8)
Portugal	14 (2.8)	69 (3.9)	16 (3.4)	79 (3.2)	61 (4.4)	89 (3.1)	97 (1.5)
Romania	48 (4.0)	90 (2.7)	51 (4.2)	81 (3.6)	37 (4.1)	78 (3.7)	97 (1.6)
Russian Federation	- -	100 (0.4)	54 (4.6)	64 (3.9)	52 (5.3)	97 (1.5)	- -
Scotland	- -	- -	- -	- -	- -	- -	- -
Singapore	- -	30 (3.8)	6 (2.2)	72 (4.9)	37 (4.7)	61 (5.2)	70 (4.7)
Slovak Republic	75 (3.8)	97 (1.3)	24 (4.4)	35 (4.7)	36 (4.3)	89 (2.8)	99 (0.9)
Slovenia	r 56 (5.2)	r 76 (4.2)	r 22 (4.4)	r 59 (5.2)	r 44 (5.0)	r 70 (4.0)	r 73 (3.9)
Spain	r 5 (2.1)	r 92 (2.5)	r 23 (3.8)	r 75 (4.3)	r 42 (4.6)	r 90 (2.1)	r 95 (1.7)
Sweden	r 59 (3.2)	r 90 (2.4)	r 19 (2.9)	r 50 (4.3)	r 53 (4.3)	r 87 (2.8)	r 79 (3.2)
Switzerland	s 28 (3.5)	s 77 (4.2)	s 6 (2.1)	s 13 (2.8)	s 14 (2.8)	s 47 (5.1)	s 54 (5.0)
Thailand	s 22 (5.1)	r 52 (6.2)	s 71 (5.0)	s 75 (5.4)	s 21 (4.5)	s 51 (7.0)	s 66 (6.6)
United States	r 20 (2.2)	r 51 (3.7)	r 26 (3.7)	r 57 (3.9)	r 35 (3.3)	r 44 (3.3)	r 45 (3.3)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.22

Teachers' Reports on Ways Assessment Information Is Used "Quite A Lot" or "A Great Deal" - Mathematics - Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers Using Assessment Information: To Provide Grades or Marks	To Provide Student Feedback	To Diagnose Learning Problems	To Report to Parents	To Assign Students to Programs or Tracks	To Plan for Future Lessons
Australia	r 86 (2.8)	r 89 (2.3)	r 75 (3.5)	r 76 (3.1)	r 55 (3.9)	r 73 (3.0)
Austria	- -	r 72 (3.8)	r 75 (3.7)	r 39 (4.3)	r 17 (3.5)	r 53 (3.9)
Belgium (Fl)	r 70 (4.1)	r 78 (3.7)	r 88 (2.7)	r 80 (3.8)	r 84 (3.3)	r 54 (4.8)
Belgium (Fr)	s 92 (3.1)	s 81 (4.3)	s 92 (2.9)	s 61 (5.6)	- -	s 89 (3.0)
Canada	87 (2.6)	92 (1.8)	84 (3.1)	79 (3.0)	52 (3.6)	79 (3.2)
Colombia	68 (4.3)	90 (2.5)	92 (2.5)	53 (5.2)	37 (5.3)	94 (2.2)
Cyprus	r 100 (0.0)	r 93 (3.2)	r 96 (2.5)	r 96 (2.3)	r 60 (6.0)	r 91 (3.2)
Czech Republic	94 (3.2)	93 (2.7)	100 (0.5)	67 (4.5)	38 (5.2)	98 (1.3)
Denmark	26 (4.3)	85 (3.6)	r 85 (3.6)	54 (5.2)	68 (4.7)	85 (3.6)
England	s 91 (1.8)	s 91 (1.8)	s 84 (2.3)	s 81 (2.7)	s 78 (2.6)	s 85 (2.1)
France	89 (2.9)	93 (2.4)	90 (3.0)	61 (4.3)	36 (4.4)	91 (2.6)
Germany	s 84 (4.3)	s 86 (3.6)	s 89 (3.6)	s 48 (5.5)	s 28 (4.8)	s 86 (3.8)
Greece	97 (1.4)	88 (2.8)	90 (2.0)	89 (3.7)	41 (4.2)	77 (3.4)
Hong Kong	72 (5.1)	82 (4.7)	81 (4.9)	13 (4.1)	13 (4.1)	74 (4.4)
Hungary	58 (4.2)	71 (3.9)	95 (2.0)	81 (3.5)	83 (3.5)	79 (3.7)
Iceland	r 84 (6.2)	r 71 (7.7)	r 82 (6.8)	r 78 (7.3)	r 10 (4.5)	r 91 (4.5)
Iran, Islamic Rep.	83 (3.6)	r 71 (4.1)	81 (3.8)	63 (4.5)	62 (4.2)	79 (3.4)
Ireland	r 72 (4.3)	83 (3.5)	r 84 (3.5)	76 (3.8)	r 54 (4.6)	85 (3.5)
Israel	r 14 (5.9)	r 14 (4.2)	r 20 (5.8)	r 27 (7.3)	r 36 (6.2)	r 7 (3.8)
Japan	73 (3.6)	60 (3.9)	66 (3.6)	9 (2.1)	29 (3.3)	58 (3.9)
Korea	39 (3.7)	42 (4.3)	65 (3.8)	10 (2.7)	3 (1.4)	56 (4.3)
Kuwait	70 (8.0)	75 (6.7)	r 81 (5.8)	r 53 (7.2)	r 66 (5.9)	r 83 (5.7)
Latvia (LSS)	r 97 (1.6)	r 69 (4.3)	r 96 (2.1)	r 39 (4.7)	r 42 (4.9)	r 95 (2.2)
Lithuania	r 78 (4.1)	52 (4.4)	r 54 (4.5)	54 (4.8)	45 (4.6)	r 78 (4.1)
Netherlands	86 (3.6)	68 (5.6)	65 (5.3)	57 (5.7)	68 (5.4)	50 (5.7)
New Zealand	87 (2.9)	87 (2.7)	81 (3.0)	86 (3.1)	45 (4.2)	76 (3.4)
Norway	r 69 (4.6)	r 77 (4.4)	r 47 (5.2)	r 31 (4.1)	r 57 (5.0)	r 82 (3.9)
Portugal	92 (2.3)	80 (3.7)	95 (2.0)	64 (4.5)	43 (4.1)	90 (2.7)
Romania	94 (1.8)	90 (2.5)	94 (1.9)	75 (3.6)	78 (3.1)	95 (1.8)
Russian Federation	90 (2.8)	97 (1.2)	98 (1.2)	25 (4.2)	90 (2.7)	98 (1.0)
Scotland	- -	- -	- -	- -	- -	- -
Singapore	71 (3.7)	87 (3.3)	88 (3.2)	39 (4.4)	31 (4.4)	76 (4.3)
Slovak Republic	74 (4.0)	79 (3.4)	90 (2.7)	68 (4.3)	12 (2.8)	78 (4.2)
Slovenia	r 73 (4.1)	r 97 (2.0)	r 95 (2.4)	r 76 (4.7)	r 40 (5.2)	r 92 (2.9)
Spain	r 95 (2.1)	r 93 (2.3)	r 90 (2.8)	r 86 (3.5)	r 72 (4.1)	r 92 (2.6)
Sweden	r 73 (3.6)	r 91 (2.4)	r 85 (2.9)	r 53 (4.2)	r 32 (3.7)	r 93 (1.9)
Switzerland	s 85 (3.5)	s 92 (2.7)	s 88 (2.9)	s 47 (4.3)	s 23 (3.3)	s 80 (4.2)
Thailand	r 65 (6.2)	r 77 (5.4)	s 84 (4.7)	s 41 (6.4)	s 72 (5.1)	s 87 (4.2)
United States	r 96 (1.0)	r 91 (2.4)	r 80 (2.8)	r 82 (2.6)	r 30 (3.1)	r 86 (2.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.23

Students' Reports on Frequency of Having a Quiz or Test in Their Mathematics Lessons - Upper Grade (Eighth Grade*)

Country	Once in a While or Never		Pretty Often		Almost Always	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	46 (1.2)	540 (5.1)	38 (0.9)	537 (4.1)	16 (0.9)	501 (6.0)
Austria	77 (1.6)	548 (3.5)	15 (1.2)	525 (5.9)	9 (0.8)	488 (5.6)
Belgium (Fl)	7 (0.8)	558 (12.7)	71 (1.7)	575 (5.8)	22 (2.0)	541 (8.3)
Belgium (Fr)	27 (1.7)	528 (4.9)	49 (1.7)	531 (3.8)	24 (1.2)	521 (5.0)
Canada	27 (1.3)	533 (4.2)	52 (1.2)	535 (2.4)	20 (1.3)	505 (4.0)
Colombia	22 (1.2)	385 (2.8)	35 (0.8)	389 (4.6)	43 (1.4)	388 (3.4)
Cyprus	22 (1.2)	466 (3.8)	63 (1.1)	482 (2.3)	15 (0.8)	455 (4.3)
Czech Republic	72 (1.3)	563 (5.1)	24 (1.2)	572 (6.8)	5 (0.4)	531 (7.5)
Denmark	69 (1.8)	508 (3.3)	21 (1.5)	500 (4.7)	10 (0.9)	489 (6.5)
England	50 (1.4)	511 (3.9)	40 (1.2)	511 (3.5)	10 (0.8)	479 (6.1)
France	30 (1.4)	540 (3.9)	51 (1.4)	543 (3.7)	20 (0.9)	528 (4.4)
Germany	66 (2.0)	521 (4.9)	22 (1.4)	499 (6.2)	12 (1.1)	474 (7.3)
Greece	44 (1.6)	488 (4.0)	40 (1.2)	491 (3.8)	16 (0.8)	458 (3.6)
Hong Kong	21 (2.2)	576 (12.1)	43 (1.3)	604 (5.7)	36 (2.4)	581 (8.3)
Hungary	80 (1.2)	542 (3.3)	15 (0.9)	540 (5.8)	5 (0.6)	486 (8.1)
Iceland	70 (1.7)	490 (4.0)	24 (1.8)	493 (6.1)	6 (1.2)	445 (18.8)
Iran, Islamic Rep.	45 (1.8)	434 (2.9)	28 (1.2)	428 (3.4)	27 (1.2)	425 (3.8)
Ireland	51 (2.1)	536 (6.1)	36 (1.6)	534 (5.6)	14 (1.0)	493 (7.5)
Israel	43 (3.3)	544 (5.8)	39 (2.4)	519 (7.3)	18 (2.0)	488 (8.0)
Japan	59 (2.3)	605 (2.6)	30 (1.6)	608 (4.1)	11 (1.5)	595 (4.7)
Korea	74 (1.5)	610 (2.6)	19 (1.3)	616 (5.3)	7 (0.6)	571 (7.5)
Kuwait	29 (1.7)	389 (3.1)	29 (1.3)	396 (5.1)	42 (2.1)	392 (2.7)
Latvia (LSS)	80 (1.4)	496 (3.0)	17 (1.2)	490 (5.7)	3 (0.4)	465 (11.2)
Lithuania	30 (1.6)	465 (4.3)	59 (1.4)	487 (4.0)	11 (0.8)	462 (7.5)
Netherlands	45 (1.6)	555 (9.5)	43 (1.3)	536 (7.1)	12 (0.9)	515 (7.4)
New Zealand	45 (1.7)	518 (5.3)	35 (1.1)	509 (4.9)	20 (1.2)	489 (5.4)
Norway	66 (1.3)	512 (2.5)	31 (1.3)	494 (3.4)	3 (0.4)	441 (7.5)
Portugal	49 (1.6)	461 (2.7)	28 (1.2)	451 (3.3)	23 (1.0)	446 (2.8)
Romania	30 (1.1)	478 (5.6)	36 (1.1)	490 (4.7)	34 (1.1)	479 (4.6)
Russian Federation	23 (1.5)	524 (5.8)	53 (2.0)	544 (5.9)	24 (1.4)	529 (5.7)
Scotland	63 (1.8)	505 (6.4)	28 (1.4)	498 (6.1)	9 (0.9)	468 (8.7)
Singapore	27 (1.2)	644 (5.6)	55 (1.0)	646 (5.2)	18 (0.9)	635 (6.2)
Slovak Republic	51 (1.6)	554 (4.0)	42 (1.4)	545 (4.2)	7 (0.5)	510 (6.8)
Slovenia	36 (1.6)	550 (4.2)	44 (1.4)	543 (3.4)	20 (1.0)	518 (4.6)
Spain	25 (1.4)	488 (2.8)	37 (1.2)	498 (2.8)	39 (1.3)	478 (2.7)
Sweden	43 (1.6)	522 (3.6)	49 (1.4)	523 (3.2)	7 (0.5)	473 (5.5)
Switzerland	41 (1.2)	550 (4.0)	45 (1.2)	553 (3.2)	14 (0.7)	519 (5.4)
Thailand	41 (1.7)	525 (6.2)	28 (0.9)	527 (6.7)	31 (1.2)	517 (5.9)
United States	15 (0.9)	497 (6.7)	47 (1.1)	517 (4.5)	38 (1.1)	483 (4.8)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Appendix A

Overview of TIMSS Procedures: Mathematics Achievement Results for Seventh- and Eighth-Grade Students

History

TIMSS represents the continuation of a long series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). Since its inception in 1959, the IEA has conducted more than 15 studies of cross-national achievement in curricular areas such as mathematics, science, language, civics, and reading. IEA conducted its First International Mathematics Study (FIMS) in 1964, and the Second International Mathematics Study (SIMS) in 1980-82. The First and Second International Science Studies (FISS and SISS) were conducted in 1970-71 and 1983-84, respectively. Since the subjects of mathematics and science are related in many respects, the third studies were conducted together as an integrated effort.[1]

The number of participating countries and testing both mathematics and science resulted in TIMSS becoming the largest, most complex IEA study to date and the largest international study of educational achievement ever undertaken. Traditionally, IEA studies have systematically worked toward gaining more in-depth understanding of how various factors contribute to the overall outcomes of schooling. Particular emphasis has been given to refining our understanding of students' opportunity to learn as this opportunity becomes successively defined and implemented by curricular and instructional practices. In an effort to extend what had been learned from previous studies and provide contextual and explanatory information, the magnitude of TIMSS expanded beyond the already substantial task of measuring achievement in two subject areas to also include a thorough investigation of curriculum and how it is delivered in classrooms around the world.

The Components of TIMSS

Continuing the approach of previous IEA studies, TIMSS addressed three conceptual levels of curriculum. The **intended curriculum** is composed of the mathematics and science instructional and learning goals as defined at the system level. The **implemented curriculum** is the mathematics and science curriculum as interpreted by teachers and made available to students. The **attained curriculum** is the mathematics and science content that students have learned and their attitudes

[1] Because a substantial amount of time has elapsed since earlier IEA studies in mathematics and science, curriculum and testing methods in these two subjects have undergone many changes. Because TIMSS has devoted considerable energy toward reflecting the most current educational and measurement practices, changes in items and methods as well as differences in the populations tested make comparisons of TIMSS results with those of previous studies very difficult. The focus of TIMSS is not on measuring achievement trends, but rather on providing up-to-date information about the current quality of education in mathematics and science.

towards these subjects. To aid in meaningful interpretation and comparison of results, TIMSS also collected extensive information about the social and cultural contexts for learning, many of which are related to variation among different educational systems.

Even though slightly fewer countries completed all the steps necessary to have their data included in this report, nearly 50 countries participated in one or more of the various components of the TIMSS data collection effort, including the curriculum analysis. To gather information about the intended curriculum, mathematics and science specialists within each participating country worked section-by-section through curriculum guides, textbooks, and other curricular materials to categorize aspects of these materials in accordance with detailed specifications derived from the TIMSS mathematics and science curriculum frameworks.[2] Initial results from this component of TIMSS can be found in two companion volumes: *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intention in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* [3]

To measure the attained curriculum, TIMSS tested more than half a million students in mathematics and science at five grade levels. TIMSS included testing at three separate populations:

Population 1. Students enrolled in the two adjacent grades that contained the largest proportion of 9-year-old students at the time of testing – third- and fourth-grade students in most countries.

Population 2. Students enrolled in the two adjacent grades that contained the largest proportion of 13-year-old students at the time of testing – seventh- and eighth-grade students in most countries.

Population 3. Students in their final year of secondary education. As an additional option, countries could test two special subgroups of these students:

1) Students taking advanced courses in mathematics, and
2) Students taking physics.

Countries participating in the study were required to administer tests to the students in the two grades at Population 2, but could choose whether or not to participate at the other levels. In about half of the countries at Populations 1 and 2, subsets of the upper-grade students who completed the written tests also participated in a performance assessment. In the performance assessment, students engaged in a number of hands-on

[2] Robitaille, D.F., McKnight, C., Schmidt, W., Britton, E., Raizen, S., and Nicol, C. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science.* Vancouver, B.C.: Pacific Educational Press.

[3] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.* Dordrecht, the Netherlands: Kluwer Academic Publishers. Schmidt, W.H., Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G.; (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

mathematics and science activities. The students designed experiments, tested hypotheses, and recorded their findings. For example, in one task, students were asked to investigate probability by repeatedly rolling a die, applying a computational algorithm, and proposing explanations in terms of probability for patterns that emerged. Figure A.1 shows the countries that participated in the various components of TIMSS achievement testing.

TIMSS also administered a broad array of questionnaires to collect data about how the curriculum is implemented in classrooms, including the instructional practices used to deliver it. The questionnaires also were used to collect information about the social and cultural contexts for learning. Questionnaires were administered at the **country level** about decision-making and organizational features within their educational systems. The **students** who were tested answered questions pertaining to their attitudes towards mathematics and science, classroom activities, home background, and out-of-school activities. The mathematics and science **teachers** of sampled students responded to questions about teaching emphasis on the topics in the curriculum frameworks, instructional practices, textbook usage, professional training and education, and their views on mathematics and science. The heads of **schools** responded to questions about school staffing and resources, mathematics and science course offerings, and teacher support. In addition, a volume was compiled that presents descriptions of the educational systems of the participating countries.[4]

With its enormous array of data, TIMSS has numerous possibilities for policy-related research, focused studies related to students' understandings of mathematics and science subtopics and processes, and integrated analyses linking the various components of TIMSS. The initial round of reports is only the beginning of a number of research efforts and publications aimed at increasing our understanding of how mathematics and science education functions across countries, investigating what impacts student performance, and helping to improve mathematics and science education.

[4] Robitaille D.F. (in press). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

Figure A.1

Countries Participating in Additional Components of TIMSS Testing

Country	Population 1		Population 2		Population 3		
	Written Test	Performance Assessment	Written Test	Performance Assessment	Mathematics & Science Literacy	Advanced Mathematics	Physics
Argentina			○				
Australia	○	○	○	○	○	○	○
Austria	○		○		○	○	○
Belgium (Fl)			○				
Belgium (Fr)			○				
Bulgaria			○				
Canada	○	○	○	○	○	○	○
Colombia			○	○			
Cyprus	○	○	○	○	○	○	○
Czech Republic	○	○	○	○	○	○	○
Denmark			○	○	○	○	○
England	○		○	○			
France			○		○	○	○
Germany			○		○	○	○
Greece	○		○		○	○	○
Hong Kong	○	○	○	○			
Hungary	○		○		○		
Iceland	○		○		○		
Indonesia	○		○				
Iran, Islamic Rep.	○	○	○	○			
Ireland	○		○				
Israel	○	○	○	○	○	○	○
Italy	○		○		○		
Japan	○		○				○
Korea	○		○				
Kuwait	○		○				
Latvia	○		○				○
Lithuania			○		○	○	
Mexico	○		○		○	○	○
Netherlands	○		○		○		
New Zealand	○	○	○	○	○		
Norway	○		○	○	○		○
Philippines			○				
Portugal	○	○	○	○			
Romania			○	○			
Russian Federation			○		○	○	○
Scotland	○		○	○			
Singapore	○		○	○			
Slovak Republic			○				
Slovenia	○	○	○	○	○	○	○
South Africa			○		○		
Spain			○	○			
Sweden			○	○	○	○	○
Switzerland			○	○	○	○	○
Thailand	○		○				
United States	○	○	○	○	○	○	○

Developing the TIMSS Mathematics Test

The TIMSS curriculum framework underlying the mathematics tests at all three populations was developed by groups of mathematics educators with input from the TIMSS National Research Coordinators (NRCs). As shown in Figure A.2, the mathematics curriculum framework contains three dimensions or aspects. The **content** aspect represents the subject matter content of school mathematics. The **performance expectations** aspect describes, in a non-hierarchical way, the many kinds of performances or behaviors that might be expected of students in school mathematics. The **perspectives** aspect focuses on the development of students' attitudes, interest, and motivations in mathematics.[5]

Working within the mathematics curriculum framework, mathematics test specifications were developed for Population 2 that included items representing a wide range of mathematics topics and eliciting a range of skills from the students. The tests were developed through an international consensus involving input from experts in mathematics and measurement specialists. The TIMSS Subject Matter Advisory Committee, including distinguished scholars from 10 countries, ensured that the test reflected current thinking and priorities within the field of mathematics. The items underwent an iterative development and review process, with one of the pilot testing efforts involving 43 countries. Every effort was made to help ensure that the tests represented the curricula of the participating countries and that the items did not exhibit any bias towards or against particular countries, including modifying specifications in accordance with data from the curriculum analysis component, obtaining ratings of the items by subject matter specialists within the participating countries, and conducting thorough statistical item analysis of data collected in the pilot testing. The final forms of the test were endorsed by the NRCs of the participating countries.[6] In addition, countries had an opportunity to match the content of the test to their curricula at the seventh and eighth grades. They identified items measuring topics not covered in their intended curriculum. The information from this Test-Curriculum Matching Analysis indicates that omitting such items has little effect on the overall pattern of results (see Appendix B).

Table A.1 presents the six content areas included in the Population 2 mathematics test and the numbers of items and score points in each category. Distributions also are included for the four performance categories derived from the performance expectations aspect of the curriculum framework. Approximately one-fourth of the items were in the free-response format, requiring students to generate and write their own answers. Designed to represent approximately one-third of students' response

[5] The complete TIMSS curriculum frameworks can be found in Robitaille, D.F. et al. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science.* Vancouver, B.C.: Pacific Educational Press.

[6] For a full discussion of the TIMSS test development effort, please see: Garden, R.A. and Orpwood, G. (1996). "TIMSS Test Development" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College; and Garden, R.A.(1996). "Development of the TIMSS Achievement Items" in D.F. Robitaille and R.A. Garden (eds.), *TIMSS Monograph No.2: Research Questions and Study Design.* Vancouver, B.C.: Pacific Educational Press.

Figure A.2

The Three Aspects and Major Categories of the Mathematics Framework

Content

- Numbers
- Measurement
- Geometry
- Proportionality
- Functions, relations, and equations
- Data representation, probability, and statistics
- Elementary Analysis
- Validation and structure

Performance Expectations

- Knowing
- Using routine procedures
- Investigating and problem solving
- Mathematical reasoning
- Communicating

Perspectives

- Attitudes
- Careers
- Participation
- Increasing interest
- Habits of mind

Table A.1

Distribution of Mathematics Items by Content Reporting Category and Performance Category - Population 2

Content Category	Percentage of Items	Total Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Fractions and Number Sense	34	51	41	9	1	52
Geometry	15	23	22	1	0	23
Algebra	18	27	22	3	2	30
Data Representation, Analysis and Probability	14	21	19	1	1	23
Measurement [2]	12	18	13	3	2	23
Proportionality	7	11	8	2	1	12

Performance Category	Percentage of Items	Total Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Knowing	22	33	31	2	0	33
Performing Routine Procedures	25	38	32	6	0	38
Using Complex Procedures	21	32	28	4	0	32
Solving Problems [3]	32	48	34	7	7	60

[1]In scoring the tests correct answers to most items were worth one point. However, responses to some constructed-response items were evaluated for partial credit with a fully correct answer awarded up to three points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test.

[2]One item in the Measurement category was deleted prior to analysis due to poor performing item statistics.

[3]Includes two extended-response items classified as "Justifying and Proving" and two extended-response items classified as "Communicating."

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

time, some free-response questions asked for short answers while others required extended responses where students needed to show their work. The remaining questions used a multiple-choice format. In scoring the tests, correct answers to most questions were worth one point. Consistent with the approach of allotting students longer response time for the constructed-response questions than for multiple-choice questions, however, responses to some of these questions (particularly those requiring extended responses) were evaluated for partial credit with a fully correct answer being awarded two or even three points (see later section on scoring). This, in addition to the fact that several items had two parts, means that the total number of score points available for analysis somewhat exceeds the number of items included in the test.

The TIMSS instruments were prepared in English and translated into 30 additional languages. In addition, it sometimes was necessary to adapt the international versions for cultural purposes, including the 11 countries that tested in English. This process represented an enormous effort for the national centers, with many checks along the way. The translation effort included: 1) developing explicit guidelines for translation and cultural adaptation, 2) translation of the instruments by the national centers in accordance with the guidelines and using two or more independent translations, 3) consultation with subject-matter experts regarding cultural adaptations to ensure that the meaning and difficulty of items did not change, 4) verification of the quality of the translations by professional translators from an independent translation company, 5) corrections by the national centers in accordance with the suggestions made, 6) verification that corrections were implemented, and 7) a series of statistical checks after the testing to detect items that did not perform comparably across countries.[7]

[7] More details about the translation verification procedures can be found in Mullis, I.V.S., Kelly, D.L., and Haley, K. (1996). "Translation Verification Procedures" in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College; and Maxwell, B. (1996). "Translation and Cultural Adaptation of the TIMSS Instruments" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

TIMSS Test Design

Not all of the students in Population 2 responded to all of the mathematics items. To ensure broad subject matter coverage without overburdening individual students, TIMSS used a rotated design that included both the mathematics and science items. Thus, the same students participated in both the mathematics and science testing. The TIMSS Population 2 test consisted of eight booklets, with each booklet requiring 90 minutes of student response time. In accordance with the design, the mathematics and science items were assembled into 26 different clusters (labeled A through Z). Eight of the clusters were designed to take students 12 minutes to complete; 10 of the clusters, 22 minutes; and 8 clusters, 10 minutes. In all, the design provided a total of 396 unique testing minutes, 198 for mathematics and 198 for science. Cluster A was a core cluster assigned to all booklets. The remaining clusters were assigned to the booklets in accordance with the rotated design so that representative samples of students responded to each cluster.[8]

Sample Implementation and Participation Rates

The selection of valid and efficient samples is crucial to the quality and success of an international comparative study such as TIMSS. The accuracy of the survey results depends on the quality of sampling information available and on the quality of the sampling activities themselves. For TIMSS, NRCs worked on all phases of sampling with staff from Statistics Canada. NRCs received training in how to select the school and student samples and in the use of the sampling software. In consultation with the TIMSS sampling referee (Keith Rust, WESTAT, Inc.), staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample execution. This documentation was used by the International Study Center in consultation with Statistics Canada, the sampling referee, and the Technical Advisory Committee, to evaluate the quality of the samples.

In a few situations where it was not possible to implement TIMSS testing for the entire internationally desired definition of Population 2 (all students in the two adjacent grades with the greatest proportion of 13-year-olds), countries were permitted to define a national desired population which did not include part of the internationally desired population. Table A.2 shows any differences in coverage between the international and national desired populations. Most participants achieved 100% coverage (36 out of 42). The countries with less than 100% coverage are annotated in tables in this report. In some instances, countries, as a matter of practicality, needed to define their tested population according to the structure of school systems, but in Germany and Switzerland, parts of the country were simply unwilling to take part in TIMSS. Because coverage fell below 65% for Latvia, the Latvian results have been labeled "Latvia (LSS)," for Latvian Speaking Schools, throughout the report.

[8] The design is fully documented in Adams, R. and Gonzalez, E. (1996). "Design of the TIMSS Achievement Instruments" in D.F. Robitaille and R.A. Garden (eds.), *TIMSS Monograph No. 2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Education Press; and Adams, R. and Gonzalez, E. (1996). "TIMSS Test Design" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table A.2

Coverage of TIMSS Target Population

The International Desired Population is defined as follows:
Population 2 - All students enrolled in the two adjacent grades with the largest proportion of 13-year-old students at the time of testing.

Country	International Desired Population: Coverage	International Desired Population: Notes on Coverage	National Desired Population: School-Level Exclusions	National Desired Population: Within-Sample Exclusions	National Desired Population: Overall Exclusions
Australia	100%		0.2%	0.7%	0.8%
Austria	100%		2.9%	0.2%	3.1%
Belgium (Fl)	100%		3.8%	0.0%	3.8%
Belgium (Fr)	100%		4.5%	0.0%	4.5%
Bulgaria	100%		0.6%	0.0%	0.6%
Canada	100%		2.4%	2.1%	4.5%
Colombia	100%		3.8%	0.0%	3.8%
Cyprus	100%		0.0%	0.0%	0.0%
Czech Republic	100%		4.9%	0.0%	4.9%
Denmark	100%		0.0%	0.0%	0.0%
[2] England	100%		8.4%	2.9%	11.3%
France	100%		2.0%	0.0%	2.0%
[1] Germany	88%	15 of 16 regions*	8.8%	0.9%	9.7%
Greece	100%		1.5%	1.3%	2.8%
Hong Kong	100%		2.0%	0.0%	2.0%
Hungary	100%		3.8%	0.0%	3.8%
Iceland	100%		1.7%	2.9%	4.5%
Iran, Islamic Rep.	100%		0.3%	0.0%	0.3%
Ireland	100%		0.0%	0.4%	0.4%
[1] Israel	74%	Hebrew Public Education System	3.1%	0.0%	3.1%
Japan	100%		0.6%	0.0%	0.6%
Korea	100%		2.2%	1.6%	3.8%
Kuwait	100%		0.0%	0.0%	0.0%
[1] Latvia (LSS)	51%	Latvian-speaking schools	2.9%	0.0%	2.9%
[1] Lithuania	84%	Lithuanian-speaking schools	6.6%	0.0%	6.6%
Netherlands	100%		1.2%	0.0%	1.2%
New Zealand	100%		1.3%	0.4%	1.7%
Norway	100%		0.3%	1.9%	2.2%
Philippines	91%	2 provinces and autonomous regions excluded	6.5%	0.0%	6.5%
Portugal	100%		0.0%	0.3%	0.3%
Romania	100%		2.8%	0.0%	2.8%
Russian Federation	100%		6.1%	0.2%	6.3%
Scotland	100%		0.3%	1.9%	2.2%
Singapore	100%		4.6%	0.0%	4.6%
Slovak Republic	100%		7.4%	0.1%	7.4%
Slovenia	100%		2.4%	0.2%	2.6%
South Africa	100%		9.6%	0.0%	9.6%
Spain	100%		6.0%	2.7%	8.7%
Sweden	100%		0.0%	0.9%	0.9%
[1] Switzerland	86%	22 of 26 cantons	4.4%	0.8%	5.3%
Thailand	100%		6.2%	0.0%	6.2%
United States	100%		0.4%	1.7%	2.1%

[1]National Desired Population does not cover all of International Desired Population. Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population.
* One region (Baden-Wuerttemberg) did not participate.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Within the desired population, countries could define a population that excluded a small percent (less than 10%) of certain kinds of schools or students that would be very difficult or resource intensive to test (e. g., schools for students with special needs or schools that were very small or located in extremely remote areas). Table A.2 also shows that the degree of such exclusions was small. Only England exceeded the 10% limit, and this is annotated in the tables in this report.

Countries were required to test the two adjacent grades with the greatest proportion of 13-year-olds. Table A.3 presents, for each country, the percentage of 13-year-olds in the lower grade tested, the percentage in the upper grade, and the percentage in both the upper and lower grades combined.

Within countries, TIMSS used a two-stage sample design at Population 2, where the first stage involved selecting 150 public and private schools within each country. Within each school, the basic approach required countries to use random procedures to select one mathematics class at the eighth grade and one at the seventh grade (or the corresponding upper and lower grades in that country). All of the students in those two classes were to participate in the TIMSS testing. This approach was designed to yield a representative sample of 7,500 students per country, with approximately 3,750 students at each grade.[9] Typically, between 450 and 3,750 students responded to each item at each grade level, depending on the booklets in which the items were located.

Countries were required to obtain a participation rate of at least 85% of both schools and students, or a combined rate (the product of school and student participation) of 75%. Tables A.4 through A.8 present the participation rates and achieved sample sizes for the eighth and seventh grades.

9 The sample design for TIMSS is described in detail in Foy, P., Rust, K. and, Schleicher, A., (1996). "TIMSS Sample Design" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table A.3

Coverage of 13-Year-Old Students

Country	Percent of 13-Year-Olds in Lower Grade (Seventh Grade*)	Percent of 13-Year-Olds in Upper Grade (Eighth Grade*)	Percent of 13-Year-Olds in Both Grades
Australia	64	28	92
Austria	62	27	89
Belgium (Fl)	46	49	94
Belgium (Fr)	41	46	87
Bulgaria	58	37	95
Canada	48	43	91
Colombia	30	15	45
Cyprus	28	70	98
Czech Republic	73	17	90
Denmark	35	64	98
England	57	42	99
France	44	35	78
Germany	71	2	73
Greece	11	85	96
Hong Kong	44	46	90
Hungary	65	24	89
Iceland	16	83	100
Iran, Islamic Rep.	47	25	72
Ireland	69	17	86
Israel	–	–	–
Japan	91	9	100
Korea	70	28	98
Kuwait	–	–	–
Latvia (LSS)	60	26	86
Lithuania	64	26	90
Netherlands	59	31	90
New Zealand	52	47	99
Norway	43	57	100
Philippines	–	–	–
Portugal	44	32	76
Romania	67	9	76
Russian Federation	50	44	95
Scotland	24	75	99
Singapore	82	15	97
Slovak Republic	73	22	95
Slovenia	65	2	67
South Africa	36	20	55
Spain	46	39	85
Sweden	45	54	99
Switzerland	48	44	92
Thailand	58	20	78
United States	58	33	91

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower (seventh) grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.4

School Participation Rates and Sample Sizes - Upper Grade (Eighth Grade*)

Country	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	75	77	214	214	158	3	161
Austria	41	84	159	159	62	62	124
Belgium (Fl)	61	94	150	150	92	49	141
Belgium (Fr)	57	79	150	150	85	34	119
Bulgaria	72	74	167	167	111	4	115
Canada	90	91	413	388	363	1	364
Colombia	91	93	150	150	136	4	140
Cyprus	100	100	55	55	55	0	55
Czech Republic	96	100	150	149	143	6	149
Denmark	93	93	158	157	144	0	144
England	56	85	150	144	80	41	121
France	86	86	151	151	127	0	127
Germany	72	93	153	150	102	32	134
Greece	87	87	180	180	156	0	156
Hong Kong	82	82	105	104	85	0	85
Hungary	100	100	150	150	150	0	150
Iceland	98	98	161	132	129	0	129
Iran, Islamic Rep.	100	100	192	191	191	0	191
Ireland	84	89	150	149	125	7	132
Israel	45	46	100	100	45	1	46
Japan	92	95	158	158	146	5	151
Korea	100	100	150	150	150	0	150
Kuwait	100	100	69	69	69	0	69
Latvia (LSS)	83	83	170	169	140	1	141
Lithuania	96	96	151	151	145	0	145
Netherlands	24	63	150	150	36	59	95
New Zealand	91	99	150	150	137	12	149
Norway	91	97	150	150	136	10	146
Philippines	96 **	97 **	200	200	192	1	193
Portugal	95	95	150	150	142	0	142
Romania	94	94	176	176	163	0	163
Russian Federation	97	100	175	175	170	4	174
Scotland	79	83	153	153	119	8	127
Singapore	100	100	137	137	137	0	137
Slovak Republic	91	97	150	150	136	9	145
Slovenia	81	81	150	150	121	0	121
South Africa	60	64	180	180	107	7	114
Spain	96	100	155	154	147	6	153
Sweden	97	97	120	120	116	0	116
Switzerland	93	95	259	258	247	3	250
Thailand	99	99	150	150	147	0	147
United States	77	85	220	217	169	14	183

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table A.5

Student Participation Rates and Sample Sizes - Upper Grade (Eighth Grade*)

Country	Within School Student Participation (Weighted Percentage)	Number of Sampled Students in Participating Schools	Number of Students Withdrawn from Class/School	Number of Students Excluded	Number of Students Eligible	Number of Students Absent	Total Number of Students Assessed
Australia	92	8027	63	61	7903	650	7253
Austria	95	2969	14	4	2951	178	2773
Belgium (Fl)	97	2979	1	0	2978	84	2894
Belgium (Fr)	91	2824	0	1	2823	232	2591
Bulgaria	86	2300	0	0	2300	327	1973
Canada	93	9240	134	206	8900	538	8362
Colombia	94	2843	6	0	2837	188	2649
Cyprus	97	3045	15	0	3030	107	2923
Czech Republic	92	3608	6	0	3602	275	3327
Denmark	93	2487	0	0	2487	190	2297
England	91	2015	37	60	1918	142	1776
France	95	3141	0	0	3141	143	2998
Germany	87	3318	0	35	3283	413	2870
Greece	97	4154	27	23	4104	114	3990
Hong Kong	98	3415	12	0	3403	64	3339
Hungary	87	3339	0	0	3339	427	2912
Iceland	90	2025	10	65	1950	177	1773
Iran, Islamic Rep.	98	3770	20	0	3750	56	3694
Ireland	91	3411	28	10	3373	297	3076
Israel	98	1453	6	0	1447	32	1415
Japan	95	5441	0	0	5441	300	5141
Korea	95	2998	31	0	2967	47	2920
Kuwait	83	1980	3	0	1977	322	1655
Latvia (LSS)	90	2705	19	0	2686	277	2409
Lithuania	87	2915	2	0	2913	388	2525
Netherlands	95	2112	14	1	2097	110	1987
New Zealand	94	4038	121	12	3905	222	3683
Norway	96	3482	26	49	3407	140	3267
Philippines	91 **	6586	93	0	6493	492	6001
Portugal	97	3589	70	13	3506	115	3391
Romania	96	3899	0	0	3899	174	3725
Russian Federation	95	4311	42	10	4259	237	4022
Scotland	88	3289	0	46	3243	380	2863
Singapore	95	4910	18	0	4892	248	4644
Slovak Republic	95	3718	5	3	3710	209	3501
Slovenia	95	2869	15	8	2846	138	2708
South Africa	97	4793	0	0	4793	302	4491
Spain	95	4198	27	102	4069	214	3855
Sweden	93	4483	71	28	4384	309	4075
Switzerland	98	4989	16	24	4949	94	4855
Thailand	100	5850	0	0	5850	0	5850
United States	92	8026	104	108	7814	727	7087

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.6

School Participation Rates and Sample Sizes - Lower Grade (Seventh Grade*)

Country	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	75	76	214	213	156	3	159
Austria	43	86	159	159	63	62	125
Belgium (Fl)	61	93	150	150	91	49	140
Belgium (Fr)	57	80	150	150	85	35	120
Bulgaria	75	77	150	150	101	3	104
Canada	90	90	413	390	366	1	367
Colombia	91	93	150	150	136	4	140
Cyprus	100	100	55	55	55	0	55
Czech Republic	96	100	150	150	144	6	150
Denmark	88	88	158	154	137	0	137
England	57	85	150	145	81	41	122
France	87	87	151	151	126	0	126
Germany	70	90	153	153	101	31	132
Greece	87	87	180	180	156	0	156
Hong Kong	83	83	105	104	86	0	86
Hungary	99	99	150	150	149	0	149
Iceland	97	97	161	149	144	0	144
Iran, Islamic Rep.	100	100	192	192	192	0	192
Ireland	82	87	150	148	122	7	129
Israel	–	–	–	–	–	–	–
Japan	92	95	158	158	146	5	151
Korea	100	100	150	150	150	0	150
Kuwait	–	–	–	–	–	–	–
Latvia (LSS)	83	84	170	169	141	1	142
Lithuania	96	96	151	151	145	0	145
Netherlands	23	61	150	150	34	58	92
New Zealand	90	99	150	150	135	13	148
Norway	84	96	150	147	124	17	141
Philippines	97 **	97 **	200	200	194	0	194
Portugal	94	94	150	150	141	0	141
Romania	94	94	176	175	162	0	162
Russian Federation	97	100	175	175	170	4	174
Scotland	79	85	153	153	120	9	129
Singapore	100	100	137	137	137	0	137
Slovak Republic	91	97	150	150	136	9	145
Slovenia	81	81	150	150	122	0	122
South Africa	83	85	161	161	133	4	137
Spain	96	100	155	154	147	6	153
Sweden	96	96	160	160	154	0	154
Switzerland	90	94	217	217	200	6	206
Thailand	99	99	150	150	146	0	146
United States	77	84	220	214	165	14	179

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.7

Student Participation Rates and Sample Sizes - Lower Grade (Seventh Grade*)

Country	Within School Student Participation (Weighted Percentage)	Number of Sampled Students in Participating Schools	Number of Students Withdrawn from Class/School	Number of Students Excluded	Number of Students Eligible	Number of Students Absent	Total Number of Students Assessed
Australia	93	6067	26	21	6020	421	5599
Austria	95	3196	22	5	3169	156	3013
Belgium (Fl)	97	2857	3	0	2854	86	2768
Belgium (Fr)	95	2418	0	1	2417	125	2292
Bulgaria	87	2080	0	0	2080	282	1798
Canada	95	8962	89	248	8625	406	8219
Colombia	93	2840	2	0	2838	183	2655
Cyprus	98	3028	17	0	3011	82	2929
Czech Republic	92	3641	11	0	3630	285	3345
Denmark	86	2408	0	0	2408	335	2073
England	92	2031	31	67	1933	130	1803
France	95	3164	0	0	3164	148	3016
Germany	87	3388	0	37	3351	458	2893
Greece	97	4166	30	78	4058	127	3931
Hong Kong	98	3507	11	0	3496	83	3413
Hungary	94	3266	0	0	3266	200	3066
Iceland	92	2243	11	72	2160	203	1957
Iran, Islamic Rep.	99	3789	18	0	3771	36	3735
Ireland	91	3480	23	17	3440	313	3127
Israel	–	–	–	–	–	–	–
Japan	96	5337	0	0	5337	207	5130
Korea	94	2996	51	0	2945	38	2907
Kuwait	–	–	–	–	–	–	–
Latvia (LSS)	91	2853	7	0	2846	279	2567
Lithuania	89	2852	3	0	2849	318	2531
Netherlands	95	2220	23	0	2197	100	2097
New Zealand	95	3471	98	17	3356	172	3184
Norway	96	2629	8	53	2568	99	2469
Philippines	93 **	6283	29	1	6253	401	5852
Portugal	96	3594	80	4	3510	148	3362
Romania	95	3938	0	0	3938	192	3746
Russian Federation	96	4408	39	11	4358	220	4138
Scotland	90	3313	0	81	3232	319	2913
Singapore	98	3744	19	0	3725	84	3641
Slovak Republic	95	3797	10	3	3784	184	3600
Slovenia	95	3058	12	4	3042	144	2898
South Africa	96	5532	0	0	5532	231	5301
Spain	95	4087	38	116	3933	192	3741
Sweden	95	3055	27	36	2992	161	2831
Switzerland	99	4199	14	44	4141	56	4085
Thailand	100	5845	0	0	5845	0	5845
United States	94	4295	42	85	4168	282	3886

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.8

Overall Participation Rates
Upper and Lower Grades (Eighth and Seventh Grades*)

Country	Upper Grade		Lower Grade	
	Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)	Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)
Australia	69	70	69	71
Austria	39	80	41	82
Belgium (Fl)	59	91	59	91
Belgium (Fr)	52	72	54	76
Bulgaria	62	63	65	67
Canada	84	84	86	86
Colombia	85	87	84	86
Cyprus	97	97	98	98
Czech Republic	89	92	88	92
Denmark	86	86	76	76
England	51	77	52	78
France	82	82	82	82
Germany	63	81	61	78
Greece	84	84	84	84
Hong Kong	81	81	81	81
Hungary	87	87	93	93
Iceland	88	88	89	89
Iran, Islamic Rep.	98	98	99	99
Ireland	76	81	75	79
Israel	44	45	–	–
Japan	87	90	88	91
Korea	95	95	94	94
Kuwait	83	83	–	–
Latvia (LSS)	75	75	75	76
Lithuania	83	83	86	86
Netherlands	23	60	22	58
New Zealand	86	94	85	94
Norway	87	93	81	92
Philippines	87 **	88 **	90 **	90 **
Portugal	92	92	90	90
Romania	89	89	89	89
Russian Federation	93	95	93	95
Scotland	69	73	71	76
Singapore	95	95	98	98
Slovak Republic	86	91	86	92
Slovenia	77	77	77	77
South Africa	58	62	79	82
Spain	91	94	91	95
Sweden	90	90	91	91
Switzerland	92	94	89	93
Thailand	99	99	99	99
United States	71	78	72	79

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
** Participation rates for the Philippines are unweighted.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Indicating Compliance with Sampling Guidelines in the Report

Figure A.3 shows how countries have been grouped in tables reporting achievement results. Countries that achieved acceptable participation rates – 85% of both the schools and students, or a combined rate (the product of school and student participation) of 75% – with or without replacement schools, and that complied with the TIMSS guidelines for grade selection and classroom sampling are shown in the first panel of Figure A.3. Countries that met the guidelines only after including replacement schools are annotated. These countries (25 at the eighth grade and 27 at the seventh grade) appear in the tables in Chapters 1, 2, and 3 ordered by achievement.

Countries not reaching at least 50% school participation without the use of replacements schools, or that failed to reach the sampling participation standard even with the inclusion of replacement schools, are shown in the second panel of Figure A.3. These countries are presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are shown in tables in Chapters 4 and 5 in italics.

To provide a better curricular match, four countries (i.e., Colombia, Germany, Romania, and Slovenia) elected to test their seventh- and eighth-grade students even though that meant not testing the two grades with the most 13-year-olds and led to their students being somewhat older than those in the other countries. These countries are also presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are shown in tables in Chapter 4 and 5 in italics. Table A.3 shows the percentage of 13-year-olds for each country in the grades tested.

For a variety of reasons, three countries (Denmark, Greece, and Thailand) did not comply with the guidelines for sampling classrooms. Their results are also presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are italicized in tables in Chapter 4 and 5. At the eighth grade, Israel, Kuwait, and South Africa also had difficulty complying with the classroom selection guidelines, but in addition had other difficulties (Kuwait tested a single grade with relatively few 13-year-olds; Israel and South Africa had low sampling participation rates), and so these countries are also presented in separate sections in tables in Chapters 1, 2, and 3, and are italicized in tables in Chapter 4 and 5. At the seventh grade, South Africa had a better sampling participation rate, and is presented in the same section of tables as Denmark, Greece, and Thailand. Israel and Kuwait did not test at the seventh grade.

Because the Philippines was not able to document clearly the school sampling procedures used, its results are not presented in the main body of the report. A small set of results for the Philippines can be found in Appendix C.

Figure A.3

Countries Grouped for Reporting of Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates

Eighth Grade	Seventh Grade
Countries satisfying guidelines for sample participation rates, grade selection and sampling procedures	
† Belgium (Fl) Canada Cyprus Czech Republic †2 England France Hong Kong Hungary Iceland Iran, Islamic Rep. Ireland Japan Korea 1 Latvia 1 Lithuania New Zealand Norway Portugal Russian Federation Singapore Slovak Republic Spain Sweden 1 Switzerland † United States	† Belgium (Fr) † Belgium (Fl) Canada Cyprus Czech Republic †2 England France Hong Kong Hungary Iceland Iran, Islamic Rep. Ireland Japan Korea 1 Latvia (LSS) 1 Lithuania New Zealand Norway Portugal Russian Federation † Scotland Singapore Slovak Republic Spain Sweden 1 Switzerland † United States
Countries not satisfying guidelines for sample participation	
Australia Austria Belgium (Fr) Bulgaria Netherlands Scotland	Australia Austria Bulgaria Netherlands
Countries not meeting age/grade specifications (high percentage of older students)	
Colombia †1 Germany Romania Slovenia	Colombia †1 Germany Romania Slovenia
Countries with unapproved sampling procedures at the classroom level	
Denmark Greece Thailand	Denmark Greece 1 South Africa Thailand
Countries with unapproved sampling procedures at classroom level and not meeting other guidelines	
1 Israel Kuwait South Africa	
Countries with unapproved sampling procedures at school level	
3 Philippines	3 Philippines

†Met guidelines for sample participation rates only after replacement schools were included.

1National Desired Population does not cover all of International Desired Population (see Table 1). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table 1).

3TIMSS was unable to compute sampling weights for the Philippines. Selected unweighted achievement results for the Philippines are presented in Appendix C.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

DATA COLLECTION

Each participating country was responsible for carrying out all aspects of the data collection, using standardized procedures developed for the study. Training manuals were developed for school coordinators and test administrators that explained procedures for receipt and distribution of materials as well as for the activities related to the testing sessions. The test administrator manuals covered procedures for test security, standardized scripts to regulate directions and timing, rules for answering students' questions, and steps to ensure that identification on the test booklets and questionnaires corresponded to the information on the forms used to track students.

Each country was responsible for conducting quality control procedures and describing this effort as part of the NRC's report documenting procedures used in the study. In addition, the International Study Center considered it essential to establish some method to monitor compliance with standardized procedures. NRCs were asked to nominate a person, such as a retired school teacher, to serve as quality control monitor for their countries, and in almost all cases, the International Study Center adopted the NRCs' first suggestion. The International Study Center developed manuals for the quality control monitors and briefed them in two-day training sessions about TIMSS, the responsibilities of the national centers in conducting the study, and their own roles and responsibilities.

The quality control monitors interviewed the NRCs about data collection plans and procedures. They also selected a sample of approximately 10 schools to visit, where they observed testing sessions and interviewed school coordinators.[10] Quality control monitors observed test administrations and interviewed school coordinators in 37 countries, and interviewed school coordinators or test administrators in 3 additional countries.

The results of the interviews indicate that, in general, NRCs had prepared well for data collection and, despite the heavy demands of the schedule and shortages of resources, were in a position to conduct the data collection in an efficient and professional manner. Similarly, the TIMSS tests appeared to have been administered in compliance with international procedures, including the activities preliminary to the testing session, the activities during the testing sessions, and the school-level activities related to receiving, distributing, and returning materials from the national centers.

[10] The results of the interviews and observations by the quality control monitors are presented in Martin, M.O., Hoyle, C.D., and Gregory, K.D. (1996). "Monitoring the TIMSS Data Collection" and "Observing the TIMSS Test Administration" both in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College.

Scoring the Free-Response Items

Because approximately one-third of the written test time was devoted to free-response items, TIMSS needed to develop procedures for reliably evaluating student responses within and across countries. Scoring utilized two-digit codes with rubrics specific to each item. Development of the rubrics was led by the Norwegian TIMSS national center. The first digit designates the correctness level of the response. The second digit, combined with the first digit, represents a diagnostic code used to identify specific types of approaches, strategies, or common errors and misconceptions. Although not specifically used in this report, analyses of responses based on the second digit should provide insight into ways to help students better understand mathematics concepts and problem-solving approaches.

To meet the goal of implementing reliable scoring procedures based on the TIMSS rubrics, the International Study Center prepared guides containing the rubrics and explanations of how to implement them together with example student responses for the various rubric categories. These guides, together with more examples of student responses for practice in applying the rubrics were used as a basis for an ambitious series of regional training sessions. The training sessions were designed to assist representatives of national centers who would then be responsible for training personnel in their respective countries to apply the two-digit codes reliably.[11]

To gather and document empirical information about the within-country agreement among scorers, TIMSS developed a procedure whereby systematic subsamples of approximately 10% of the students' responses were to be coded independently by two different readers. To provide information about the cross-country agreement among scorers, TIMSS conducted a special study at Population 2, where 39 scorers from 21 of the participating countries evaluated common sets of students' responses to more than half of the free-response items.

Table A.9 shows the average and range of the within-country exact percent of agreement between scorers on the free-response items in the Population 2 mathematics test for 26 countries. Unfortunately, lack of resources precluded several countries from providing this information. A very high percent of exact agreement was observed, with averages across the items for the correctness score ranging from 97% to 100% and an overall average of 99% across the 26 countries.

The cross-country coding reliability study involved 350 students' responses for each of 14 mathematics and 17 science items, totaling 10,850 responses in all. The responses were random samples from the within-country reliability samples from seven English-test countries: Australia, Canada, England, Ireland, New Zealand, Singapore, and the United States. The responses were presented to the scorers according to a

[11] The procedures used in the training sessions are documented in Mullis, I.V.S., Garden, R.A., and Jones, C.A. (1996). "Training for Scoring the TIMSS Free-Response Items" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table A.9

TIMSS Within-Country Free-Response Coding Reliability Data for Population 2 Mathematics Items*

Country	Correctness Score Agreement: Average of Exact Percent Agreement Across Items	Correctness Score Agreement: Range of Exact Percent Agreement		Diagnostic Code Agreement: Average of Exact Percent Agreement Across Items	Diagnostic Code Agreement: Range of Exact Percent Agreement	
		Min	Max		Min	Max
Australia	98	90	100	90	61	98
Belgium (Fl)	100	98	100	99	92	100
Bulgaria	98	93	100	94	59	100
Canada	98	85	100	92	70	99
Colombia	99	97	100	96	91	100
Czech Republic	98	77	100	95	68	100
England	100	96	100	97	89	100
France	100	96	100	98	93	100
Germany	98	89	100	94	75	100
Hong Kong	99	94	100	96	84	100
Iceland	98	84	100	91	73	100
Iran, Islamic Rep.	98	94	100	93	70	100
Ireland	99	95	100	97	83	100
Japan	100	96	100	99	90	100
Netherlands	98	87	100	91	68	100
New Zealand	99	95	100	95	81	100
Norway	99	90	100	95	79	100
Portugal	98	88	100	93	82	99
Russian Federation	99	94	100	96	84	100
Scotland	97	81	100	89	63	99
Singapore	99	95	100	98	87	100
Slovak Republic	97	84	100	91	70	98
Spain	98	88	100	94	75	100
Sweden	99	90	100	94	75	100
Switzerland	100	95	100	98	83	100
United States	99	95	100	96	85	99
AVERAGE	99	91	100	95	78	100

*Based on 26 mathematics items, including 6 multiple-part items.
Note: Percent agreement was computed separately for each part, and each part was treated as a separate item in computing averages and ranges.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

rotated design whereby each response was coded by 7 to 18 different scorers. This design resulted in a large number of comparisons between coders, approximately 10,000 or more for each item.

Table A.10 presents the percent of exact agreement for the 14 mathematics items and the scorers involved in the international study. For comparison purposes, it also shows the average and range of the percent of exact agreement for each of the items within the 26 countries submitting data about their scoring reliability. The percent of exact agreement for each mathematics item was very high, with only two items having measures below 90% on the correctness score agreement. Also, for the correctness score agreement, all items were well within the range of the within-country results. The TIMSS data from the reliability studies indicate that scoring procedures were extremely robust for the mathematics items, especially for the correctness score used for the analyses in this report.[12]

[12] Details about the reliability studies can be found in Mullis, I.V.S., and Smith, T.A. (1996). "Quality Control Steps for Free-Response Scoring" in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College.

Table A.10

Percent Exact Agreement for Coding of Mathematics Items for International and Within-Country Reliability Studies

Item Label	Total Valid Comparisons in International Study	Correctness Score Agreement				Diagnostic Code Agreement			
		International Study	Within-Country Study			International Study	Within-Country Study		
			Average	Min	Max		Average	Min	Max
R13	9150	100	99	96	100	97	97	84	100
[1] T02A	46050	100	100	96	100	98	98	94	100
K02	12600	99	99	95	100	98	97	92	100
O06	46050	99	99	96	100	99	98	87	100
K05	45985	99	100	96	100	97	98	92	100
V04	12600	99	99	98	100	97	98	91	100
Q10	12600	99	99	96	100	95	98	92	100
P16	12600	99	99	94	100	91	95	89	100
R14	9150	99	99	94	100	94	97	90	100
[1] T02B	46050	99	99	95	100	91	94	74	100
[1] U01A	45938	98	100	98	100	95	97	90	100
[1] T01A	12592	97	98	84	100	91	94	77	100
V01	12600	97	99	95	100	93	95	88	99
[1] T01B	12600	96	98	95	100	74	88	68	100
[1] U02A	12600	95	97	90	100	85	92	75	99
V02	12600	91	96	81	100	77	89	72	98
[1] U02B	12592	89	96	84	100	71	88	75	100
[1] U01B	46050	84	93	77	99	61	82	61	97
AVERAGE MATH ITEMS		97	98	92	100	89	94	83	100

[1]Two-part items; each part is analyzed separately.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Test Reliability

Table A.11 displays the test reliability coefficient for each country for the lower and upper grades (usually seventh and eighth grades). This coefficient is the median KR-20 reliability across the eight test booklets. Median reliabilities in the lower grade ranged from 0.91 in Hong Kong and Korea to 0.75 in Iran, and in the upper grade from 0.91 in Bulgaria to 0.73 in Kuwait. The international median, shown in the last row of the table is the median of the reliability coefficients for all countries. These international medians are 0.86 for the lower grade and 0.89 for the upper grade.

Data Processing

To ensure the availability of comparable, high quality data for analysis, TIMSS engaged in a rigorous set of quality control steps to create the international database.[13] TIMSS prepared manuals and software for countries to use in entering their data so the information would be in a standardized international format before being forwarded to the IEA Data Processing Center in Hamburg for creation of the international database. Upon arrival at the IEA Data Processing Center, the data from each country underwent an exhaustive cleaning process. The data cleaning process involved several iterative steps and procedures designed to identify, document, and correct deviations from the international instruments, file structures, and coding schemes. This process also emphasized consistency of information within national data sets and appropriate linking among the many student, teacher, and school data files.

Throughout the process, the data were checked and double-checked by the IEA Data Processing Center, the International Study Center, and the national centers. The national centers were contacted regularly and given multiple opportunities to review the data for their countries. In conjunction with the Australian Council for Educational Research (ACER), the International Study Center conducted a review of item statistics for each of the cognitive items in each of the countries to identify poorly performing items. Twenty-one countries had one or more items deleted (in most cases, one). Usually the poor statistics (negative point-biserials for the key, large item-by-country interactions, and statistics indicating lack of fit with the model) were a result of translation, adaptation, or printing deviations.

[13] These steps are detailed in Jungclaus, H. and Bruneforth, M. (1996). "Data Consistency Checking Across Countries" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table A.11

Cronbach's Alpha Reliability Coefficients[1] - TIMSS Mathematics Test Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Lower Grade	Upper Grade
Australia	0.89	0.90
Austria	0.88	0.89
Belgium (Fl)	0.84	0.89
Belgium (Fr)	0.85	0.89
Bulgaria	0.90	0.91
Canada	0.86	0.88
Colombia	0.76	0.79
Cyprus	0.85	0.88
Czech Republic	0.89	0.89
Denmark	0.84	0.87
England	0.89	0.90
France	0.84	0.85
Germany	0.88	0.89
Greece	0.88	0.89
Hong Kong	0.91	0.90
Hungary	0.88	0.90
Iceland	0.82	0.87
Iran, Islamic Rep.	0.75	0.78
Ireland	0.88	0.90
Israel	–	0.89
Japan	0.89	0.90
Korea	0.91	0.92
Kuwait	–	0.73
Latvia (LSS)	0.86	0.88
Lithuania	0.84	0.88
Netherlands	0.86	0.89
New Zealand	0.88	0.90
Norway	0.85	0.87
Philippines	0.86	0.87
Portugal	0.77	0.82
Romania	0.87	0.88
Russian Federation	0.88	0.89
Scotland	0.87	0.89
Singapore	0.88	0.83
Slovak Republic	0.87	0.89
Slovenia	0.87	0.89
South Africa	0.79	0.81
Spain	0.83	0.86
Sweden	0.86	0.88
Switzerland	0.84	0.88
Thailand	0.86	0.88
United States	0.89	0.89
International Median	0.86	0.89

*Seventh and eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Israel and Kuwait did not test the lower grade.
[1]The reliability coefficient for each country is the median KR-20 reliability across the eight test booklets.
The international median is the median of the reliability coefficients for all countries.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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IRT Scaling and Data Analysis

Two general analysis approaches were used for this report – item response theory scaling methods and average percent correct technology. The overall mathematics results were summarized using an item response theory (IRT) scaling method (Rasch model). This scaling method produces a mathematics score by averaging the responses of each student to the items which they took in a way that takes into account the difficulty of each item. The methodology used in TIMSS includes refinements that enable reliable scores to be produced even though individual students responded to relatively small subsets of the total mathematics item pool. Analyses of the response patterns of students from participating countries indicated that, although the items in the test address a wide range of mathematical content, the performance of the students across the items was sufficiently consistent to be usefully summarized in a single mathematics score.

The IRT methodology was preferred for developing comparable estimates of performance for all students, since students answered different test items depending upon which of the eight test booklets they received. The IRT analysis provides a common scale on which performance can be compared across countries. In addition to providing a basis for estimating mean achievement, scale scores permit estimates of how students within countries vary and provide information on percentiles of performance. The scale was standardized using students from both the grades tested. When all participating countries and grades are treated equally, the TIMSS scale average is 500 and the standard deviation is 100. Since the countries varied in size, each country was reweighted to contribute equally to the mean and standard deviation of the scale. The average of the scale scores was constructed to be the average of the 41 means of participants that were available at the eighth grade and the 39 means at the seventh grade. The average and standard deviation of the scale scores are arbitrary and do not affect scale interpretations.

The analytic approach underlying the results in Chapters 2 and 3 of this report involved calculating the percentage of correct answers for each item for each participating country (as well as the percentages of different types of incorrect responses). The percents correct were averaged to summarize mathematics performance overall and in each of the content areas for each country as a whole and by gender. For items with more than one part, each part was analyzed separately in calculating the average percents correct. Also, for items with more than one point awarded for full credit, the average percents correct reflect an average of the points received by students in each country. This was achieved by including the percent of students receiving one score point as well as the percentage receiving two score points and three score points in the calculations. Thus, the average percents correct are based on the number of score points rather than the number of items, per se. An exception to this is the international average percents correct reported for example items, where the values reflect the percent of students receiving full credit.

Estimating Sampling Error

Because the statistics presented in this report are estimates of national performance based on samples of students, rather than the values that could be calculated if every student in every country would have answered every question, it is important to have measures of the degree of uncertainty of the estimates. The jackknife procedure was used to estimate the standard error associated with each statistic presented in this report. The use of confidence intervals, based on the standard errors, provides a way to make inferences about the population means and proportions in a manner that reflects the uncertainty associated with the sample estimates. An estimated sample statistic plus or minus two standard errors represents a 95% confidence interval for the corresponding population result.

Appendix B

The Test-Curriculum Matching Analysis

When comparing student achievement across countries, it is important that the comparisons be as "fair" as possible. TIMSS has worked towards this goal in a number of ways, including providing detailed procedures for standardizing the population definitions, sampling, test translations, test administration, scoring, and database formation. Developing the TIMSS tests involved the interaction of experts in the field of mathematics with representatives of the participating countries and testing specialists.[1] The National Research Coordinators (NRCs) from each country formally approved the TIMSS test, thus accepting it as being sufficiently fair to compare their students' mathematics achievement with that of students from other countries.

Although the TIMSS test was developed to represent a set of agreed-upon mathematics content areas, there are differences among the curricula of participating countries that result in various mathematics topics being taught at different grades. To restrict test items not only to those topics in the curricula of all countries but also to those covered in the same sequence in all participating countries would severely limit test coverage and restrict the research questions about international differences that TIMSS is designed to address. The TIMSS tests, therefore, inevitably contain some items measuring topics unfamiliar to some students in some countries.

The Test-Curriculum Matching Analysis (TCMA) was developed and conducted to investigate the appropriateness of the TIMSS mathematics test for seventh- and eighth-grade students in the participating countries, and to show how student performance for individual countries varied when based only on the test questions that were judged to be relevant to their own curriculum.[2]

To gather data about the extent to which the TIMSS tests were relevant to the curriculum of the participating countries, TIMSS asked the NRC of each country to report whether or not each item was in the country's intended curriculum at each of the two grades being tested. The NRC was asked to choose a person or persons who were very familiar with the curricula at the grades being tested to make the determination. Since an item might be in the curriculum for some but not all students in a country, an item was determined appropriate if it was in the intended curriculum for more than 50% of the students. The NRCs had considerable flexibility in selecting items and may have considered items inappropriate for other reasons. All participating countries except Thailand returned the information for analysis.

[1] See Appendix A for more information on the test development.

[2] Because there also may be curriculum areas covered in some countries that are not covered by the TIMSS tests, the TCMA does not provide complete information about how well the TIMSS tests cover the curricula of the countries.

Tables B.1 and B.2 present the TCMA results for the eighth and seventh grades, respectively. The first row of each table indicates that at both grades the countries varied substantially in the number of items considered appropriate. At the eighth grade, half of the countries indicated that items representing 90% or more of the score points (145 out of a possible 162) were appropriate,[3] with the percent ranging from 100% in Hungary and the United States to 47% (76 score points) in Greece. Although, in general, fewer items were selected at the seventh grade than at the eighth grade, nearly half of the countries selected items representing at least three-quarters of the score points (121), and several countries selected items representing 90% or more. The number of score points represented by the selected items for the seventh grade ranged from 59 (36%) in Denmark to 162 (100%) in the United States. That somewhat lower percentages of items were selected for the TCMA at the seventh grade is consistent with the instrument-development process, which put more emphasis on the upper-grade curriculum.

Since most countries indicated that some items were not included in their intended curricula at the two grades tested, the question becomes whether the inclusion of these items had any effect on the international performance comparisons.[4] The TCMA results provide a method for answering this question, providing evidence that it is reasonable to make cross-national comparisons on the basis of the TIMSS mathematics test.

Each of the first columns in Tables B.1 and B.2 shows the overall average percent correct for each country (as discussed in Chapter 2 and reproduced here for convenience in making comparisons). The countries are presented in the order of their overall performance, from highest to lowest. To interpret these tables, reading across a row provides the average percent correct for the students in the country identified by that row on the items selected by each of the countries named across the top of the table. For example, eighth-grade Korean students had an average of 71% correct on the items that Singapore selected as appropriate for the Singaporean students, an average of 72% percent correct on the items selected for the Japanese students, 73% correct for its own items, 72% on the items selected by Hong Kong, and so forth. The column for a country shows how each of the other countries performed on the subset of items selected for its own students. Using the set of items selected by Switzerland as an example, on average, 80% of these items were answered correctly by the Singaporean students, 75% by the Japanese students, 72% by the students from Hong Kong, 71% by the Belgian (Flemish) students, and so forth. The shaded diagonal elements in

[3] Of the 151 items in the test, some items were assigned more score points than others. In particular, some items had two parts, and some extended-response items were scored on a two-point scale and others on a three-point scale. The total number of score points available for analysis was 162. The TCMA uses the score points in order to give the same importance to items that they received in the test scoring.

[4] It should be noted that the performance levels presented in Tables B.1 and B.2 are based on average percents correct as was done in Chapter 2, which is different from the average scale scores that were presented in Chapter 1. The cost and delay of scaling would have been prohibitive for the TCMA analyses.

Table B.1 Test-Curriculum Matching Analysis Results - Mathematics - Upper Grade (Eighth Grade*)

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table B.3 for corresponding standard errors)

Instructions: Read *across* the row to compare that country's performance based on the test items included by each of the countries across the top.
Read *down* the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the *diagonal* to compare performance for each different country based on its own decisions about the test items to include.

Country	Average Percent Correct on All Items	Singapore	Japan	Korea	Hong Kong	Belgium (Fl)	Czech Republic	Slovak Republic	Switzerland	*Austria*	Hungary	France	*Slovenia*	Russian Federation	*Netherlands*	*Bulgaria*	Canada	Ireland	*Belgium (Fr)*	*Australia*	*Israel*	Sweden	*Germany*	New Zealand	Norway	England	United States	*Denmark*	*Scotland*	Latvia (LSS)	Spain	Iceland	*Greece*	*Romania*	Lithuania	Cyprus	Portugal	Iran, Islamic Rep.	*Kuwait*	*Colombia*	*South Africa*
(Number of Score Points Included)	162**	144	153	148	150	140	150	152	133	147	162	140	151	126	116	119	147	145	138	154	159	127	155	145	150	130	162	135	125	161	158	133	76	143	155	124	152	147	140	133	129
Singapore	79 (0.9)	79	79	80	79	79	79	79	80	80	79	79	79	81	79	80	79	79	79	79	79	79	79	79	79	81	79	80	80	79	79	80	79	79	79	80	79	79	79	80	79
Japan	73 (0.4)	73	73	74	73	73	73	73	75	74	73	73	73	74	73	73	74	73	73	74	73	73	73	75	74	75	73	75	74	73	73	74	74	74	73	73	73	74	74	74	73
Korea	72 (0.5)	71	72	73	72	71	72	71	72	72	72	71	71	72	70	72	72	71	71	72	72	71	72	73	72	73	72	73	72	72	72	73	72	72	71	71	72	72	72	72	70
Hong Kong	70 (1.4)	70	70	71	70	70	70	70	71	71	70	70	70	71	69	71	70	70	69	70	70	69	70	71	70	71	70	71	70	70	70	70	70	70	70	70	70	70	70	71	70
Belgium (Fl)	66 (1.4)	65	65	67	65	65	65	65	68	66	66	66	65	67	64	65	66	65	65	66	66	67	66	67	66	68	66	67	67	66	65	67	65	66	65	65	65	66	66	66	65
Czech Republic	66 (1.1)	65	66	67	66	66	66	66	68	66	66	66	66	67	64	65	66	66	65	66	66	66	66	67	66	67	66	67	66	66	65	67	68	66	66	65	66	66	66	66	65
Slovak Republic	62 (0.8)	63	63	64	63	63	63	63	65	63	62	63	63	64	61	63	63	62	62	63	62	62	63	63	62	64	62	64	62	62	62	64	64	62	63	62	63	63	63	63	63
Switzerland	62 (0.6)	61	62	63	61	61	61	62	64	62	62	62	61	62	62	60	63	61	60	62	62	64	62	64	62	66	62	64	65	62	62	63	60	61	62	61	62	62	62	61	61
Austria	62 (0.8)	62	62	63	62	61	62	62	64	62	62	62	61	63	61	61	63	62	61	62	62	64	62	63	62	65	62	64	63	62	62	63	62	62	62	62	62	62	62	62	62
Hungary	62 (0.7)	61	61	63	61	61	61	61	63	62	62	61	61	62	60	61	62	61	61	62	62	62	62	63	62	63	62	63	61	62	61	62	63	61	61	61	61	62	62	62	61
France	61 (0.8)	61	61	62	61	60	61	61	63	61	61	61	61	62	60	60	62	61	60	62	61	62	61	63	62	63	61	63	62	61	61	62	60	61	61	60	61	61	62	62	60
Slovenia	61 (0.7)	61	61	62	61	61	61	61	63	62	61	61	61	63	59	61	62	61	61	62	61	61	61	62	61	63	61	62	61	61	61	62	62	61	61	61	61	62	62	62	61
Russian Federation	60 (1.3)	61	60	61	60	60	60	60	62	61	60	60	60	62	58	61	61	60	60	61	60	60	60	61	60	61	60	61	60	60	60	61	62	60	60	60	60	61	61	61	60
Netherlands	60 (1.6)	59	60	60	59	58	59	59	61	60	60	59	59	59	59	58	61	59	58	60	60	62	60	63	61	63	60	62	62	60	59	61	60	59	59	58	60	60	60	59	58
Bulgaria	60 (1.2)	60	59	61	59	59	59	59	61	60	60	59	59	61	57	60	60	59	59	60	60	58	60	61	60	61	60	61	59	60	60	61	61	60	59	58	60	60	60	61	59
Canada	59 (0.5)	58	58	59	58	58	58	58	60	59	59	58	58	59	58	57	60	58	57	59	59	60	59	61	59	62	59	61	60	59	58	60	58	59	58	58	59	59	59	58	58
Ireland	59 (1.2)	58	58	59	58	58	58	58	60	59	59	58	58	59	58	57	59	58	57	59	59	60	58	61	59	62	59	60	60	59	58	60	59	58	58	58	59	59	59	58	58
Belgium (Fr)	59 (0.9)	58	58	60	58	58	58	58	61	59	59	59	58	59	57	58	59	58	58	59	59	60	59	60	59	62	59	61	60	59	59	59	58	58	58	58	58	59	59	59	58
Australia	58 (0.9)	57	58	59	57	57	58	58	60	58	58	57	57	58	57	56	59	57	56	58	58	59	58	61	58	61	58	60	60	58	58	59	59	58	58	57	58	59	58	57	57
Israel	57 (1.3)	57	57	59	57	57	57	57	59	58	57	57	57	59	55	57	58	57	57	58	58	58	57	59	57	59	57	58	57	57	57	58	60	58	57	57	57	58	58	58	57
Sweden	56 (0.7)	55	55	56	55	54	55	55	57	55	56	55	54	55	56	53	57	55	54	56	56	60	55	59	57	59	56	58	59	55	55	57	53	55	55	54	56	56	56	54	54
Germany	54 (1.1)	53	54	55	53	53	54	53	56	54	54	54	53	54	53	52	55	54	52	54	54	55	54	56	54	57	54	56	55	54	54	55	54	53	54	53	54	54	54	54	53
New Zealand	54 (1.0)	53	54	54	53	52	53	53	55	54	54	53	53	53	53	51	55	53	52	54	54	56	54	57	54	57	54	56	57	54	54	55	55	53	53	52	54	55	54	53	52
Norway	54 (0.5)	53	53	54	53	52	53	53	56	54	54	53	53	53	53	51	54	53	52	54	54	56	53	56	54	57	54	56	56	53	53	55	52	53	53	52	53	54	54	52	52
England	53 (0.7)	52	53	53	52	51	52	52	54	53	53	52	52	52	52	49	54	52	50	53	53	55	53	56	54	57	53	55	56	53	53	54	55	52	52	51	53	54	53	51	51
United States	53 (1.1)	52	53	54	52	52	53	52	54	53	53	52	52	53	52	51	54	52	51	53	53	54	53	55	53	56	53	55	54	53	53	54	54	53	53	52	53	54	53	52	52
Denmark	52 (0.7)	51	52	52	52	51	51	52	54	52	52	51	51	52	52	49	53	51	50	53	52	54	52	55	53	56	52	55	55	52	52	53	53	51	52	50	52	53	52	51	50
Scotland	52 (1.3)	51	51	52	51	50	51	51	53	51	52	50	51	51	51	48	52	51	49	52	52	54	51	55	52	55	52	54	55	52	51	52	53	51	51	49	52	52	52	50	50
Latvia (LSS)	51 (0.8)	51	51	52	51	51	51	51	53	52	51	51	51	53	50	51	52	51	51	52	51	51	52	53	51	53	51	53	52	51	51	52	53	51	51	50	51	52	52	52	51
Spain	51 (0.5)	50	51	52	51	50	51	51	52	51	51	51	50	51	48	50	51	50	50	51	51	51	51	52	51	53	51	52	51	51	51	52	53	51	51	50	51	51	51	51	50
Iceland	50 (1.1)	49	50	50	49	48	49	49	52	49	50	49	49	49	49	47	50	49	48	50	50	53	49	53	50	54	50	53	53	50	49	51	49	49	49	48	49	51	50	49	48
Greece	49 (0.7)	49	49	50	49	49	49	49	51	49	49	49	49	50	48	49	50	49	49	50	49	50	49	51	50	52	49	51	50	49	49	50	50	49	49	49	49	50	50	49	48
Romania	49 (1.0)	49	49	50	49	49	49	49	50	50	49	49	49	51	47	50	49	49	49	49	49	48	49	50	49	50	49	49	48	49	49	49	50	49	49	49	49	50	49	51	49
Lithuania	48 (0.9)	49	49	49	49	48	49	49	51	49	48	48	48	50	47	48	50	48	48	49	48	49	49	50	49	50	48	50	49	48	49	49	50	48	49	47	49	49	49	49	48
Cyprus	48 (0.5)	48	47	49	47	47	48	47	49	48	48	48	47	49	46	48	48	47	47	48	48	48	48	49	48	50	48	48	48	48	48	48	48	48	47	47	48	48	48	49	47
Portugal	43 (0.7)	42	43	43	43	42	43	43	45	43	43	42	42	43	41	41	44	42	41	43	43	44	43	45	43	45	43	45	44	43	43	43	44	42	43	41	43	44	43	43	41
Iran, Islamic Rep.	38 (0.6)	38	38	39	38	38	38	38	39	38	38	38	38	39	37	38	39	37	37	38	38	37	38	39	38	40	38	39	38	38	38	39	39	38	38	37	38	38	38	39	37
Kuwait	30 (0.7)	29	30	30	29	29	29	29	31	29	30	29	30	30	29	28	30	29	29	30	30	29	30	32	30	31	30	30	30	30	30	30	32	30	30	28	30	30	30	30	28
Colombia	29 (0.8)	29	29	30	29	29	29	29	31	29	29	29	29	29	28	28	30	29	28	30	29	30	29	31	30	32	29	30	30	29	29	30	31	29	29	28	29	30	30	29	28
South Africa	24 (1.1)	23	24	25	24	24	24	24	25	24	24	23	24	24	23	24	24	24	24	24	24	24	24	25	24	25	24	24	24	24	24	25	24	24	24	23	24	24	24	24	23
International Average	**55 (0.9)**	**55**	**55**	**56**	**55**	**54**	**55**	**55**	**57**	**55**	**55**	**55**	**55**	**56**	**54**	**54**	**56**	**55**	**54**	**55**	**55**	**56**	**55**	**57**	**55**	**58**	**55**	**57**	**56**	**55**	**55**	**56**	**56**	**55**	**55**	**54**	**55**	**56**	**55**	**55**	**54**

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Of the 151 items in the mathematics test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 162 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses. Standard errors for scores based on subsets of items are provided in Table B.3.
Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).
Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table B.2 Test-Curriculum Matching Analysis Results - Mathematics - Lower Grade (Seventh Grade*)

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table B.4 for corresponding standard errors)

Instructions: Read ***across*** the row to compare that country's performance based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** to compare performance for each different country based on its own decisions about the test items to include.

Country	Average Percent Correct on All Items	Singapore	Japan	Korea	Hong Kong	Belgium (Fl)	Czech Republic	*Austria*	*Bulgaria*	*Netherlands*	Belgium (Fr)	Slovak Republic	Hungary	Ireland	Switzerland	Russian Federation	*Slovenia*	*Australia*	Canada	France	*Germany*	United States	England	Sweden	New Zealand	Scotland	Norway	Latvia (LSS)	*Denmark*	*Romania*	Iceland	Spain	Cyprus	*Greece*	Lithuania	Portugal	Iran, Islamic Rep.	*Colombia*	*South Africa*
(Number of Score Points Included)	*162***	*126*	*145*	*144*	*139*	*104*	*145*	*131*	*119*	*81*	*104*	*152*	*158*	*113*	*91*	*121*	*144*	*114*	*87*	*128*	*132*	*162*	*93*	*100*	*115*	*76*	*118*	*150*	*59*	*87*	*102*	*150*	*101*	*108*	*146*	*148*	*128*	*89*	*81*
Singapore	73 (1.3)	74	73	74	74	77	73	76	74	76	74	73	73	75	77	75	74	75	78	73	74	73	76	73	75	78	74	73	78	75	74	72	75	76	73	74	73	77	77
Japan	67 (0.4)	66	68	68	68	70	67	68	67	69	66	67	68	67	70	68	67	71	74	67	68	67	72	68	71	71	69	67	74	67	70	67	67	68	67	67	67	71	70
Korea	67 (0.6)	66	67	68	68	69	67	68	67	67	65	67	68	66	70	68	67	70	73	66	68	67	70	67	70	70	68	67	75	69	69	67	66	68	67	67	66	70	69
Hong Kong	65 (1.8)	65	66	66	66	68	65	67	66	67	64	65	66	65	67	67	65	68	69	65	65	65	69	66	68	70	66	65	72	66	66	65	65	67	65	65	65	69	68
Belgium (Fl)	65 (0.8)	65	65	66	65	69	65	67	65	67	66	64	65	66	71	66	65	70	73	66	66	65	72	67	70	74	68	65	76	66	69	65	65	68	65	65	64	69	70
Czech Republic	57 (1.2)	57	58	59	59	61	58	59	56	58	58	57	58	57	63	58	57	61	65	58	58	57	63	59	61	64	60	57	69	60	61	57	56	59	57	58	57	62	62
Austria	56 (0.7)	55	56	56	56	59	56	57	54	57	56	55	56	56	62	56	56	60	64	56	57	56	62	59	61	64	59	56	68	57	59	55	55	57	55	56	54	61	60
Bulgaria	55 (1.7)	55	55	57	57	59	55	57	57	53	55	55	56	55	57	57	55	58	60	55	55	55	58	54	58	60	55	55	63	58	57	55	53	56	55	56	56	60	57
Netherlands	55 (1.0)	53	55	56	54	57	55	56	53	59	56	54	55	54	62	55	55	60	63	55	58	55	65	60	62	65	62	55	69	54	60	56	54	56	54	55	53	59	59
Belgium (Fr)	54 (0.9)	53	55	55	55	57	54	56	53	56	56	54	55	55	61	55	54	60	63	55	57	54	62	58	60	64	59	54	68	55	59	54	54	56	54	54	54	60	59
Slovak Republic	54 (0.8)	54	55	56	56	58	55	56	54	54	54	54	55	54	59	56	54	58	62	54	55	54	59	55	58	60	56	54	65	57	57	54	53	56	54	55	54	59	59
Hungary	54 (0.8)	53	54	55	54	57	54	54	53	54	53	53	54	53	58	55	53	58	61	53	55	54	60	55	58	60	56	54	64	55	57	53	52	55	53	54	53	58	58
Ireland	53 (1.0)	53	53	54	54	56	53	54	52	55	54	53	54	55	60	54	53	58	61	53	55	53	60	56	58	61	56	54	64	54	56	53	53	55	53	53	52	56	58
Switzerland	53 (0.5)	52	53	53	53	55	53	54	50	57	55	52	53	54	62	53	53	60	63	54	56	53	62	59	60	65	60	54	68	52	58	53	53	55	53	53	52	58	59
Russian Federation	53 (0.9)	53	53	54	54	56	53	54	53	52	53	53	53	53	57	55	53	56	59	54	53	53	57	53	55	59	54	53	64	56	55	53	52	55	53	54	53	57	56
Slovenia	53 (0.7)	51	53	53	53	55	53	53	51	53	52	52	53	52	58	54	52	57	60	52	54	52	58	54	57	59	55	53	65	55	56	53	51	54	52	53	51	58	56
Australia	52 (0.8)	51	52	53	53	55	52	53	50	54	52	52	53	52	59	52	52	57	60	53	54	52	61	57	59	61	57	53	65	51	57	52	51	54	52	52	51	56	56
Canada	52 (0.5)	50	52	52	52	54	51	52	49	54	52	51	52	51	59	51	51	57	61	51	54	52	60	55	58	60	56	52	65	51	56	51	51	53	51	51	50	55	56
France	51 (0.8)	49	51	51	51	52	51	51	49	52	51	50	51	49	56	51	51	55	60	51	53	51	58	54	57	60	55	50	65	51	56	52	49	51	50	51	49	56	54
Germany	49 (1.0)	48	49	49	49	52	49	50	47	51	50	48	49	49	56	49	49	55	59	49	51	49	57	53	56	58	53	49	64	50	54	49	48	51	49	49	47	54	54
United States	48 (1.2)	46	48	48	48	50	48	48	46	50	47	47	48	47	54	47	47	52	56	48	49	48	55	50	54	55	52	48	59	48	52	47	46	49	47	48	46	51	51
England	47 (0.9)	45	47	47	47	48	47	47	44	47	46	46	47	45	53	45	46	52	55	47	49	47	57	52	54	56	53	47	60	45	52	48	44	47	46	47	45	49	49
Sweden	47 (0.6)	45	47	47	47	48	47	47	44	49	48	46	47	47	55	46	46	53	56	47	49	47	57	54	55	57	54	47	62	45	53	48	45	47	47	47	44	51	50
New Zealand	46 (0.9)	44	46	46	46	48	46	47	43	48	47	45	47	45	53	45	46	51	54	46	48	46	56	51	53	55	52	46	59	44	51	47	44	47	46	46	45	49	49
Scotland	44 (0.9)	42	44	44	44	46	44	45	41	46	45	44	45	43	51	43	44	50	53	45	46	44	55	50	51	54	51	44	58	42	50	45	42	44	43	44	43	47	47
Norway	44 (0.7)	43	45	44	45	46	45	45	42	47	46	43	44	44	52	44	44	50	53	45	47	44	54	50	52	54	51	45	59	43	50	45	43	45	44	44	42	48	48
Latvia (LSS)	44 (0.7)	43	45	45	45	46	44	45	44	43	44	44	44	43	49	45	44	48	50	45	45	44	50	46	48	50	46	44	56	47	47	44	42	45	44	44	43	49	47
Denmark	44 (0.5)	42	44	44	44	45	44	44	41	45	44	43	44	43	50	43	43	49	53	44	46	44	54	49	51	54	50	44	60	44	49	44	41	44	43	44	42	48	46
Romania	43 (0.8)	44	44	45	44	46	44	45	44	41	43	43	44	43	45	45	44	45	47	44	43	43	46	43	45	48	44	43	51	47	45	43	42	44	44	44	44	48	44
Iceland	43 (0.7)	42	44	44	44	45	43	44	40	46	44	42	44	42	51	42	43	49	53	43	46	43	54	50	51	54	50	43	60	41	50	44	41	44	42	43	42	47	47
Spain	42 (0.6)	41	42	43	43	44	42	42	41	41	42	42	43	41	47	43	42	46	48	43	43	42	49	44	47	49	46	42	55	43	46	43	40	43	42	42	41	47	44
Cyprus	42 (0.4)	41	42	43	42	44	42	43	42	41	41	41	42	42	44	43	42	45	46	41	43	42	47	42	45	47	43	42	51	44	43	42	42	43	42	42	41	46	44
Greece	40 (0.6)	40	41	41	41	43	41	41	40	42	42	40	41	41	46	41	41	44	47	41	42	40	46	42	45	47	44	41	51	42	44	41	40	42	40	41	39	45	45
Lithuania	38 (0.8)	37	39	39	39	41	38	39	37	37	38	38	38	37	43	40	38	42	45	39	39	38	44	39	42	44	40	38	50	40	41	38	36	39	38	38	37	42	41
Portugal	37 (0.6)	35	37	37	37	38	37	37	35	36	37	36	37	36	42	37	36	41	44	37	38	37	43	39	42	44	40	37	49	38	41	37	34	37	37	37	35	41	39
Iran, Islamic Rep.	32 (0.5)	32	32	33	33	33	33	33	32	32	32	32	33	32	35	33	33	35	36	33	34	32	37	32	35	37	34	32	41	33	34	32	31	33	32	32	32	37	33
Colombia	26 (0.6)	25	26	26	27	27	26	26	25	26	26	26	26	26	30	26	26	30	32	26	27	26	31	28	30	32	29	26	35	27	29	26	24	27	26	26	25	30	28
South Africa	23 (0.9)	22	22	23	23	24	22	23	22	23	23	22	23	23	25	23	22	24	26	22	23	23	25	23	24	26	24	23	29	23	25	22	22	24	22	23	22	24	24
International Average	**49 (0.8)**	**48**	**49**	**50**	**50**	**52**	**49**	**50**	**48**	**50**	**49**	**49**	**49**	**49**	**55**	**50**	**49**	**53**	**56**	**49**	**51**	**49**	**56**	**52**	**54**	**56**	**53**	**49**	**61**	**50**	**53**	**49**	**48**	**50**	**49**	**49**	**48**	**53**	**52**

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.
**Of the 151 items in the mathematics test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 162 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses. Standard errors for scores based on subsets of items are provided in Table B.4.
Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).
Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

each table show how each country performed on the subset of items that it selected based on its own curriculum. Thus, the Swiss students themselves averaged 64% correct responses on the items identified by Switzerland for the analysis.

The international averages presented across the last row of the tables show that the selection of items for the participating countries varied somewhat in average difficulty, ranging from 54% to 58% at the eighth grade and from 48% to 61% at the seventh grade. Despite these differences, the overall picture provided by both Tables B.1 and B.2 reveals that different item selections do not make a major difference in how well countries perform relative to each other. The items selected by some countries were more difficult than those selected by others. The relative performance of countries on the various item selections did vary somewhat, but generally not in a statistically significant manner.[5]

Comparing the diagonal element for a country with the overall average percentage correct shows the difference between performance on this subset of items and performance on the test as a whole. In general, there were small increases in each country's performance on its own subset of items. To illustrate, the average percent correct for eighth-grade students in the Russian Federation is 60%. The diagonal element shows that Russian students had about the same average percent correct (62%) based on the smaller set of items selected as relevant to the curriculum in the Russian Federation as they did overall. In the eighth grade, the differences were extremely small (2 average percentage points or less) for most countries. Only a few countries had an average percent correct on their own selected items more than 3 percentage points higher than their average on the test as a whole. Performance differences between the entire TIMSS test and the subset of items selected for the TCMA were, in general, somewhat larger for seventh-grade students, including several countries with average performance that was 5 to 10 percentage points higher on the items selected for the TCMA for their own students. The largest increase (16 average percentage points) was for the seventh-grade students in Denmark.

It is clear that the selection of items does not have a major effect on the general relationship among countries. Countries that had substantially higher or lower performance on the overall test in comparison to each other also had higher or lower relative performance on the different sets of items selected for the TCMA. At the eighth grade, Singapore, Japan, Korea, and Hong Kong were the highest-performing countries and in the same order of performance, both on the test as a whole and on all the different sets of item selections. At the seventh grade, Singapore had the highest average percent correct on the test as a whole and on all of the different item selections, with Japan, Korea, Hong Kong, and Belgium (Flemish) among the top five highest performing countries in all cases. Although there were some changes in

[5] Small differences in performance in these tables are not statistically significant. The standard errors for the estimated average percent correct statistics can found in Tables B.3 and B.4. We can say with 95% confidence that the value for the entire population will fall between the sample estimate plus or minus two standard errors.

the ordering of countries based on the items selected for the TCMA, most of these differences are within the boundaries of sampling error. As the most extreme example, consider the 59 score points selected by Denmark for the seventh grade. Denmark did substantially better on these items than on the test as a whole, with 60% correct responses to these items, on average, compared to only 44% average correct on the test as a whole. However, all other countries also did better on these particular items, with an international average of 61% for the items selected by Denmark compared with 49% on the test as a whole. Also, for example, Scotland, Norway, and Latvia (LSS), which also averaged 44% correct over all items at the seventh grade, performed similarly to Denmark on the set of items selected by Denmark – 58%, 59%, and 56%, respectively.

The TCMA results provide evidence that the TIMSS mathematics test provides a reasonable basis for comparing achievement for the participating countries. This result is not unexpected, since making the test as fair as possible was a major consideration in test development. The fact that the majority of countries indicated that most items were appropriate for their students means that the different average percent correct estimates were based substantially on the same items. Insofar as countries rejected items that would be difficult for their own students, these items tended to be difficult for students in other countries as well. The analysis shows that omitting such items improves the results for that country, but also tends to improve the results for all other countries, so that the overall pattern of results is largely unaffected.

Table B.3 Standard Errors for the Test-Curriculum Matching Analysis Results - Mathematics - Upper Grade (Eighth Grade*)

See Table B.1 for the Test-Curriculum Matching Analysis Results

Instructions: Read ***across*** the row for the standard error for the score based on the test items included by each of the countries across the top.

Read ***down*** the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.

Read along the ***diagonal*** for the standard error for the score for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	Singapore	Japan	Korea	Hong Kong	Belgium (Fl)	Czech Republic	Slovak Republic	Switzerland	*Austria*	Hungary	France	*Slovenia*	Russian Federation	*Netherlands*	*Bulgaria*	Canada	Ireland	*Belgium (Fr)*	*Australia*	*Israel*	Sweden	*Germany*	New Zealand	Norway	England	United States	*Denmark*	*Scotland*	Latvia (LSS)	Spain	Iceland	*Greece*	*Romania*	Lithuania	Cyprus	Portugal	Iran, Islamic Rep.	*Kuwait*	*Colombia*	*South Africa*
(Number of Score Points Included)	*162***	*144*	*153*	*148*	*150*	*140*	*150*	*152*	*133*	*147*	*162*	*140*	*151*	*126*	*116*	*119*	*147*	*145*	*138*	*154*	*159*	*127*	*155*	*145*	*150*	*130*	*162*	*135*	*125*	*161*	*158*	*133*	*76*	*143*	*155*	*124*	*152*	*147*	*140*	*133*	*129*
Singapore	79 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Japan	73 (0.4)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Korea	72 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Hong Kong	70 (1.4)	1.5	1.4	1.5	1.4	1.5	1.5	1.5	1.4	1.5	1.4	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.5	1.4	1.4	1.5	1.5	1.5
Belgium (Fl)	66 (1.4)	1.4	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.4	1.4	1.4	1.3	1.4	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.4	1.4
Czech Republic	66 (1.1)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Slovak Republic	62 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Switzerland	62 (0.8)	0.6	0.6	0.7	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.6
Austria	62 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Hungary	62 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.8
France	61 (0.8)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Slovenia	61 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Russian Federation	60 (1.3)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Netherlands	60 (1.8)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Bulgaria	60 (1.3)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.3
Canada	59 (0.5)	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.6
Ireland	59 (1.2)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Belgium (Fr)	59 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Australia	58 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Israel	57 (1.3)	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.4	1.3	1.4	1.3	1.4	1.4	1.4	1.4
Sweden	56 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Germany	54 (1.1)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
New Zealand	54 (1.0)	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.0	1.0	1.1	1.1	1.1
Norway	54 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
England	53 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.8
United States	53 (1.1)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Denmark	52 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Scotland	52 (1.4)	1.4	1.3	1.3	1.3	1.4	1.4	1.3	1.3	1.3	1.4	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.3	1.3	1.3	1.4	1.3	1.4	1.3	1.3	1.4	1.4	1.4
Latvia (LSS)	51 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Spain	51 (0.5)	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.6
Iceland	50 (1.1)	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.2	1.2	1.3	1.1	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.2	1.2
Greece	49 (0.7)	0.8	0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.8
Romania	49 (1.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lithuania	48 (0.9)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0	0.9	1.0	0.9	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cyprus	48 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Portugal	43 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Iran, Islamic Rep.	38 (0.8)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Kuwait	30 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7
Colombia	29 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
South Africa	24 (1.1)	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.2	1.1	1.1	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.1	1.2	1.1	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.2
International Average	55 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

**Of the 151 items in the mathematics test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 162 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses. The matrix contains standard errors corresponding to the average percent of correct responses based on TCMA subsets of items, as displayed in Table B.1. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).

Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table B.4 Standard Errors for the Test-Curriculum Matching Analysis Results - Mathematics - Lower Grade (Seventh Grade*)

See Table B.3 for the Test-Curriculum Matching Analysis Results

Instructions: Read ***across*** the row for the standard error for the score based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** for the standard error for the score for each different country based on its own decisions about the test items to include.

(Number of Score Points Included)

Country	Average Percent Correct on All Items (162**)	Singapore (126)	Japan (145)	Korea (144)	Hong Kong (139)	Belgium (Fl) (104)	Czech Republic (145)	*Austria* (131)	*Bulgaria* (119)	*Netherlands* (81)	Belgium (Fr) (104)	Slovak Republic (152)	Hungary (158)	Ireland (113)	Switzerland (91)	Russian Federation (121)
Singapore	73 (1.3)	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.2	1.3
Japan	67 (0.4)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Korea	67 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Hong Kong	65 (1.8)	1.9	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.8
Belgium (Fl)	65 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.8	0.8	0.8	0.7	0.8
Czech Republic	57 (1.2)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Austria	56 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7
Bulgaria	55 (1.7)	1.9	1.7	1.8	1.7	1.8	1.7	1.8	1.9	1.8	1.8	1.7	1.7	1.8	1.6	1.8
Netherlands	55 (1.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.1	1.1	1.0
Belgium (Fr)	54 (0.9)	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Slovak Republic	54 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Hungary	54 (0.8)	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.9
Ireland	53 (1.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Switzerland	53 (0.5)	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.5	0.6	0.6	0.6
Russian Federation	53 (0.9)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	1.0
Slovenia	53 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7
Australia	52 (0.8)	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.9	0.8	0.9
Canada	52 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6
France	51 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Germany	49 (1.1)	1.1	1.0	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.0	1.1
United States	48 (1.2)	1.3	1.2	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3
England	47 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
Sweden	47 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.7	0.6	0.6	0.6	0.6	0.7	0.6
New Zealand	46 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Scotland	44 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9	1.0	0.9
Norway	44 (0.7)	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.8	0.8	0.7	0.7	0.7	0.8	0.7
Latvia (LSS)	44 (0.7)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.7	0.8
Denmark	44 (0.5)	0.6	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6
Romania	43 (0.9)	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Iceland	43 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.6
Spain	42 (0.5)	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6
Cyprus	42 (0.4)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Greece	40 (0.6)	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.7
Lithuania	38 (0.8)	0.8	0.8	0.8	0.9	0.9	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.9
Portugal	37 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Iran, Islamic Rep.	32 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5
Colombia	26 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6
South Africa	23 (0.9)	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.9	0.9	0.9	1.1	1.0
International Average	**49 (0.8)**	**0.8**	**0.8**	**0.8**	**0.8**	**0.9**	**0.8**	**0.8**	**0.9**	**0.9**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**

Country	*Slovenia* (144)	*Australia* (114)	Canada (87)	France (128)	*Germany* (132)	United States (162)	England (93)	Sweden (100)	New Zealand (115)	Scotland (76)	Norway (118)	Latvia (LSS) (150)	*Denmark* (59)	*Romania* (87)	Iceland (102)	Spain (150)	Cyprus (101)	*Greece* (108)	Lithuania (146)	Portugal (148)	Iran, Islamic Rep. (128)	*Colombia* (89)	*South Africa* (81)
Singapore	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.3	1.2	1.2	1.3	1.3	1.0	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.3	1.2	1.3
Japan	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Korea	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6
Hong Kong	1.8	1.7	1.7	1.8	1.7	1.8	1.7	1.7	1.7	1.7	1.7	1.8	1.6	1.9	1.7	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8
Belgium (Fl)	0.8	0.7	0.7	0.8	0.8	0.8	0.7	0.8	0.7	0.7	0.8	0.8	0.7	0.9	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8
Czech Republic	1.2	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.2	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.3
Austria	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7
Bulgaria	1.8	1.6	1.5	1.7	1.6	1.7	1.5	1.6	1.6	1.7	1.6	1.7	1.5	1.7	1.5	1.7	1.9	1.8	1.8	1.7	1.9	1.7	1.7
Netherlands	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.1
Belgium (Fr)	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Slovak Republic	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8
Hungary	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.9
Ireland	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Switzerland	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.7	0.6	0.5	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.6	0.6
Russian Federation	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	0.9	1.0	1.0	1.0	1.0
Slovenia	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7
Australia	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.9
Canada	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.6	0.5
France	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Germany	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.0	1.0	1.1	1.0	1.1	1.0	1.1	1.0	1.1
United States	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.2	1.3	1.2	1.3	1.4
England	0.9	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sweden	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
New Zealand	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Scotland	0.9	0.9	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.8	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0
Norway	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.6	0.8	0.7	0.7	0.7	0.7	0.7	0.8
Latvia (LSS)	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Denmark	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.5	0.5	0.6	0.6
Romania	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.8	0.9
Iceland	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6
Spain	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.6	0.6
Cyprus	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Greece	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.6	0.6	0.6	0.7	0.7
Lithuania	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.9
Portugal	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Iran, Islamic Rep.	0.5	0.5	0.6	0.5	0.5	0.5	0.7	0.6	0.6	0.6	0.6	0.5	0.8	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.5
Colombia	0.6	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
South Africa	1.0	1.0	1.1	1.0	1.0	0.9	1.1	1.0	1.1	1.1	1.0	0.9	1.1	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.1	1.1
International Average	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.9**	**0.9**	**0.8**	**0.8**	**0.8**	**0.8**	**0.9**

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.

**Of the 151 items in the mathematics test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 162 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses. The matrix contains standard errors corresponding to the average percent of correct responses based on TCMA subsets of items, as displayed in Table B.2. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).

Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Appendix C

SELECTED MATHEMATICS ACHIEVEMENT RESULTS FOR THE PHILIPPINES

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Table C.1

Philippines - Selected Mathematics Achievement Results - Unweighted Data

Distributions of Mathematics Achievement - Seventh Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	Data Rep., Analysis, and Prob.	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
399 (1.9)	7	14.0	291 (1.0)	349 (1.3)	389 (1.1)	440 (2.8)	546 (1.4)

Distributions of Mathematics Achievement - Sixth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	Data Rep., Analysis, and Prob.	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
386 (1.0)	6	12.9	284 (1.4)	339 (0.4)	377 (0.7)	422 (2.6)	531 (1.6)

Gender Differences in Mathematics Achievement - Seventh Grade

Boys Mean	Girls Mean	Difference
396 (2.3)	402 (1.8)	6 (2.9)

Gender Differences in Mathematics Achievement - Sixth Grade

Boys Mean	Girls Mean	Difference
384 (1.0)	388 (1.2)	4 (1.6)

Percentages of Students Achieving International Marker Levels in Mathematics Seventh Grade

Top 10% Level	Top Quarter Level	Top Half Level
1 (0.1)	2 (0.2)	10 (0.6)

Percentages of Students Achieving International Marker Levels in Mathematics Sixth Grade

Top 10% Level	Top Quarter Level	Top Half Level
1 (0.0)	3 (0.1)	11 (0.2)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table C.1 (Continued)

Philippines - Selected Mathematics Achievement Results - Unweighted Data

Average Percent Correct by Mathematics Content Areas - Seventh Grade

Mathematics Overall	Fractions and Number Sense	Geometry	Algebra	Data Rep., Analysis, and Prob.	Measure-ment	Proportion-ality
33 (0.4)	39 (0.5)	32 (0.4)	31 (0.5)	39 (0.5)	21 (0.4)	27 (0.5)

Average Percent Correct by Mathematics Content Areas -Sixth Grade

Mathematics Overall	Fractions and Number Sense	Geometry	Algebra	Data Rep., Analysis, and Prob.	Measure-ment	Proportion-ality
31 (0.2)	36 (0.3)	30 (0.3)	28 (0.2)	36 (0.3)	20 (0.2)	25 (0.3)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Seventh Grade

Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
32 (0.5)	33 (0.4)	37 (0.6)	39 (0.5)	33 (0.5)	32 (0.4)	30 (0.6)	32 (0.5)

Data Representation, Analysis & Probability		Measurement		Proportionality	
Boys	Girls	Boys	Girls	Boys	Girls
38 (0.6)	40 (0.5)	22 (0.5)	21 (0.4)	27 (0.6)	27 (0.5)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Sixth Grade

Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
30 (0.3)	31 (0.3)	36 (0.3)	37 (0.4)	29 (0.4)	30 (0.4)	27 (0.3)	29 (0.3)

Data Representation, Analysis & Probability		Measurement		Proportionality	
Boys	Girls	Boys	Girls	Boys	Girls
35 (0.4)	37 (0.4)	20 (0.3)	20 (0.2)	25 (0.3)	26 (0.3)

*Seventh or Eighth grades in most countries; see Table 2 for information about the grades tested in the Philippines.

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix D

Selected Mathematics Achievement Results for Denmark, Sweden, and Switzerland (German–Speaking) – Eighth Grade

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Table D.1

Denmark - Selected Mathematics Achievement Results

Distributions of Mathematics Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
542 (2.9)	8	14.9	400 (3.9)	481 (1.7)	542 (5.9)	609 (3.2)	679 (7.2)

Gender Differences in Mathematics Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
547 (3.6)	537 (4.1)	10 (5.4)

Percentages of Students Achieving International Marker Levels in Mathematics Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
5 (0.5)	19 (1.0)	42 (1.4)

Average Percent Correct by Mathematics Content Areas - Eighth Grade

Mathematics Overall	Fractions and Number Sense	Geometry	Algebra	Data Rep., Analysis, and Prob.	Measurement	Proportionality
60 (0.7)	62 (0.8)	59 (0.9)	54 (0.8)	73 (0.8)	59 (0.9)	47 (0.8)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Eighth Grade

Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
61 (0.8)	59 (1.0)	64 (0.9)	60 (1.2)	58 (1.0)	60 (1.3)	55 (1.1)	55 (1.1)

Data Representation, Analysis & Probability		Measurement		Proportionality	
Boys	Girls	Boys	Girls	Boys	Girls
74 (1.1)	71 (1.0)	61 (1.0)	57 (1.3)	49 (1.1)	45 (1.2)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table D.2

Sweden - Selected Mathematics Achievement Results

Distributions of Mathematics Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
554 (4.4)	8	14.9	407 (10.9)	491 (3.1)	559 (11.5)	621 (2.4)	699 (2.2)

Gender Differences in Mathematics Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
553 (5.0)	555 (5.0)	2 (7.1)

Percentages of Students Achieving International Marker Levels in Mathematics Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
8 (0.8)	23 (1.5)	48 (2.3)

Average Percent Correct by Mathematics Content Areas - Eighth Grade

Mathematics Overall	Fractions and Number Sense	Geometry	Algebra	Data Rep., Analysis, and Prob.	Measurement	Proportionality
62 (1.1)	68 (1.1)	56 (1.1)	54 (1.3)	76 (1.1)	61 (1.2)	50 (1.4)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Eighth Grade

Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
62 (1.2)	63 (1.1)	67 (1.2)	68 (1.2)	57 (1.3)	55 (1.2)	52 (1.4)	55 (1.5)

Data Representation, Analysis & Probability		Measurement		Proportionality	
Boys	Girls	Boys	Girls	Boys	Girls
76 (1.3)	76 (1.2)	61 (1.4)	61 (1.3)	50 (1.5)	50 (1.4)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table D.3

Switzerland (German Speaking) - Selected Mathematics Achievement Results

Distributions of Mathematics Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
590 (3.2)	8	15.1	446 (5.8)	528 (7.2)	589 (3.8)	658 (4.2)	740 (5.7)

Gender Differences in Mathematics Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
598 (3.8)	584 (4.3)	14 (5.7)

Percentages of Students Achieving International Marker Levels in Mathematics Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
18 (1.0)	35 (1.4)	61 (1.7)

Average Percent Correct by Mathematics Content Areas - Eighth Grade

Mathematics Overall	Fractions and Number Sense	Geometry	Algebra	Data Rep., Analysis, and Prob.	Measure-ment	Proportion-ality
70 (0.7)	74 (0.7)	69 (0.8)	65 (0.9)	78 (0.7)	70 (0.9)	60 (0.9)

Average Percent Correct for Boys and Girls by Mathematics Content Areas Eighth Grade

Mathematics Overall		Fractions & Number Sense		Geometry		Algebra	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
72 (0.7)	69 (0.9)	76 (0.7)	73 (1.0)	70 (1.0)	68 (1.0)	66 (1.0)	63 (1.3)

Data Representation, Analysis & Probability		Measurement		Proportionality	
Boys	Girls	Boys	Girls	Boys	Girls
79 (0.8)	77 (1.0)	71 (1.0)	68 (1.2)	62 (1.1)	59 (1.2)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix E

Percentiles and Standard Deviations of Mathematics Achievement

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Table E.1

Percentiles of Achievement in Mathematics Upper Grade (Eighth Grade*)

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	372 (4.1)	460 (1.5)	529 (7.0)	600 (7.2)	690 (5.4)
Austria	393 (5.1)	474 (4.1)	537 (5.8)	608 (2.6)	693 (6.4)
Belgium (Fl)	416 (7.7)	502 (8.7)	566 (8.7)	631 (5.7)	710 (3.5)
Belgium (Fr)	385 (13.8)	467 (1.1)	532 (5.5)	587 (3.7)	658 (6.2)
Bulgaria	378 (11.4)	460 (4.2)	530 (10.6)	621 (13.8)	728 (0.4)
Canada	389 (3.3)	468 (2.0)	527 (2.7)	587 (2.4)	670 (3.7)
Colombia	292 (5.8)	343 (4.4)	379 (3.6)	421 (6.1)	496 (7.5)
Cyprus	333 (3.3)	412 (1.2)	469 (1.6)	535 (3.2)	621 (7.3)
Czech Republic	423 (3.5)	496 (2.6)	558 (7.5)	633 (8.5)	725 (12.6)
Denmark	369 (9.8)	443 (2.9)	500 (4.9)	561 (2.2)	641 (5.9)
England	361 (8.8)	443 (4.8)	501 (3.5)	570 (2.7)	665 (4.1)
France	415 (5.2)	484 (1.4)	534 (3.0)	591 (2.5)	666 (3.4)
Germany	368 (8.2)	448 (9.4)	506 (6.3)	572 (7.5)	661 (10.9)
Greece	347 (2.8)	422 (1.9)	478 (3.8)	546 (3.6)	633 (6.6)
Hong Kong	415 (14.2)	526 (6.8)	595 (5.9)	659 (4.9)	742 (5.4)
Hungary	391 (2.3)	471 (2.1)	534 (2.6)	602 (2.7)	693 (9.2)
Iceland	365 (4.3)	435 (3.3)	481 (6.2)	540 (4.8)	615 (21.0)
Iran, Islamic Rep.	336 (4.4)	388 (2.2)	424 (2.9)	466 (5.8)	535 (9.8)
Ireland	381 (6.5)	462 (4.9)	526 (8.2)	594 (9.6)	681 (3.3)
Israel	371 (6.3)	459 (7.5)	523 (9.3)	586 (4.9)	672 (7.2)
Japan	435 (2.1)	536 (6.8)	608 (2.5)	676 (1.4)	771 (4.8)
Korea	418 (4.0)	540 (5.0)	609 (3.9)	682 (2.7)	786 (7.1)
Kuwait	302 (4.7)	355 (3.5)	389 (5.0)	427 (3.2)	493 (6.1)
Latvia (LSS)	375 (5.2)	435 (2.6)	487 (3.3)	550 (4.3)	638 (8.1)
Lithuania	348 (5.0)	422 (3.1)	473 (5.3)	533 (4.3)	616 (8.5)
Netherlands	397 (10.6)	477 (9.1)	543 (9.2)	604 (7.4)	688 (6.9)
New Zealand	366 (3.1)	443 (4.0)	503 (5.0)	570 (5.5)	663 (9.1)
Norway	372 (5.5)	445 (2.0)	499 (2.8)	560 (3.1)	649 (5.9)
Portugal	357 (3.0)	411 (1.0)	449 (2.2)	495 (6.7)	569 (7.1)
Romania	343 (3.1)	418 (3.0)	476 (5.5)	544 (5.2)	635 (9.7)
Russian Federation	388 (4.5)	471 (5.6)	536 (11.3)	600 (8.2)	687 (2.9)
Scotland	364 (2.1)	436 (3.2)	493 (7.2)	559 (7.1)	649 (15.3)
Singapore	499 (5.8)	584 (8.9)	642 (7.2)	704 (4.5)	792 (7.5)
Slovak Republic	401 (1.6)	483 (0.6)	543 (4.4)	612 (3.9)	700 (2.7)
Slovenia	404 (2.5)	477 (3.6)	535 (6.7)	604 (4.0)	690 (4.3)
South Africa	259 (3.7)	313 (2.2)	347 (2.0)	386 (4.9)	484 (10.4)
Spain	376 (2.0)	436 (2.5)	481 (1.8)	536 (3.5)	616 (3.9)
Sweden	384 (2.9)	460 (6.0)	515 (3.7)	579 (3.4)	661 (4.7)
Switzerland	401 (6.3)	485 (2.1)	549 (6.1)	607 (2.9)	685 (2.8)
Thailand	388 (3.7)	462 (4.4)	518 (5.9)	580 (6.8)	669 (12.0)
United States	356 (3.3)	435 (3.4)	494 (6.4)	563 (8.2)	653 (3.7)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

() Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table E.2

Percentiles of Achievement in Mathematics Lower Grade (Seventh Grade*)

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	350 (4.4)	435 (5.5)	495 (3.9)	564 (5.9)	651 (6.8)
Austria	378 (2.4)	450 (6.3)	506 (3.5)	568 (4.5)	652 (4.5)
Belgium (Fl)	436 (2.0)	506 (4.4)	556 (4.4)	608 (7.0)	688 (3.1)
Belgium (Fr)	382 (5.0)	456 (6.0)	506 (6.2)	562 (5.5)	640 (3.2)
Bulgaria	355 (8.1)	435 (4.9)	511 (11.0)	589 (7.2)	691 (15.6)
Canada	368 (2.0)	440 (5.0)	488 (1.9)	551 (3.2)	632 (5.9)
Colombia	273 (4.3)	329 (2.5)	362 (2.5)	404 (5.4)	476 (6.6)
Cyprus	320 (7.0)	386 (2.5)	440 (2.5)	504 (3.2)	585 (5.9)
Czech Republic	390 (1.9)	461 (6.1)	515 (5.7)	583 (8.2)	678 (4.9)
Denmark	342 (3.9)	412 (1.7)	464 (3.4)	516 (3.6)	595 (23.0)
England	342 (5.4)	410 (7.4)	469 (5.0)	540 (5.2)	639 (6.3)
France	375 (7.2)	444 (6.3)	491 (3.5)	543 (7.5)	615 (5.1)
Germany	353 (6.5)	426 (5.8)	481 (5.2)	542 (6.7)	629 (7.8)
Greece	308 (3.9)	380 (5.9)	434 (3.9)	499 (8.7)	586 (3.0)
Hong Kong	392 (12.5)	503 (7.5)	569 (10.4)	634 (6.9)	716 (5.3)
Hungary	365 (6.9)	437 (6.6)	496 (4.6)	562 (6.7)	656 (8.2)
Iceland	353 (2.4)	416 (3.0)	457 (2.2)	504 (4.1)	577 (6.6)
Iran, Islamic Rep.	316 (1.4)	363 (3.9)	396 (2.2)	436 (4.1)	503 (8.3)
Ireland	361 (4.0)	442 (3.3)	498 (6.8)	560 (7.1)	648 (11.3)
Japan	413 (7.1)	508 (2.2)	568 (1.9)	635 (3.0)	734 (7.0)
Korea	401 (7.6)	508 (5.2)	583 (5.9)	649 (3.7)	744 (2.3)
Latvia (LSS)	345 (5.0)	409 (4.4)	455 (2.4)	510 (3.2)	598 (4.6)
Lithuania	309 (4.0)	380 (3.5)	423 (4.3)	477 (2.9)	559 (5.4)
Netherlands	388 (8.5)	466 (3.2)	519 (8.0)	569 (3.7)	646 (6.9)
New Zealand	337 (6.4)	412 (5.4)	468 (3.2)	530 (9.0)	620 (2.5)
Norway	335 (5.3)	407 (6.0)	460 (4.4)	513 (4.0)	592 (9.8)
Portugal	332 (1.3)	385 (0.8)	417 (2.7)	461 (4.5)	528 (4.2)
Romania	325 (4.6)	394 (5.2)	449 (3.2)	513 (8.8)	600 (2.4)
Russian Federation	363 (5.5)	440 (6.7)	496 (3.9)	563 (5.6)	651 (3.9)
Scotland	337 (1.2)	405 (4.7)	459 (3.7)	520 (6.1)	604 (1.5)
Singapore	447 (8.0)	538 (9.7)	604 (12.1)	665 (6.4)	751 (6.0)
Slovak Republic	376 (3.2)	449 (4.2)	504 (4.4)	569 (3.1)	650 (9.4)
Slovenia	373 (3.8)	442 (5.7)	493 (3.0)	553 (4.6)	643 (3.8)
South Africa	254 (3.6)	308 (0.7)	342 (3.2)	382 (3.3)	462 (17.0)
Spain	342 (4.4)	400 (1.9)	441 (2.0)	494 (4.2)	572 (3.1)
Sweden	355 (3.6)	425 (2.0)	475 (2.0)	527 (2.9)	609 (8.9)
Switzerland	387 (12.4)	454 (3.3)	502 (3.0)	558 (3.0)	628 (4.0)
Thailand	373 (3.8)	440 (4.5)	490 (5.2)	547 (7.1)	632 (9.1)
United States	345 (8.0)	411 (3.1)	465 (3.2)	536 (11.7)	635 (12.1)

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.

() Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table E.3

Standard Deviations of Achievement in Mathematics Upper Grade (Eighth Grade*)

Country	Overall		Boys		Girls	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	530 (4.0)	98	527 (5.1)	100	532 (4.6)	96
Austria	539 (3.0)	92	544 (3.2)	94	536 (4.5)	90
Belgium (Fl)	565 (5.7)	92	563 (8.8)	96	567 (7.4)	88
Belgium (Fr)	526 (3.4)	86	530 (4.7)	88	524 (3.7)	83
Bulgaria	540 (6.3)	110	– –	–	– –	–
Canada	527 (2.4)	86	526 (3.2)	88	530 (2.7)	84
Colombia	385 (3.4)	64	386 (6.9)	66	384 (3.6)	63
Cyprus	474 (1.9)	88	472 (2.8)	89	475 (2.5)	86
Czech Republic	564 (4.9)	94	569 (4.5)	94	558 (6.3)	93
Denmark	502 (2.8)	84	511 (3.2)	86	494 (3.4)	80
England	506 (2.6)	93	508 (5.1)	95	504 (3.5)	91
France	538 (2.9)	76	542 (3.1)	74	536 (3.8)	78
Germany	509 (4.5)	90	512 (5.1)	89	509 (5.0)	88
Greece	484 (3.1)	88	490 (3.7)	91	478 (3.1)	85
Hong Kong	588 (6.5)	101	597 (7.7)	103	577 (7.7)	97
Hungary	537 (3.2)	93	537 (3.6)	92	537 (3.6)	94
Iceland	487 (4.5)	76	488 (5.5)	80	486 (5.6)	72
Iran, Islamic Rep.	428 (2.2)	59	434 (2.9)	59	421 (3.3)	59
Ireland	527 (5.1)	93	535 (7.2)	96	520 (6.0)	89
Israel	522 (6.2)	92	539 (6.6)	89	509 (6.9)	90
Japan	605 (1.9)	102	609 (2.6)	106	600 (2.1)	97
Korea	607 (2.4)	109	615 (3.2)	109	598 (3.4)	108
Kuwait	392 (2.5)	58	– –	–	– –	–
Latvia (LSS)	493 (3.1)	82	496 (3.8)	82	491 (3.5)	82
Lithuania	477 (3.5)	80	477 (4.0)	79	478 (4.1)	81
Netherlands	541 (6.7)	89	545 (7.8)	90	536 (6.4)	88
New Zealand	508 (4.5)	90	512 (5.9)	92	503 (5.3)	88
Norway	503 (2.2)	84	505 (2.8)	87	501 (2.7)	80
Portugal	454 (2.5)	64	460 (2.8)	64	449 (2.7)	64
Romania	482 (4.0)	89	483 (4.8)	91	480 (4.0)	87
Russian Federation	535 (5.3)	92	535 (6.3)	97	536 (5.0)	87
Scotland	498 (5.5)	87	506 (6.6)	89	490 (5.2)	85
Singapore	643 (4.9)	88	642 (6.3)	88	645 (5.4)	88
Slovak Republic	547 (3.3)	92	549 (3.7)	94	545 (3.6)	90
Slovenia	541 (3.1)	88	545 (3.8)	88	537 (3.3)	87
South Africa	354 (4.4)	65	360 (6.3)	68	349 (4.1)	62
Spain	487 (2.0)	73	492 (2.5)	75	483 (2.6)	72
Sweden	519 (3.0)	85	520 (3.6)	85	518 (3.1)	86
Switzerland	545 (2.8)	88	548 (3.5)	90	543 (3.1)	85
Thailand	522 (5.7)	86	517 (5.6)	84	526 (7.0)	87
United States	500 (4.6)	91	502 (5.2)	93	497 (4.5)	89

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
A dash (–) indicates data are not available.
( ) Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table E.4

Standard Deviations of Achievement in Mathematics Lower Grade (Seventh Grade*)

Country	Overall		Boys		Girls	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	498 (3.8)	92	495 (5.2)	94	500 (4.3)	90
Austria	509 (3.0)	85	510 (4.6)	89	509 (3.3)	81
Belgium (Fl)	558 (3.5)	77	557 (4.5)	76	559 (4.7)	78
Belgium (Fr)	507 (3.5)	78	514 (4.1)	79	501 (4.2)	76
Bulgaria	514 (7.5)	103	– –	–	– –	–
Canada	494 (2.2)	80	495 (2.7)	80	493 (2.6)	80
Colombia	369 (2.7)	63	372 (3.8)	62	365 (3.9)	63
Cyprus	446 (1.9)	82	446 (2.5)	86	446 (2.6)	78
Czech Republic	523 (4.9)	89	527 (4.8)	90	520 (5.6)	88
Denmark	465 (2.1)	78	468 (2.8)	79	462 (2.9)	76
England	476 (3.7)	90	484 (6.2)	91	467 (4.3)	88
France	492 (3.1)	74	497 (3.6)	75	489 (3.3)	72
Germany	484 (4.1)	85	486 (4.8)	86	484 (4.5)	83
Greece	440 (2.8)	85	440 (3.2)	88	440 (3.0)	83
Hong Kong	564 (7.8)	99	570 (9.7)	103	556 (8.3)	94
Hungary	502 (3.7)	91	503 (3.8)	93	501 (4.4)	88
Iceland	459 (2.6)	68	460 (2.7)	68	458 (3.2)	68
Iran, Islamic Rep.	401 (2.0)	57	407 (2.7)	57	393 (2.3)	55
Ireland	500 (4.1)	87	507 (6.0)	87	494 (4.8)	86
Israel	– –	–	– –	–	– –	–
Japan	571 (1.9)	96	576 (2.7)	100	565 (2.0)	91
Korea	577 (2.5)	105	584 (3.7)	104	567 (4.4)	104
Kuwait	– –	–	– –	–	– –	–
Latvia (LSS)	462 (2.8)	77	463 (3.5)	77	460 (3.3)	76
Lithuania	428 (3.2)	75	423 (3.6)	77	433 (3.5)	73
Netherlands	516 (4.1)	79	517 (5.2)	80	515 (4.3)	77
New Zealand	472 (3.8)	87	473 (4.6)	89	470 (3.8)	84
Norway	461 (2.8)	76	462 (3.3)	77	459 (3.2)	75
Portugal	423 (2.2)	60	426 (2.7)	61	420 (2.2)	59
Romania	454 (3.4)	84	457 (3.7)	84	452 (3.7)	84
Russian Federation	501 (4.0)	88	502 (5.1)	91	499 (3.5)	85
Scotland	463 (3.7)	82	465 (4.6)	84	462 (3.8)	79
Singapore	601 (6.3)	93	601 (7.1)	94	601 (8.0)	92
Slovak Republic	508 (3.4)	85	511 (4.4)	87	505 (3.3)	83
Slovenia	498 (3.0)	82	501 (3.5)	82	496 (3.2)	82
South Africa	348 (3.8)	63	352 (5.3)	67	344 (3.3)	60
Spain	448 (2.2)	70	451 (2.7)	72	445 (2.7)	67
Sweden	477 (2.5)	77	480 (2.8)	77	475 (3.2)	76
Switzerland	506 (2.3)	75	513 (2.9)	76	498 (2.6)	74
Thailand	495 (4.8)	79	494 (4.8)	78	495 (5.7)	79
United States	476 (5.5)	89	478 (5.7)	92	473 (5.7)	86

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
A dash (–) indicates data are not available. Israel and Kuwait did not test the lower grade.
( ) Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix F

ACKNOWLEDGMENTS

TIMSS was truly a collaborative effort among hundreds of individuals around the world. Staff from the national research centers, the international management, advisors, and funding agencies worked closely to design and implement the most ambitious study of international comparative achievement ever undertaken. TIMSS would not have been possible without the tireless efforts of all involved. Below, the individuals and organizations are acknowledged for their contributions. Given that implementing TIMSS has spanned more than seven years and involved so many people and organizations, this list may not pay heed to all who contributed throughout the life of the project. Any omission is inadvertent. TIMSS also acknowledges the students, teachers, and school principals who contributed their time and effort to the study. This report would not be possible without them.

MANAGEMENT AND OPERATIONS

Since 1993, TIMSS has been directed by the International Study Center at Boston College in the United States. Prior to this, the study was coordinated by the International Coordinating Center at the University of British Columbia in Canada. Although the study was directed centrally by the International Study Center and its staff members implemented various parts of TIMSS, important activities also were carried out in centers around the world. The data were processed centrally by the IEA Data Processing Center in Hamburg, Germany. Statistics Canada was responsible for collecting and evaluating the sampling documentation from each country and for calculating the sampling weights. The Australian Council for Educational Research conducted the scaling of the achievement data.

INTERNATIONAL STUDY CENTER (1993-)

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NATIONAL RESEARCH COORDINATORS

The TIMSS National Research Coordinators and their staff had the enormous task of implementing the TIMSS design in their countries. This required obtaining funding for the project; participating in the development of the instruments and procedures; conducting field tests; participating in and conducting training sessions; translating the instruments and procedural manuals into the local language; selecting the sample of schools and students; working with the schools to arrange for the testing; arranging for data collection, coding, and data entry; preparing the data files for submission to the IEA Data Processing Center; contributing to the development of the international reports; and preparing national reports. The way in which the national centers operated and the resources that were available varied considerably across the TIMSS countries. In some countries, the tasks were conducted centrally, while in others, various components were subcontracted to other organizations. In some countries, resources were more than adequate, while in others, the national centers were operating with limited resources. Of course, across the life of the project, some NRCs have changed. This list attempts to include all past NRCs who served for a significant period of time as well as all the present NRCs. All of the TIMSS National Research Coordinators and their staff members are to be commended for their professionalism and their dedication in conducting all aspects of TIMSS.

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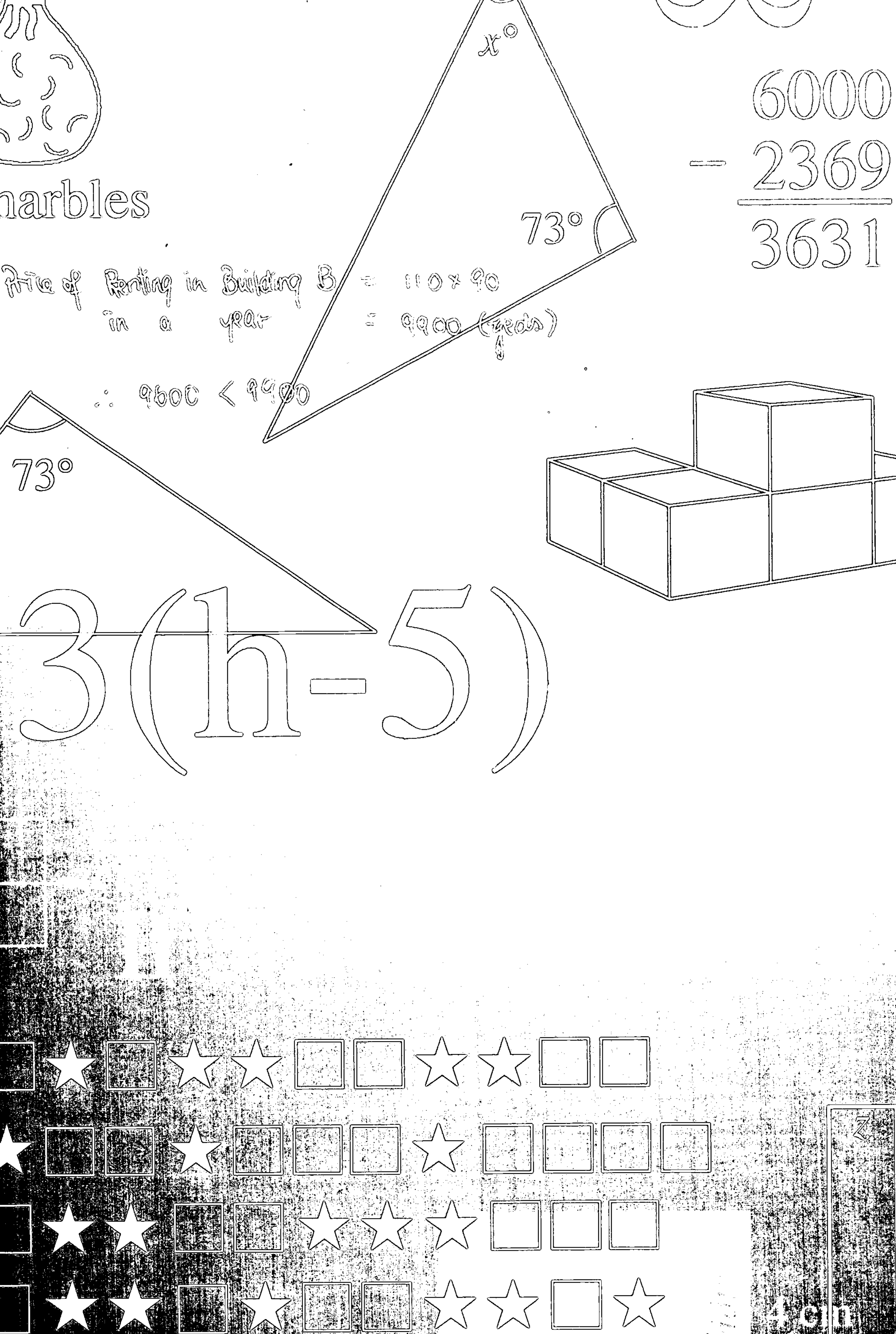

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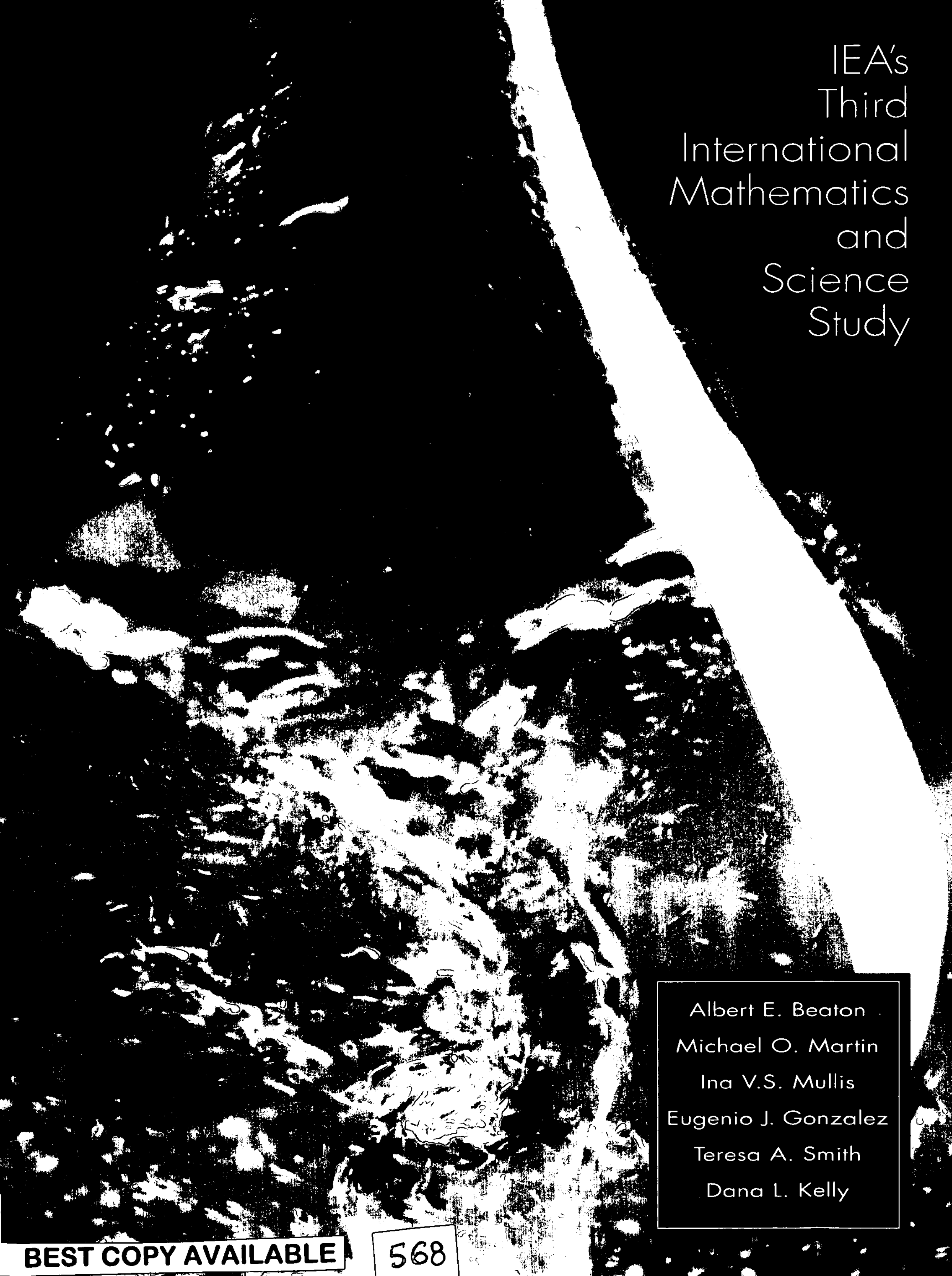
TIMSS

Science Achievement in the Middle School Years

IEA's Third International Mathematics and Science Study



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November 1996

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Contents

Executive Summary

Science

Since its inception in 1959, the International Association for the Evaluation of Educational Achievement (IEA) has conducted a series of international comparative studies designed to provide policy makers, educators, researchers, and practitioners with information about educational achievement and learning contexts. The Third International Mathematics and Science Study (TIMSS) is the largest and most ambitious of these studies ever undertaken.

The scope and complexity of TIMSS is enormous. Forty-five countries collected data in more than 30 different languages. Five grade levels were tested in the two subject areas, totaling more than half a million students tested around the world. The success of TIMSS depended on a collaborative effort between the research centers in each country responsible for implementing the steps of the project and the network of centers responsible for managing the across-country tasks such as training country representatives in standardized procedures, selecting comparable samples of schools and students, and conducting the various steps required for data processing and analysis. Including the administrators in the approximately 15,000 schools involved, many thousands of individuals around the world were involved in the data collection effort. Most countries collected their data in May and June of 1995, although those countries on a southern hemisphere schedule tested in late 1994, which was the end of their school year.

Five content dimensions were covered in the TIMSS science tests given to the middle-school students: earth science, life science, physics, chemistry and environmental issues and the nature of science. About one-fourth of the questions were in free-response format requiring students to generate and write their answers. These types of questions, some of which required extended responses, were allotted approximately one-third of the testing time. Chapter 3 of this report contains 25 example items illustrating the range of science concepts and processes addressed by the TIMSS test.

Because the home, school, and national contexts within which education takes place can play important roles in how students learn science, TIMSS collected extensive information about such background factors. The students who participated in TIMSS completed questionnaires about their home and school experiences related to learning science. Also, teachers and school administrators completed questionnaires about instructional practices. System-level information was provided by each participating country.

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed specifically to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality control monitors observed testing sessions, and sent reports back to the TIMSS International Study Center at Boston College. The samples of students selected for testing were scrutinized according to rigorous standards designed to prevent bias and ensure comparability. In this publication, the countries are grouped for reporting of achievement according to their compliance with the sampling guidelines and the level of their participation rates. Prior to analysis, the data from each country were subjected to exhaustive checks for adherence to the international formats as well as for within-country consistency and comparability across countries.

The results provided in this report describe students' science achievement at both the seventh and eighth grades. For most, but not all TIMSS countries, the two grades tested at the middle-school level represented the seventh and eighth years of formal schooling. Special emphasis is placed on the eighth-grade results, including selected information about students' background experiences and teachers' classroom practices in science. Results are reported for the 41 countries that completed all of the steps on the schedule necessary to appear in this report. The results for students in the third and fourth grades, and for those in their final year of secondary school will appear in subsequent reports.

The following sections summarize the major findings described in this report.

Students' Science Achievement

- Singapore was the top-performing country at both the eighth and seventh grades. The Czech Republic, Japan, and Korea also performed very well at both grades. Lower-performing countries included Colombia, Kuwait, and South Africa (see Tables 1.1 and 1.2; Figures 1.1 and 1.2).

- Perhaps the most striking finding was the large difference in average science achievement between the top-performing and bottom-performing countries. Despite this large difference, when countries were ordered by average achievement there were only small or negligible differences in achievement between each country and the one with the next-lowest average achievement. In some sense, at both grades, the results provide a chain of overlapping performances, where most countries had average achievement similar to a cluster of other countries, but from the beginning to the end of the chain there were substantial differences. For example, at both grades, average achievement in top-performing Singapore was comparable to or even exceeded performance for 95% of the students in the lowest-performing countries.

- In most countries and internationally, boys had significantly higher mean science achievement than girls at both the seventh and eighth grades. This is attributable mainly to significantly higher performance by boys in earth science, physics, and chemistry. In few countries were significant gender differences found in life science or environmental issues and the nature of science, although in life science one such difference favored girls in one country at the eighth grade.

▷ Compared to their overall performance in science, many countries did relatively better or worse in some content areas than they did in others. Consistent with the idea of countries having different emphases in curriculum, some countries performed better in life science, some performed better in physics, and others performed better in chemistry.

▷ Internationally, students had the most difficulty with the chemistry items. For example, an item that required students to explain how carbon dioxide fire extinguishers work was answered correctly by about half or fewer of both seventh- and eighth-grade students in many countries. Eighth-grade students, in general, performed better than seventh-grade students on this item, but in only four countries did 70% or more of eighth-grade students correctly explain the displacement of oxygen required for combustion – Austria, England, Singapore, and Sweden.

▷ A multiple-choice physics item requiring students to demonstrate knowledge of the earth's gravitational force acting on a falling apple was of similar international difficulty, with about half or fewer of the students in many countries selecting the correct response. Except in the Czech Republic and the Slovak Republic, where about three-quarters or more of students in both grades responded correctly, students' responses to this item indicated a common misconception internationally that gravity does not act on a stationary object when it is on the ground.

▷ One of the more difficult earth science items was an extended-response item requiring students to apply scientific principles and draw a diagram to explain the earth's water cycle. Internationally, about a third or fewer of both seventh- and eighth-grade students provided a completely correct response that included all three steps in the water cycle – evaporation, transportation, and precipitation. Performance on this item varied widely across countries, however, with percentages correct ranging from less than 10% in Lithuania and South Africa to 60% in Flemish-speaking Belgium.

Students' Attitudes Towards Science

▷ Even though the majority of eighth-graders in nearly every country indicated they liked science to some degree, clearly not all students feel positive about this subject area. Among countries where science is taught to eighth-grade students as a single subject, boys reported liking science more than did girls in England, Hong Kong, Japan, Kuwait, New Zealand, Norway, and Singapore. Where the major scientific disciplines are taught as separate subjects, the major gender differences were found in physical science, with boys expressing a liking for this content area more often than girls.

- In all except three countries, the majority of students agreed or strongly agreed that they did well in science or science subject areas – a perception that did not always coincide with the comparisons in achievement across countries on the TIMSS test. Interestingly, the exceptions included two of the higher-performing countries – Japan and Korea – where only 45% and 35% of the students, respectively, agreed or strongly agreed about doing well (the third was Hong Kong).

- In the majority of countries, for eighth-grade students, pleasing their parents and getting into their preferred university or secondary school were both stronger motivators for doing well in science than was getting their desired job.

Home Environment

Home factors were strongly related to science achievement in every country that participated in TIMSS.

- In every country, eighth-grade students who reported having more educational resources in the home had higher science achievement than those who reported little access to such resources. Strong positive relationships were found between science achievement and having study aids in the home, including a dictionary, a computer, and a study desk/table for the student's own use.

- The number of books in the home can be an indicator of a home environment that values and provides general academic support. In most TIMSS countries, the more books students reported in the home, the higher their science achievement.

- In every country, the pattern was for the eighth-grade students whose parents had more education to also have higher achievement in science.

- Beyond the one to two hours of daily television viewing reported by close to the majority of eighth graders in all participating countries, the amount of television students watched was negatively associated with science achievement.

- In most countries, eighth-graders reported spending as much out-of-school time each day in non-academic activities as they did in academic activities. Besides watching television, students reported spending several hours, on average, each day playing or talking with friends, and nearly two hours playing sports. (It should be noted, however, the time spent in these activities is not additive because students can talk with their friends at sporting events or while watching TV, for example.)

Instructional Contexts and Practices

In comparison to the positive relationships observed between science achievement and home factors, the relationships were less clear between achievement and various instructional variables, both within and across countries. Obviously, educational practices such as tracking and streaming can serve to systematically confound these relationships. Also, the interaction among instructional variables can be extremely complex and merits further study.

- The qualifications required for teaching certification were relatively uniform across countries. Most countries reported that four years of post-secondary education were required, even though there was a range from two to six years. Almost all countries reported that teaching practice was a requirement, as was an examination or evaluation.

- Teachers in most countries that teach integrated science reported that science classes typically meet for at least two hours a week, but less than three and one-half hours. At the extremes, less than two hours of in-class instruction was most common in Switzerland whereas three and one-half to five hours was most common in Singapore. The data, however, revealed no clear pattern across countries between the number of in-class instructional hours and science achievement.

- There was considerable variation in class-size across the TIMSS countries. In a number of countries, nearly all students (90% or more) were in classes of fewer than 30 students. At the other end of the spectrum, 89% of the students in Korea were in classes with more than 40 students. The TIMSS data showed different patterns of science achievement in relation to class size for different countries.

- Across countries, science teachers reported that working together as a class with the teacher teaching the whole class, and having students work individually with assistance from the teacher were the most frequently used instructional approaches. Working without teacher assistance was less common in most countries.

- In most participating countries, teachers reported using a textbook in teaching science for 95% or more of the students. Reasoning tasks were reported to be very common activities in science classes, with the majority of students in all countries being asked to do some type of science reasoning task in most or every science lesson. Using things from everyday life in solving science problems appears more common in countries where science is taught as an integrated subject than in countries where science is taught as separate subject areas.

- Demonstrations of experiments by the teacher were common in almost all countries where science is taught as an integrated subject, and were also common in chemistry and physics classes. In most countries with integrated science where students reported high frequencies of teacher demonstrations, there was also a high percentage of students that reported doing experiments or practical investigations in class. In countries where science is taught as separate subjects, according to students teachers performed demonstrations more frequently than students themselves did practical, hands-on work, particularly in physics and chemistry.

- Internationally, science teachers reported that most eighth-grade students were assigned science homework at least once a week, although most typically, the majority of students were assigned up to 30 minutes of homework once or twice a week. Student reports of the amount of time spent on science homework suggest higher levels of assigned homework.

- In some countries, students reported a lot of student assessment in their science classes, while in other countries there was apparently less reliance on quizzes or tests in science lessons. Of the countries where science is taught as an integrated subject more than half the students in Austria, Canada, Colombia, Cyprus, England, Hong Kong, Iran, Kuwait, Singapore, Spain, Thailand, and the United States reported having a quiz or test pretty often or almost always in their science lessons.

Introduction

SCIENCE

As the 21st century approaches, technology is having more and more impact on the daily lives of individuals throughout the world. It influences our receipt of news and information, how we spend our leisure time, and where we work. At an ever-increasing pace, technology also is becoming a major factor in determining the economic health of countries. To ensure their economic well-being, countries will need citizens prepared to participate in "brain-power" industries such as micro-electronics, computers, and telecommunications. The young adolescents of today will be seeking jobs in a global economy requiring levels of technical competence and flexible thinking that were required by only a few workers in the past. To make sensible decisions and participate effectively in a world transformed by the ability to exchange all types of information almost instantly, these students will need to be well educated in a number of core areas, especially mathematics and science.

The fact that skills in mathematics and science are so critical to economic progress in a technologically-based society has led countries to seek information about what their school-age populations know and can do in mathematics and science. There is interest in what concepts students understand, how well they can apply their knowledge to problem-solving situations, and whether they can communicate their understandings. Even more vital, countries are desirous of furthering their knowledge about what can be done to improve students' understanding of mathematical and scientific concepts, their ability to solve problems, and their attitudes toward learning.

The Third International Mathematics and Science Study (TIMSS) provided countries with a vehicle for investigating these issues while expanding their perspectives of what is possible beyond the confines of their national borders. It is the most ambitious and complex comparative education study in a series of such undertakings conducted during the past 37 years by the International Association for the Evaluation of Educational Achievement (IEA).[1] The main purpose of TIMSS was to focus on educational policies, practices, and outcomes in order to enhance mathematics and science learning within and across systems of education.

With its wealth of information covering more than half a million students at five grade levels in 15,000 schools and more than 40 countries around the world, TIMSS offers an unprecedented opportunity to examine similarities and differences in how mathematics and science education works and how well it works. The study used innovative testing approaches and collected extensive information about the contexts within which students learn mathematics and science.

[1] The previous IEA mathematics studies were conducted in 1964 and 1980-82, and the science studies in 1970-71 and 1983-84. For information about TIMSS procedures, see Appendix A.

The present report focuses on the science achievement of students in the two grades with the largest proportion of 13-year-olds – the seventh and eighth grades in most countries. Special emphasis is placed on the eighth-grade results, including selected information about students' background and classroom practices in teaching science.

All countries that participated in TIMSS were to test students in the two grades with the largest proportion of 13-year-olds in both mathematics and science. A companion report, *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS),* [2] presents corresponding results about students' mathematics achievement.

Many TIMSS countries also tested the mathematics and science achievement of students in the two grades with the largest proportion of 9-year-olds (third and fourth grades in most countries) and of students in their final year of secondary education. Subsets of students, except the final-year students, also had the opportunity to participate in a "hands-on" performance assessment where they designed experiments and tested hypotheses. The results of these components of TIMSS will be presented in forthcoming reports.

Together with the achievement tests, TIMSS administered a broad array of background questionnaires. The data collected from students, teachers, and school principals, as well as the system-level information collected from the participating countries, provide an abundance of information for further study and research. TIMSS data make it possible to examine differences in current levels of performance in relation to a wide variety of variables associated with classroom, school, and national contexts within which education takes place.

Which Countries Participated?

TIMSS was very much a collaborative process among countries. Table 1 shows the 45 participating countries. Each participant designated a national center to conduct the activities of the study and a National Research Coordinator (NRC) to assume responsibility for the successful completion of these tasks.[3] For the sake of comparability, all testing was conducted at the end of the school year. The four countries on a Southern Hemisphere school schedule (Australia, Korea, New Zealand, and Singapore) tested in September through November of 1994, which was the end of the school year in the Southern Hemisphere. The remaining countries tested the mathematics and science achievement of their students at the end of the 1994-95 school year, most often in May and June of 1995. Because Argentina, Italy, and Indonesia were unable to complete the steps necessary to appear in this report, the tables throughout the

[2] Beaton, A.E., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., Smith, T.A. (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[3] Appendix F lists the National Research Coordinators as well as the members of the TIMSS advisory committees.

Table 1

Countries Participating in TIMSS[1]

- Argentina
- Australia
- Austria
- Belgium *
- Bulgaria
- Canada
- Colombia
- Cyprus
- Czech Republic
- Denmark
- England
- France
- Germany
- Greece
- Hong Kong
- Hungary
- Iceland
- Indonesia
- Iran, Islamic Republic
- Ireland
- Israel
- Italy
- Japan
- Korea, Republic of
- Kuwait
- Latvia
- Lithuania
- Mexico
- Netherlands
- New Zealand
- Norway
- Philippines
- Portugal
- Romania
- Russian Federation
- Scotland
- Singapore
- Slovak Republic
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Thailand
- United States

* The Flemish and French educational systems in Belgium participated separately.

1 Argentina, Italy, and Indonesia were unable to complete the steps necessary for their data to appear in this report. Because the characteristics of its school sample are not completely known, achievement results for the Philippines are presented in Appendix C. Mexico participated in the testing portion of TIMSS, but chose not to release its results at grades 7 and 8 in the international report.

report do not include data for these three countries. Results also are not presented for Mexico, which chose not to release its seventh- and eighth-grade results in the international reports.

Table 2 shows information about the lower and upper grades tested in each country, including the country names for those two grades and the years of formal schooling students in those grades had completed when they were tested for TIMSS. Table 2 reveals that for most, but not all, countries, the two grades tested represented the seventh and eighth years of formal schooling. Thus, solely for convenience, the report often refers to the upper grade tested as the eighth grade and the lower grade tested as the seventh grade. As a point of interest, a system-split (where the lower grade was in upper primary and the upper grade was in lower secondary) occurred in six countries: New Zealand, Norway, the Philippines, South Africa, Sweden, and Switzerland. Two countries, Israel and Kuwait, tested only at the upper grade.

Having valid and efficient samples in each country is crucial to the quality and success of any international comparative study. The accuracy of the survey results depends on the quality of the sampling information available, and particularly on the quality of the samples. TIMSS developed procedures and guidelines to ensure that the national samples were of the highest quality possible. Standards for coverage of the target population, participation rates, and the age of students were established, as were clearly documented procedures on how to obtain the national samples. For the most part, the national samples were drawn in accordance with the TIMSS standards, and achievement results can be compared with confidence. However, despite efforts to meet the TIMSS specifications, some countries did not do so. These countries are specially annotated and/or shown in separate sections of the tables in this report.[4]

[4] The TIMSS sampling requirements and the outcomes of the sampling procedures are described in Appendix A.

Table 2

Information About the Grades Tested

Country	Lower Grade: Country's Name for Lower Grade	Lower Grade: Years of Formal Schooling Including Lower Grade[1]	Upper Grade: Country's Name for Upper Grade	Upper Grade: Years of Formal Schooling Including Upper Grade[1]
[2] Australia	7 or 8	7 or 8	8 or 9	8 or 9
Austria	3. Klasse	7	4. Klasse	8
Belgium (Fl)	1A	7	2A & 2P	8
Belgium (Fr)	1A	7	2A & 2P	8
Bulgaria	7	7	8	8
Canada	7	7	8	8
Colombia	7	7	8	8
Cyprus	7	7	8	8
Czech Republic	7	7	8	8
Denmark	6	6	7	7
England	Year 8	8	Year 9	9
France	5ème	7	4ème (90%) or 4ème Technologique (10%)	8
Germany	7	7	8	8
Greece	Secondary 1	7	Secondary 2	8
Hong Kong	Secondary 1	7	Secondary 2	8
Hungary	7	7	8	8
Iceland	7	7	8	8
Iran, Islamic Rep.	7	7	8	8
Ireland	1st Year	7	2nd Year	8
Israel	–	–	8	8
Japan	1st Grade Lower Secondary	7	2nd Grade Lower Secondary	8
Korea, Republic of	1st Grade Middle School	7	2nd Grade Middle School	8
Kuwait	–	–	9	9
Latvia	7	7	8	8
Lithuania	7	7	8	8
Netherlands	Secondary 1	7	Secondary 2	8
[3,4] New Zealand	Form 2	7.5 - 8.5	Form 3	8.5 - 9.5
[3] Norway	6	6	7	7
[3] Philippines	Grade 6 Elementary	6	1st Year High School	7
Portugal	Grade 7	7	Grade 8	8
Romania	7	7	8	8
[5] Russian Federation	7	6 or 7	8	7 or 8
Scotland	Secondary 1	8	Secondary 2	9
Singapore	Secondary 1	7	Secondary 2	8
Slovak Republic	7	7	8	8
Slovenia	7	7	8	8
Spain	7 EGB	7	8 EGB	8
[3] South Africa	Standard 5	7	Standard 6	8
[3] Sweden	6	6	7	7
[3] Switzerland				
(German)	6	6	7	7
(French and Italian)	7	7	8	8
Thailand	Secondary 1	7	Secondary 2	8
United States	7	7	8	8

[1]Years of schooling based on the number of years children in the grade level have been in formal schooling, beginning with primary education (International Standard Classification of Education Level 1). Does not include preprimary education.

[2]Australia: Each state/territory has its own policy regarding age of entry to primary school. In 4 of the 8 states/territories students were sampled from grades 7 and 8; in the other four states/territories students were sampled from grades 8 and 9.

[3]Indicates that there is a system-split between the lower and upper grades. In Switzerland there is a system-split in 14 of 26 cantons.

[4]New Zealand: The majority of students begin primary school on or near their 5th birthday so the "years of formal schooling" vary.

[5]Russian Federation: 70% of students in the seventh grade have had 6 years of formal schooling; 70% in the eighth grade have had 7 years of formal schooling.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

WHAT WAS THE NATURE OF THE SCIENCE TEST?

Together with the quality of the samples, the quality of the test also receives considerable scrutiny in any comparative study. All participants wish to ensure that the achievement items are appropriate for their students and reflect their current curriculum. Developing the TIMSS tests was a cooperative venture involving all of the NRCs during the entire process. Through a series of efforts, countries submitted items that were reviewed by science subject-matter specialists, and additional items were written to ensure that the desired science topics were covered adequately. Items were piloted, the results reviewed, and new items were written and piloted. The resulting TIMSS science test contained 135 items representing a range of science topics and skills.

The TIMSS curriculum frameworks described the content dimensions for the TIMSS tests as well as performance expectations (behaviors that might be expected of students in school science).[5] Five content areas are covered in the science test taken by seventh- and eighth-grade students. These areas and the percentage of the test items devoted to each include: earth science (16%), life science (30%), physics (30%), chemistry (14%), and environmental issues and the nature of science (10%). The performance expectations include: understanding simple information (40%); understanding complex information (29%); theorizing, analyzing, and solving problems (21%); using tools, routine procedures, and science processes (6%); and investigating the natural world (4%).

About one-fourth of the questions were in the free-response format, requiring students to generate and write their answers. These questions, some of which required extended responses, were allotted approximately one-third of the testing time. Responses to the free-response questions were evaluated to capture diagnostic information, and some were scored using procedures that permitted partial credit.[6] Chapter 3 of this report contains 25 example items illustrating the range of science concepts and processes addressed by the TIMSS test.

The TIMSS tests were prepared in English and translated into 30 additional languages using explicit guidelines and procedures. A series of verification checks were conducted to ensure the comparability of the translations.[7]

The tests were given so that no one student took all of the items, which would have required more than three hours. Instead, the test was assembled in eight booklets, each requiring 90 minutes to complete. Each student took only one booklet, and the items were rotated through the booklets so that each one was answered by a representative sample of students.

[5] Robitaille, D.F., McKnight, C.C., Schmidt, W.H., Britton, E.D., Raizen, S.A., and Nicol, C. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science.* Vancouver, B.C.: Pacific Educational Press.

[6] TIMSS scoring reliability studies within and across countries indicate that the percent of exact agreement for correctness scores averaged over 85%. For more details, see Appendix A.

[7] See Appendix A for more information about the translation procedures.

TIMSS conducted a Test-Curriculum Matching Analysis whereby countries examined the TIMSS test to identify items measuring topics not addressed in their curricula. The analysis showed that omitting such items for each country had little effect on the overall pattern of achievement results across all countries.[8]

How Do Country Characteristics Differ?

International studies of student achievement provide valuable comparative information about student performance and instructional practices. Along with the benefits of international studies, though, are challenges associated with comparing achievement across countries, cultures, and languages. In TIMSS, extensive efforts were made to attend to these issues through careful planning and documentation, cooperation among the participating countries, standardized procedures, and rigorous attention to quality control throughout.[9]

Beyond the integrity of the study procedures, the results of comparative studies such as TIMSS also need to be considered in light of the larger contexts in which students are educated and the kinds of system-wide factors that might influence students' opportunity to learn. A number of these factors are more fully described in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*;[10] however, some selected demographic characteristics of the TIMSS countries are presented in Table 3. Table 4 contains information about public expenditure on education. The information in these two tables show that some of the TIMSS countries are densely populated and others are more rural, some are large and some small, and some expend considerably more resources on education than others. Although these factors do not necessarily determine high or low performance in science, they do provide a context for considering the difficulty of the educational task from country to country.

Describing students' educational opportunities also includes understanding the knowledge and skills that students are supposed to master. To help complete the picture of educational practices in the TIMSS countries, science and curriculum specialists within each country provided detailed categorizations of their curriculum guides, textbooks, and curricular materials. The initial results from this effort can be found

[8] Results of the Test-Curriculum Matching Analysis are presented in Appendix B.

[9] Appendix A contains an overview of the procedures used and cites a number of references providing details about TIMSS methodology.

[10] Robitaille D.F. (in press). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

Table 3

Selected Demographic Characteristics of TIMSS Countries

Country	Population Size (1,000) [1]	Area of Country (1000 Square Kilometers) [2]	Density (Population per Square Kilometer) [3]	Percentage of Population Living in Urban Areas	Life Expectancy [4]	Percent in Secondary School [5]
Australia	17843	7713	2.29	84.8	77	84
Austria	8028	84	95.28	55.5	77	107
Belgium	10116	31	330.40	96.9	76	103
Bulgaria	8435	111	76.39	70.1	71	68
Canada	29248	9976	2.90	76.7	78	88
Colombia	36330	1139	31.33	72.2	70	62
Cyprus	726	9	77.62	53.6	77	95
Czech Republic	10333	79	130.99	65.3	73	86
Denmark	5205	43	120.42	85.1	75	114
[6] England	48533	130	373.33	–	77	–
France	57928	552	104.56	72.8	78	106
Germany	81516	357	227.39	86.3	76	101
Greece	10426	132	78.63	64.7	78	99
[7] Hong Kong	6061	1	5691.35	94.8	78	98
Hungary	10261	93	110.03	64.2	70	81
Iceland	266	103	2.56	91.4	79	103
Iran	62550	1648	36.98	58.5	68	66
Ireland	3571	70	50.70	57.4	76	105
Israel	5383	21	252.14	90.5	77	87
Japan	124961	378	329.63	77.5	79	96
Korea, Republic of	44453	99	444.92	79.8	71	93
Kuwait	1620	18	80.42	96.8	76	60
Latvia	2547	65	40.09	72.6	68	87
Lithuania	3721	65	57.21	71.4	69	78
Netherlands	15381	37	409.30	88.9	78	93
New Zealand	3493	271	12.78	85.8	76	104
Norway	4337	324	13.31	73.0	78	116
Philippines	67038	300	218.83	53.1	65	79
Portugal	9902	92	106.95	35.2	75	81
Romania	22731	238	95.81	55.0	70	82
Russian Federation	148350	17075	8.70	73.2	64	88
[8] Scotland	5132	79	65.15	–	75	–
Singapore	2930	1	4635.48	100.0	75	84
Slovak Republic	5347	49	108.61	58.3	72	89
Slovenia	1989	20	97.14	62.7	74	85
South Africa	40539	1221	32.46	50.5	64	77
Spain	39143	505	77.43	76.3	77	113
Sweden	8781	450	19.38	83.1	78	99
Switzerland	6994	41	168.03	60.6	78	91
Thailand	58024	513	111.76	31.9	69	37
United States	260650	9809	27.56	76.0	77	97

[1] Estimates for 1994 based, in most cases, on a de facto definition. Refugees not permanently settled in the country of asylum are generally considered to be part of their country of origin.
[2] Area is the total surface area in square kilometers, comprising all land area and inland waters.
[3] Density is population per square kilometer of total surface area.
[4] Number of years a newborn infant would live if prevailing patterns of mortality at its birth were to stay the same throughout its life.
[5] Gross enrollment of all ages at the secondary level as a percentage of school-age children as defined by each country. This may be reported in excess of 100% if some pupils are younger or older than the country's standard range of secondary school age.
[6] Annual Abstract of Statistics 1995, and Office of National Statistics. All data are for 1993.
[7] Number for Secondary Enrollment is from Education Department (1985) Education Indicators for the Hong Kong Education System (unpublished document).
[8] Registrar General for Scotland Annual Report 1995 and Scottish Abstract of Statistics 1993.
(–) A dash indicates the data were unavailable.

SOURCE: The World Bank, Social Indicators of Development, 1996.

Table 4

Public Expenditure on Education at Primary and Secondary Levels[1] in TIMSS Countries

Country	Gross National Product per Capita (US Dollars)[2]	Gross National Product per Capita (Intl. Dollars)[3]	Public Expenditure on Education (Levels 1 & 2) as % of Gross National Product[4]	Public Expenditure on Education (Intl. Dollars per Capita)[5]
Australia	17980	19000	3.69	701
Austria	24950	20230	4.24	858
Belgium	22920	20450	3.70	757
Bulgaria	1160	4230	3.06	129
Canada	19570	21230	4.62	981
Colombia	1620	5970	2.83	169
[6] Cyprus	10380	–	3.60	–
Czech Republic	3210	7910	3.75	297
Denmark	28110	20800	4.80	998
[7] England	18410	18170	3.57	649
France	23470	19820	3.61	716
Germany	25580	19890	2.43	483
Greece	7710	11400	2.27	259
[8] Hong Kong	21650	23080	1.34	309
Hungary	3840	6310	4.31	272
Iceland	24590	18900	4.77	902
Iran	–	4650	3.93	183
Ireland	13630	14550	4.21	613
Israel	14410	15690	3.72	584
Japan	34360	21350	2.82	602
Korea, Republic of	8220	10540	3.43	362
Kuwait	19040	24500	3.46	848
Latvia	2290	5170	2.85	147
Lithuania	1350	3240	2.18	71
Netherlands	21970	18080	3.30	597
New Zealand	13190	16780	3.15	529
Norway	26480	21120	5.26	1111
Philippines	960	2800	1.78	50
Portugal	9370	12400	2.98	370
Romania	1230	2920	1.89	55
Russian Federation	2650	5260	–	–
[7] Scotland	18410	18170	3.57	649
Singapore	23360	21430	3.38	724
Slovak Republic	2230	6660	2.69	179
Slovenia	7140	–	4.20	–
South Africa	3010	–	5.12	–
Spain	13280	14040	3.17	445
Sweden	23630	17850	4.92	878
Switzerland	37180	24390	3.72	907
Thailand	2210	6870	3.00	206
United States	25860	25860	4.02	1040

[1] The levels of education are based on the International Standard Classification of Education. The duration of Primary (level 1) and Secondary (level 2) vary depending on the country.

[2] SOURCE: The World Bank Atlas, 1996. Estimates for 1994 at current market prices in U.S. dollars, calculated by the conversion method used for the World Bank Atlas.

[3] SOURCE: The World Bank Atlas, 1996. Converted at purchasing power parity (PPP). PPP is defined as number of units of a country's currency required to buy same amounts of goods and services in domestic market as one dollar would buy in the United States.

[4] SOURCE: UNESCO Statistical Yearbook, 1995. Calculated by multiplying the Public Expenditure on Education as a % of GNP by the percentage of public education expenditure on the first and second levels of education. Figures represent the most recent figures released.

[5] Calculated by multiplying the GNP per Capita (Intl. Dollars) column by Public Expenditure on Education.

[6] GNP per capita figure for Cyprus is for 1993.

[7] The figures for England and Scotland are for the United Kingdom.

[8] Calculated using Education Department (1985) Education Indicators for the Hong Kong Education System (unpublished document).

(–) A dash indicates the data were unavailable.

in two reports, entitled *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.*[11]

Depending on the educational system, students' learning goals are commonly set at one of three main levels: the national or regional level, the school level, or the classroom level. Some countries are highly centralized, with the ministry of education (or highest authority in the system) having exclusive responsibility for making the major decisions governing the direction of education. In others, such decisions are made regionally or locally. Each approach has its strengths and weaknesses. Centralized decision-making can add coherence in curriculum coverage, but may constrain a school or teacher's flexibility in tailoring instruction to the different needs of students.

Figures 1, 2, and 3 show the degree of centralization in the TIMSS countries regarding decision-making about curriculum syllabi, textbooks, and examinations. Thirty of the TIMSS participants reported nationally-centralized decision-making about curriculum. Fewer countries reported nationally-centralized decision-making about textbooks, although 16 participants were in this category. Thirteen countries reported nationally-centralized decision-making about examinations. Regional decision-making about these three aspects of education does not appear very common among the TIMSS countries, with only a few countries reporting this level of decision-making for curriculum syllabi and textbooks, and none reporting it for examinations.

Most countries reported having centralized decision-making for one or two of the areas and "not centralized" decision-making for one or two of the areas. However, six countries – Bulgaria, Hong Kong, Lithuania, the Philippines, Romania, and Singapore – reported nationally-centralized decision-making for all three areas: curriculum syllabi, textbooks, and examinations. Six countries – Australia, Hungary, Iceland, Latvia, Scotland, and the United States – reported that decision-making is not centralized for any of these areas.

[11] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.* Dordrecht, the Netherlands: Kluwer Academic Publishers. Schmidt, Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G., (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Figure 1

Centralization of Decision-Making Regarding Curriculum Syllabi

Criteria

Countries are in the "Nationally Centralized" category regarding curriculum if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the syllabi for courses of study. If curriculum syllabi are determined at the regional level (e.g., state, province, territory), a country is in the "Regionally Centralized" Category. If syllabi for courses of study are not determined nationally or regionally, a country is in the "Not Centralized" category.

Nationally Centralized

Austria
Belgium (Fl)[1]
Belgium (Fr)[1]
Bulgaria
Colombia
Cyprus
Czech Republic
England
France
Greece
Hong Kong
Iran, Islamic Rep.
Ireland
Israel
Japan
Korea
Kuwait
Lithuania
New Zealand
Norway[2]
Philippines
Portugal
Romania
Singapore
Slovak Republic
Slovenia
South Africa
Spain[3]
Sweden[4]
Thailand

Regionally Centralized

Canada
Germany
Switzerland[5]

Not Centralized

Australia[6]
Denmark[7]
Hungary[8]
Iceland
Latvia
Netherlands[9]
Russian Federation
Scotland
United States

[1] Belgium: In Belgium, decision-making is centralized separately for the two educational systems.

[2] Norway: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

[3] Spain: Spain is now reforming to a regionally centralized system with high responsibility at the school level.

[4] Sweden: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

[5] Switzerland: Decision-making regarding curricula in upper secondary varies across cantons and types of education.

[6] Australia: Students tested in TIMSS were educated under a decentralized system. Reforms beginning in 1994 are introducing regionally centralized (state-determined) curriculum guidelines.

[7] Denmark: The Danish Parliament makes decisions governing the overall aim of education, and the Minister of Education sets the target, the central knowledge, and proficiency for each subject and the grades for teaching the subject. The local school administration can implement the subjects from guidelines from the Ministry; however, these are recommendations and are not mandatory.

[8] Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

[9] Netherlands: The Ministry of Education sets core objectives (for subjects in primary education and in 'basic education' at lower secondary level) and goals/objectives (for subjects in the four student ability tracks in secondary education) which schools are required to work towards. Schools have the freedom, though, to decide how to reach these objectives.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Figure 2

Centralization of Decision-Making Regarding Textbooks

Criteria

Countries are in the "Nationally Centralized" category regarding textbooks if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for determining the approved textbooks. If textbooks are selected from a regionally approved list (e.g., state. province. territory), a country is in the "Regionally Centralized" Category. If that decision-making body has less than exclusive repsonsibility for determining the approved textbooks, a country is in the "Not Centralized" category.

Nationally Centralized	Regionally Centralized	Not Centralized
Austria	Canada	Australia
Bulgaria	Germany	Belgium (Fl)
Cyprus	Japan	Belgium (Fr)
Greece	South Africa	Colombia
Hong Kong	Switzerland[2]	Czech Republic
Iran, Islamic Rep.		Denmark
Korea		England
Kuwait		France
Lithuania		Hungary[3]
Norway		Iceland
Philippines		Ireland
Romania		Israel
Singapore		Latvia
Slovenia		Netherlands
Spain[1]		New Zealand
Thailand		Portugal
		Russian Federation
		Scotland
		Slovak Republic
		Sweden
		United States

[1]Spain: Spain is now reforming to a regionally centralized system with high responsibility at the school level.
[2]Switzerland: Decision-making regarding textbooks in upper secondary varies across the cantons and the types of education.
[3]Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Figure 3

Centralization of Decision-Making Regarding Examinations

Criteria

Countries are in the "Nationally Centralized" category regarding examinations if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the content of examinations. The notes explain during which school years the examinations are administered. If that decision-making body has less than exclusive responsibility for or final approval of the examination content, the country is in the "Not Centralized" category.

Nationally Centralized

Bulgaria
Denmark[1]
England[2]
Hong Kong[3]
Ireland[4]
Lithuania
Netherlands[5]
New Zealand[6]
Philippines[7]
Romania
Russian Federation[8]
Singapore[9]
South Africa

Not Centralized

Australia[10]
Austria
Belgium (Fl)
Belgium (Fr)
Canada
Colombia
Cyprus
Czech Republic
France
Germany[11]
Greece
Hungary
Iceland
Iran, Islamic Rep.
Israel[12]
Japan
Korea
Kuwait
Latvia[13]
Norway
Portugal
Scotland
Singapore
Slovak Republic
Slovenia[14]
Spain
Sweden[15]
Switzerland
Thailand
United States

[1]Denmark: Written examinations are set and marked centrally. The Ministry of Education sets the rules and framework for oral examinations. However, oral examinations are conducted by the pupil's own teacher, together with a teacher from another local school or an external (ministry-appointed) examiner.

[2]England: Centralized national curriculum assessments taken at Years 2, 6 and 9. Regionally centralized examinations taken at Years 11 and 13.

[3]Hong Kong: Centralized examination taken at Year 11.

[4]Ireland: Centralized examinations taken at Grade 9 and Grade 12.

[5]Netherlands: School-leaving examinations consisting of a centralized part and a school-bound part are taken in the final grades of the four student ability tracks in secondary education.

[6]New Zealand: Centralized examinations taken at Years 11, 12 and 13. Centralized national monitoring at Years 4 and 8.

[7]Philippines: Centralized examinations taken at Grade 6 and Year 10 (4th year high school).

[8]Russian Federation: Centralized examinations taken in Grades 9 and 11 in mathematics and Russian/literature.

[9]Singapore: Centralized examinations taken at Grades 6, 10, and 12.

[10]Australia: Not centralized as a country, but low-stakes statewide population assessments are undertaken in most states at one or more of Grades 3, 5, 6 and 10. In most states, centralized examinations are taken at Grade 12.

[11]Germany: Not centralized as a country, but is centralized within 6 (of 16) federal states.

[12]Israel: Centralized examinations taken at the end of secondary school that affect opportunities for further education.

[13]Latvia: Centralized examinations taken at Grade 9 and Grade 12.

[14]Slovenia: Two-subject national examination taken after Grade 8 (end of compulsory education); five-subject externally-assessed baccalaureat after Grade 12 for everyone entering university.

[15]Sweden: There are no examinations in Sweden.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Chapter 1

International Student Achievement in Science

What Are the Overall Differences in Science Achievement?

Chapter 1 summarizes achievement on the TIMSS science test for each of the participating countries. Comparisons are provided overall and by gender for the upper grade tested (often the eighth grade) and the lower grade tested (often the seventh grade), as well as for 13-year-olds.

Table 1.1 presents the mean (or average) achievement for 41 countries at the eighth grade.[1] The 25 countries shown by decreasing order of mean achievement in the upper part of the table were judged to have met the TIMSS requirements for testing a representative sample of students. Although all countries tried very hard to meet the TIMSS sampling requirements, several encountered resistance from schools and teachers and did not have participation rates of 85% or higher as specified in the TIMSS guidelines (i.e., Australia, Austria, Belgium (French), Bulgaria, the Netherlands, and Scotland). To provide a better curricular match, four countries (i.e., Colombia, Germany, Romania, and Slovenia) elected to test their seventh- and eighth-grade students even though that meant not testing the two grades with the most 13-year-olds and led to their students being somewhat older than those in the other countries. The countries in the remaining two categories encountered various degrees of difficulty in implementing the prescribed methods for sampling classrooms within schools. Because the Philippines did not document clearly its procedures for sampling schools, its achievement results are presented in Appendix C. A full discussion of the sampling procedures and outcomes for each country can be found in Appendix A.

To aid in interpretation, the table also contains the years of formal schooling and average age of the students. Equivalence of chronological age does not necessarily mean that students have received the same number of years of formal schooling or studied the same curriculum. Most notably, students in the three Scandinavian countries, Sweden, Norway, and Denmark, had fewer years of formal schooling than their counterparts in other countries,[2] and those in England, Scotland, New Zealand, and Kuwait had more. Countries with a high percentage of older students may have policies that include retaining students in lower grades.

The results reveal substantial differences in science achievement between the top- and bottom-performing countries, although the average achievement of most countries was somewhere in the middle ranges. The broad range of achievement both across

[1] TIMSS used item response theory (IRT) methods to summarize the achievement results for both grades on a scale with a mean of 500 and a standard deviation of 100. Scaling averages students' responses to the subsets of items they took in a way that accounts for differences in the difficulty of those items. It allows students' performance to be summarized on a common metric even though individual students responded to different items in the science test. For more detailed information, see the "IRT Scaling and Data Analysis" section of Appendix A.

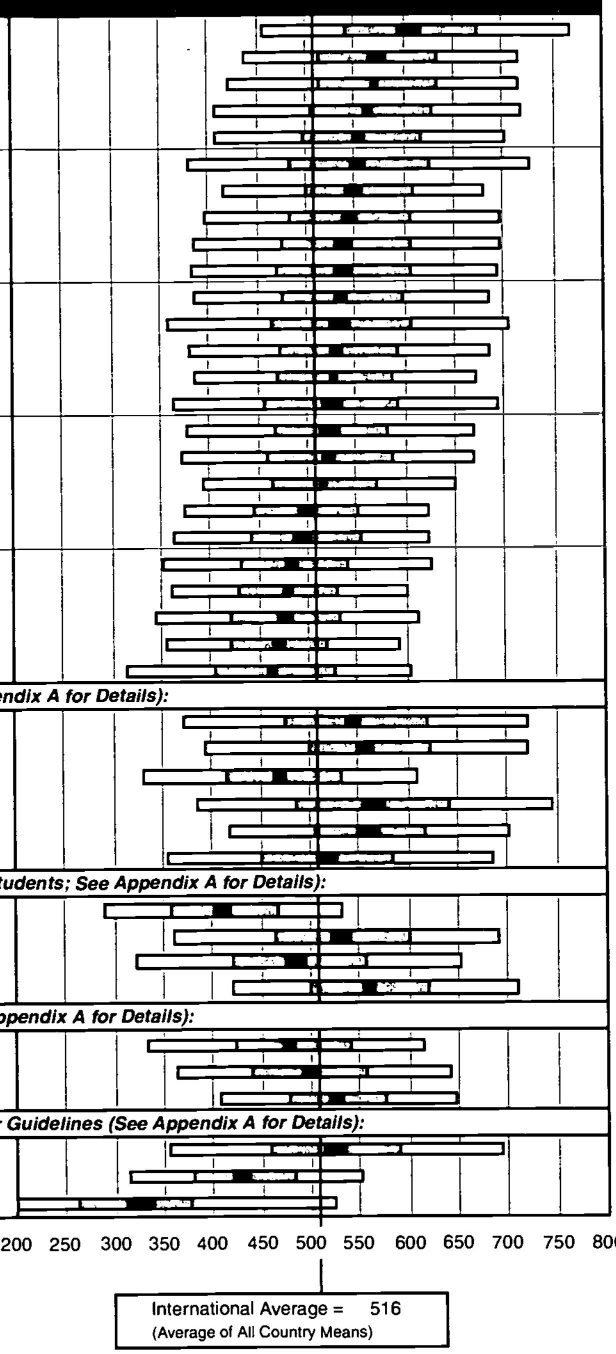
[2] Achievement results for the eighth-grade students in Denmark and Sweden, as well as for the eighth-grade students in German-speaking schools in Switzerland are presented in Appendix D.

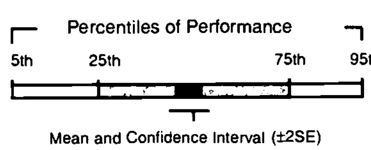
Table 1.1

Distributions of Achievement in the Sciences - Upper Grade (Eighth Grade*)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	607 (5.5)	8	14.5
Czech Republic	574 (4.3)	8	14.4
Japan	571 (1.6)	8	14.4
Korea	565 (1.9)	8	14.2
Hungary	554 (2.8)	8	14.3
†2 England	552 (3.3)	9	14.0
† Belgium (Fl)	550 (4.2)	8	14.1
Slovak Republic	544 (3.2)	8	14.3
Russian Federation	538 (4.0)	7 or 8	14.0
Ireland	538 (4.5)	8	14.4
Sweden	535 (3.0)	7	13.9
† United States	534 (4.7)	8	14.2
Canada	531 (2.6)	8	14.1
Norway	527 (1.9)	7	13.9
New Zealand	525 (4.4)	8.5 - 9.5	14.0
Hong Kong	522 (4.7)	8	14.2
1 Switzerland	522 (2.5)	7 or 8	14.2
Spain	517 (1.7)	8	14.3
France	498 (2.5)	8	14.3
Iceland	494 (4.0)	8	13.6
1 Latvia (LSS)	485 (2.7)	8	14.3
Portugal	480 (2.3)	8	14.5
1 Lithuania	476 (3.4)	8	14.3
Iran, Islamic Rep.	470 (2.4)	8	14.6
Cyprus	463 (1.9)	8	13.7
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	545 (3.9)	8 or 9	14.2
Austria	558 (3.7)	8	14.3
Belgium (Fr)	471 (2.8)	8	14.3
Bulgaria	565 (5.3)	8	14.0
Netherlands	560 (5.0)	8	14.3
Scotland	517 (5.1)	9	13.7
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	411 (4.1)	8	15.7
†1 Germany	531 (4.8)	8	14.8
Romania	486 (4.7)	8	14.6
Slovenia	560 (2.5)	8	14.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	478 (3.1)	7	13.9
Greece	497 (2.2)	8	13.6
Thailand	525 (3.7)	8	14.3
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
1 Israel	524 (5.7)	8	14.1
Kuwait	430 (3.7)	9	15.3
South Africa	326 (6.6)	8	15.4

Science Achievement Scale Score





*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 1.1

Multiple Comparisons of Achievement in the Sciences - Upper Grade (Eighth Grade*)

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.[†]

Country	Singapore	Czech Republic	Japan	Korea	*Bulgaria*	*Netherlands*	*Slovenia*	*Austria*	Hungary	England	Belgium (Fl)	*Australia*	Slovak Republic	Russian Fed.	Ireland	Sweden	United States	*Germany*	Canada	Norway	New Zealand	*Thailand*	*Israel*	Hong Kong	Switzerland	*Scotland*	Spain	France	*Greece*	Iceland	*Romania*	Latvia (LSS)	Portugal	*Denmark*	Lithuania	*Belgium (Fr)*	Iran, Islamic Rep.	Cyprus	*Kuwait*	*Colombia*	*South Africa*
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	▼	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	▼	●	●		●	●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	▼	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	●	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	●	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	●	●	▼	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Israel	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●	●	●	●	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	▲	▲	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	▲	▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●		●	●	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●		●	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		▲	▲	▲
Kuwait	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.

[†]Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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and within countries is illustrated in Table 1.1 by a graphical representation of the distribution of student performance within each country. Achievement for each country is shown for the 25th and 75th percentiles as well as for the 5th and 95th percentiles.[3] Each percentile point indicates the percentages of students performing below and above that point on the scale. For example, 25% of the eighth-grade students in each country performed below the 25th percentile for that country, and 75% performed above the 25th percentile. The range between the 25th and 75th percentiles represents performance by the middle half of the students. In contrast, performance at the 5th and 95th percentiles represents the extremes in both lower and higher achievement. The dark boxes at the midpoints of the distributions show the 95% confidence intervals around the average achievement in each country.[4] These intervals can be compared to the international average of 516, which was derived by averaging across the means for each of the 41 participants shown in the table.[5] A number of countries had mean achievement well above or well below that level.

Considerable variation in student performance is observed between countries. For example, average performance in Singapore was comparable to or even exceeded performance at the 95th percentile in the lower-performing countries such as Colombia, Kuwait, and South Africa. The differences between the extremes in performance were also very large within most countries.

Figure 1.1 provides a method for making appropriate comparisons in overall mean achievement between countries.[6] This figure shows whether or not the differences in mean achievement between pairs of countries are statistically significant. Selecting a country of interest and reading across the table, a triangle pointing up indicates significantly higher performance than the country listed across the top, a dot indicates no significant difference in performance, and a triangle pointing down indicates significantly lower performance.

At the eighth grade, Singapore, with all triangles pointing up, had a significantly higher mean achievement than other participating countries. Other countries that performed very well included the Czech Republic, Japan, Korea, Bulgaria, the Netherlands, Slovenia, and Austria. These countries had performance levels similar to each other, although Japan had significantly higher performance than Slovenia and Austria. Interestingly, from the top-performing countries on down through the list of participants, the differences in performance from one country to the next was often negligible. For example, in addition to performing at about the same level as the other countries mentioned above, the Netherlands did not differ significantly from Hungary, England,

[3] Tables of the percentile values and standard deviations for all countries are presented in Appendix E.

[4] See the "IRT Scaling and Data Analysis" section of Appendix A for more details about calculating standard errors and confidence intervals for the TIMSS statistics.

[5] Because the Flemish and French educational systems in Belgium participated separately, their results are presented separately in the tables of this report.

[6] The significance tests in Figures 1.1 and 1.2 are based on a Bonferroni procedure for multiple comparisons that holds to 5% the probability of erroneously declaring the mean of one country to be different from another country.

Flemish-speaking Belgium, Australia, and the Slovak Republic. In turn, Hungary, while performing less well than Singapore, the Czech Republic, Japan, and Korea, performed at about the same level as Bulgaria, the Netherlands, Slovenia, Austria, England, Flemish-speaking Belgium, Australia, the Slovak Republic, the Russian Federation, and Ireland, and higher than all other countries.

Despite the small differences between adjacent countries when participants are ordered by performance, the differences between the top-performing and bottom-performing countries was very large. Because of this large range in performance, the pattern for a number of countries was one of having lower mean achievement than some countries, about the same mean achievement as other countries, and higher mean achievement than a third group. In contrast, Kuwait, Colombia, and South Africa performed less well than the other countries, with Colombia having significantly lower achievement than Kuwait, and South Africa having significantly lower achievement than Colombia.

Table 1.2 and Figure 1.2 present corresponding data for the seventh grade.[7] At the seventh grade there was no significant difference in mean science achievement among the seven top-performing countries – Singapore, Korea, the Czech Republic, Japan, Bulgaria, Slovenia, and Belgium (Flemish). The three lowest-performing countries were Lithuania, Colombia, and South Africa. However, students in Colombia performed less well than those in Lithuania, and students in South Africa below those in Colombia. For the remaining countries, performance rankings also tended to be similar, but not identical, to those found at the eighth grade.

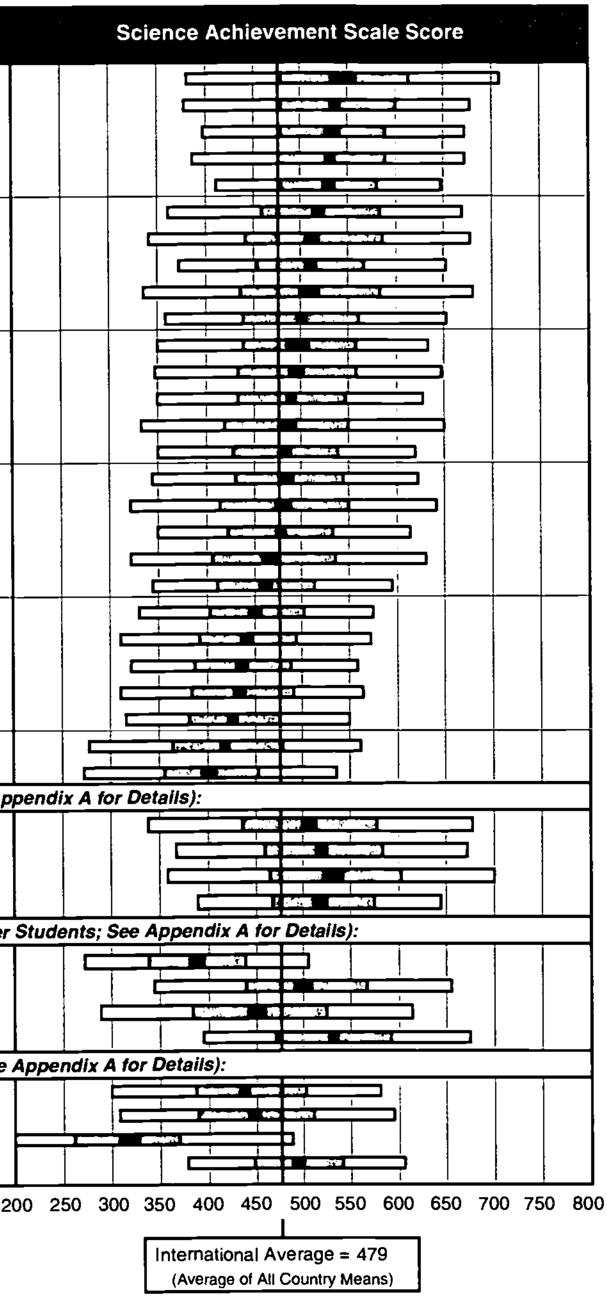
Performance in eighth grade was naturally somewhat higher than that in seventh grade, since eighth-grade students have had one year more of schooling. The international average at the eighth grade (516) was 37 points higher than the international average of 479 at the seventh grade. Even though equivalent achievement increases cannot be assumed from grade to grade throughout schooling, this 37-point difference does provide a rough indication of grade-by-grade increases in science achievement during the middle years. By this gauge, the achievement differences across countries at both grades reflect several grade levels in learning between the higher- and lower-performing countries. A similarly large range in performance can be noted within most countries. There needs to be a further note of caution, however, in using growth from grade to grade as an indicator of achievement. The TIMSS scale measures achievement in science judged to be appropriate for seventh- and eighth-grade students around the world. Thus, higher performance does not mean students can do advanced high-school science, only that they are more proficient at middle-school science.

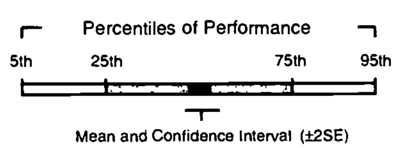
[7] Results are presented for 27 countries in the top portion of Table 1.2 because French-speaking Belgium and Scotland met the sampling requirements at this grade. Thirty-nine countries are presented in total because Kuwait and Israel tested only the eighth grade.

Table 1.2

Distributions of Achievement in the Sciences - Lower Grade (Seventh Grade*)

Country	Mean	Years of Formal Schooling	Average Age
Singapore	545 (6.6)	7	13.3
Korea	535 (2.1)	7	13.2
Czech Republic	533 (3.3)	7	13.4
Japan	531 (1.9)	7	13.4
† Belgium (Fl)	529 (2.6)	7	13.0
Hungary	518 (3.2)	7	13.4
†2 England	512 (3.5)	8	13.1
Slovak Republic	510 (3.0)	7	13.3
† United States	508 (5.5)	7	13.2
Canada	499 (2.3)	7	13.1
Hong Kong	495 (5.5)	7	13.2
Ireland	495 (3.5)	7	13.4
Sweden	488 (2.6)	6	12.9
Russian Federation	484 (4.2)	6 or 7	13.0
1 Switzerland	484 (2.5)	6 or 7	13.1
Norway	483 (2.9)	6	12.9
New Zealand	481 (3.4)	7.5 - 8.5	13.0
Spain	477 (2.1)	7	13.2
† Scotland	468 (3.8)	8	12.7
Iceland	462 (2.8)	7	12.6
France	451 (2.6)	7	13.3
† Belgium (Fr)	442 (3.0)	7	13.2
Iran, Islamic Rep.	436 (2.6)	7	13.6
1 Latvia (LSS)	435 (2.7)	7	13.3
Portugal	428 (2.1)	7	13.4
Cyprus	420 (1.8)	7	12.8
1 Lithuania	403 (3.4)	7	13.4
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	504 (3.6)	7 or 8	13.2
Austria	519 (3.1)	7	13.3
Bulgaria	531 (5.4)	7	13.1
Netherlands	517 (3.6)	7	13.2
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	387 (3.2)	7	14.5
†1 Germany	499 (4.1)	7	13.8
Romania	452 (4.4)	7	13.7
Slovenia	530 (2.4)	7	13.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	439 (2.1)	6	12.9
Greece	449 (2.6)	7	12.6
† South Africa	317 (5.3)	7	13.9
Thailand	493 (3.0)	7	13.5





*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 1.2

Multiple Comparisons of Achievement in the Sciences - Lower Grade (Seventh Grade*)

Instructions: Read *across* the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.[†]

Country	Singapore	Korea	Czech Republic	Japan	*Bulgaria*	*Slovenia*	Belgium (Fl)	*Austria*	Hungary	*Netherlands*	England	Slovak Republic	United States	*Australia*	*Germany*	Canada	Hong Kong	Ireland	*Thailand*	Sweden	Russian Fed.	Switzerland	Norway	New Zealand	Spain	Scotland	Iceland	*Romania*	France	*Greece*	Belgium (Fr)	*Denmark*	Iran, Islamic Rep.	Latvia (LSS)	Portugal	Cyprus	Lithuania	*Colombia*	*South Africa*
Singapore		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Korea	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	●	●		●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Japan	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Bulgaria	●	●	●	●		●	●	●	●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Belgium (Fl)	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	●	▼	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	▼	●	▼	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
England	▼	▼	▼	▼	●	▼	▼	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	●	▼	▼	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hong Kong	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Ireland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Thailand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Fed.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Spain	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Romania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	▲	▲	▲	▲	▲	▲	▲
Belgium (Fr)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●		●	●	▲	▲	▲	▲	▲
Iran, Islamic Rep.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	▲	▲	▲	▲
Latvia (LSS)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	▲	▲	▲	▲
Portugal	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	▲	▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Colombia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.

[†]Statistically significant at .05 level, adjusted for multiple comparisons.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Appendix A for details).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are the Increases in Achievement Between the Lower and Upper Grades?

Table 1.3 presents the increases in mean achievement between the two grades tested in each TIMSS country. Countries in the upper portion of the table are shown in decreasing order by the amount of this between-grade difference. Increases in mean performance between the two grades ranged from a high of 73 points in Lithuania to 22 points in the Flemish-speaking part of Belgium[8] and a low of 9 points in South Africa.[9] This degree of increase can be compared to the difference of 37 points between the international average of 516 at eighth grade and that of 479 at seventh grade. Despite the larger increases in some countries compared to others, there is no obvious relationship between mean seventh-grade performance and the between-grade increase. That is, countries showing the highest performance at the seventh grade did not necessarily show either the largest or smallest increases in achievement at the eighth grade. Still, in general, countries with high mean performance in the seventh grade also had high mean performance in the eighth grade.

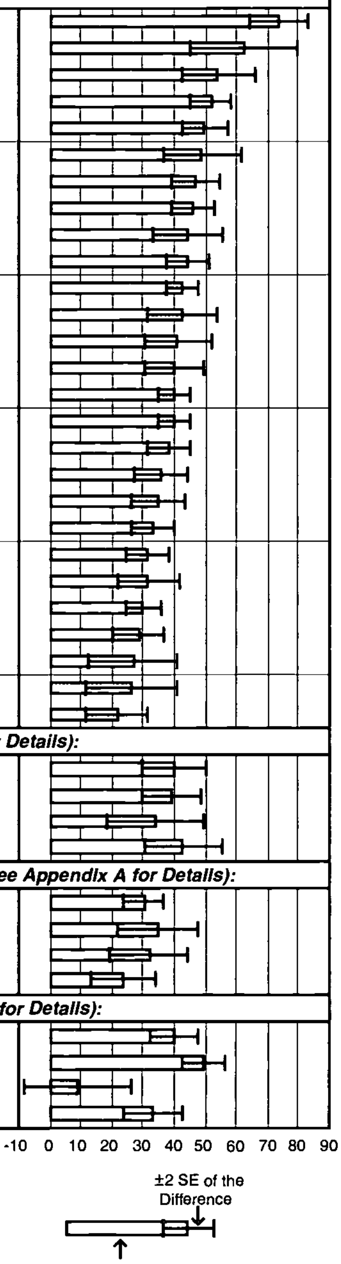
[8] Both educational systems in Belgium have policies whereby lower-performing sixth-grade students continue their study of the primary school curriculum and then re-enter the system as part of a vocational track in the eighth grade. Since these lower-performing students are not included in the seventh-grade results, but do compose about 10% of the sample at the eighth grade, this contributed to reduced performance differences between grades 7 and 8.

[9] In South Africa, there is no structural reason to explain the relatively small difference between seventh- and eighth-grade performance. However, in 1995, its education system was undergoing radical reorganization from 18 racially-divided systems into 9 provincial systems.

Table 1.3

Achievement Differences in the Sciences Between Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Seventh Grade Mean	Eighth Grade Mean	Eighth-Seventh Difference
† Lithuania	403 (3.4)	476 (3.4)	73 (4.8)
Singapore	545 (6.6)	607 (5.5)	63 (8.6)
Russian Federation	484 (4.2)	538 (4.0)	54 (5.8)
Portugal	428 (2.1)	480 (2.3)	52 (3.1)
1 Latvia (LSS)	435 (2.7)	485 (2.7)	50 (3.8)
† Scotland	468 (3.8)	517 (5.1)	49 (6.4)
Sweden	488 (2.6)	535 (3.0)	47 (3.9)
France	451 (2.6)	498 (2.5)	46 (3.6)
New Zealand	481 (3.4)	525 (4.4)	44 (5.5)
Norway	483 (2.9)	527 (1.9)	44 (3.5)
Cyprus	420 (1.8)	463 (1.9)	43 (2.7)
Ireland	495 (3.5)	538 (4.5)	43 (5.7)
Czech Republic	533 (3.3)	574 (4.3)	41 (5.4)
†2 England	512 (3.5)	552 (3.3)	40 (4.8)
Japan	531 (1.9)	571 (1.6)	40 (2.5)
Spain	477 (2.1)	517 (1.7)	40 (2.7)
1 Switzerland	484 (2.5)	522 (2.5)	38 (3.5)
Hungary	518 (3.2)	554 (2.8)	36 (4.2)
Slovak Republic	510 (3.0)	544 (3.2)	35 (4.4)
Iran, Islamic Rep.	436 (2.6)	470 (2.4)	33 (3.5)
Canada	499 (2.3)	531 (2.6)	32 (3.5)
Iceland	462 (2.8)	494 (4.0)	32 (4.9)
Korea	535 (2.1)	565 (1.9)	30 (2.9)
† Belgium (Fr)	442 (3.0)	471 (2.8)	29 (4.2)
Hong Kong	495 (5.5)	522 (4.7)	27 (7.2)
† United States	508 (5.5)	534 (4.7)	26 (7.2)
† Belgium (Fl)	529 (2.6)	550 (4.2)	22 (4.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	504 (3.6)	545 (3.9)	40 (5.3)
Austria	519 (3.1)	558 (3.7)	39 (4.8)
Bulgaria	531 (5.4)	565 (5.3)	34 (7.6)
Netherlands	517 (3.6)	560 (5.0)	43 (6.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Slovenia	530 (2.4)	560 (2.5)	30 (3.4)
Romania	452 (4.4)	486 (4.7)	34 (6.5)
†1 Germany	499 (4.1)	531 (4.8)	32 (6.3)
Colombia	387 (3.2)	411 (4.1)	24 (5.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	439 (2.1)	478 (3.1)	39 (3.8)
Greece	449 (2.6)	497 (2.2)	49 (3.4)
† South Africa	317 (5.3)	326 (6.6)	9 (8.5)
Thailand	493 (3.0)	525 (3.7)	33 (4.8)



*Seventh and eighth grades in most countries; see Table 2 for infomation about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are the Differences in Performance Compared to Three Marker Levels of International Science Achievement?

Tables 1.4 and 1.5 portray the performance of students in each TIMSS country in terms of international levels of achievement for the eighth and seventh grades, respectively. This method provides another useful comparison of student performance across countries by determining the percentage of students in each country reaching specific levels of performance. Since the TIMSS achievement tests do not have any pre-specified performance standards, three marker levels were chosen on the basis of the combined performance of all students at a grade level in the study – the Top 10%, the Top Quarter (25%), and the Top Half (50%). For example, Table 1.4 shows that 10% of all eighth graders in countries participating in the TIMSS study achieved at the level of 655 or better. This score point, then, was designated as the marker level for the Top 10%. Similarly, the Top Quarter marker level was determined as 592 and the Top Half marker level as 522. At the seventh grade, these marker levels are 615, 553 and 483, respectively.

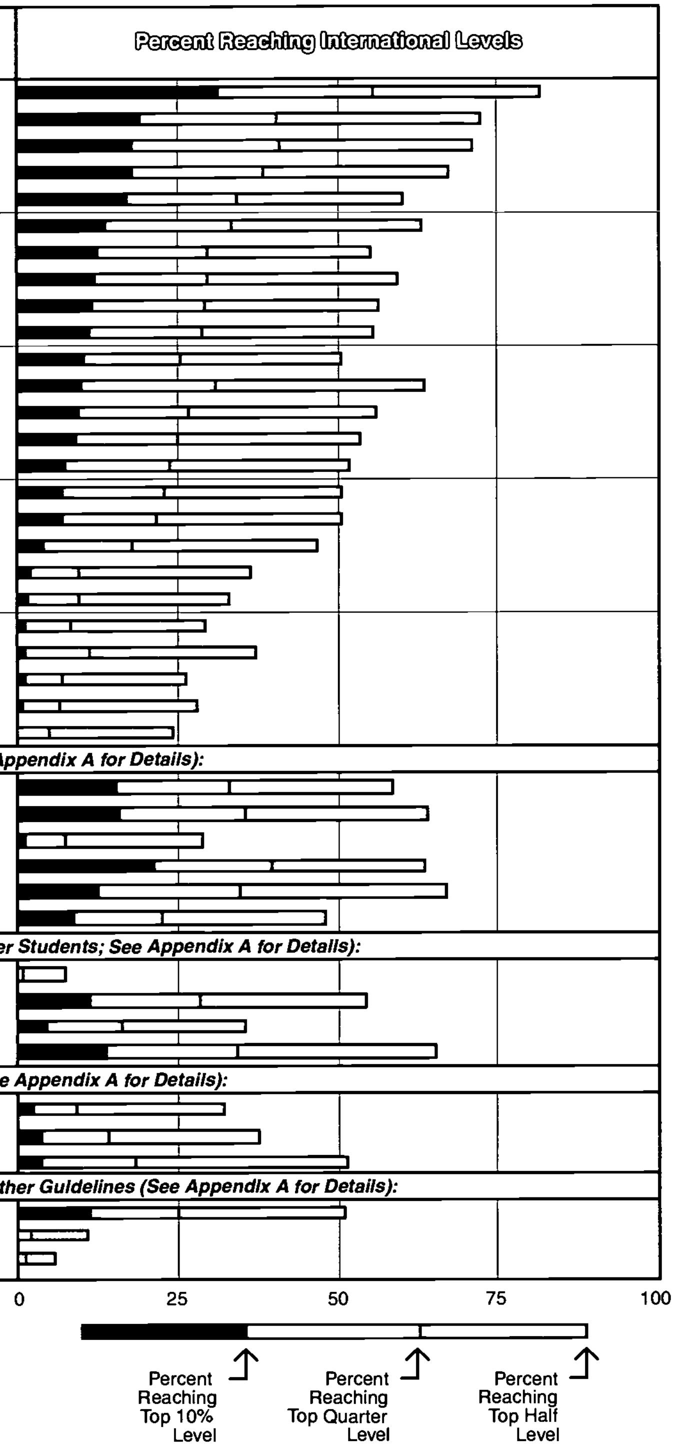
If every country had the same distribution of high-, medium-, and low-performing students, then each country would be expected to have approximately 10% of its students reaching the Top 10% level, 25% reaching the Top Quarter level, and 50% reaching the Top Half level. Although no country achieved exactly this pattern, the distributions of eighth- and/or seventh-grade students in several countries were quite close. For example, 9%, 24%, and 49% of the seventh-grade students in the Russian Federation reached the corresponding levels. Similarly, percentages close to the international norm were noted at the eighth grade for New Zealand, Sweden, Scotland, and Israel. In contrast, in Singapore nearly one-third (31%) of the eighth-grade students and 24% of seventh-grade students reached the Top 10% level, approximately half or more reached the Top Quarter level (56% at the eighth grade and 48% at the seventh grade), and about three-quarters or more reached the Top Half level (82% at the eighth grade and 74% at the seventh grade).

It can be informative to look at performance at each marker level. For example, at the eighth grade, Norway, Switzerland, and Hong Kong did not quite attain the Top 10% level, with 7% of students reaching that level. However, performance in these countries approximated both the Top Quarter and Top Half levels. In comparison, eighth-grade students in Belgium (Flemish) attained approximately the Top 10% level (10%) and exceeded both the Top Quarter and Top Half levels (31% and 64%). This pattern for the Belgian (Flemish) students was even more pronounced at the seventh grade, with 73% of students reaching the Top Half level.

Table 1.4

Percentages of Students Achieving International Marker Levels in the Sciences Upper Grade (Eighth Grade*)

Country	Top 10% Level	Top Quarter Level	Top Half Level
Singapore	31 (2.3)	56 (2.5)	82 (1.6)
Czech Republic	19 (1.6)	41 (2.1)	72 (1.6)
Japan	18 (0.6)	41 (0.8)	71 (0.7)
Korea	18 (0.8)	39 (0.9)	68 (0.9)
†2 England	17 (0.9)	34 (1.4)	60 (1.4)
Hungary	14 (0.8)	34 (1.3)	63 (1.4)
† United States	13 (0.8)	30 (1.6)	55 (1.9)
Slovak Republic	12 (0.9)	30 (1.4)	59 (1.5)
Ireland	12 (0.9)	29 (1.6)	57 (2.0)
Russian Federation	11 (0.8)	29 (1.3)	56 (1.8)
New Zealand	11 (0.9)	26 (1.5)	51 (1.9)
† Belgium (Fl)	10 (0.8)	31 (1.8)	64 (2.1)
Sweden	9 (0.6)	27 (1.2)	56 (1.5)
Canada	9 (0.6)	25 (0.9)	54 (1.3)
Norway	7 (0.5)	24 (0.9)	52 (1.1)
1 Switzerland	7 (0.6)	23 (1.0)	51 (1.2)
Hong Kong	7 (0.8)	22 (1.5)	51 (2.3)
Spain	4 (0.3)	18 (0.7)	47 (1.0)
Iceland	2 (0.5)	10 (1.3)	36 (2.1)
1 Latvia (LSS)	2 (0.3)	10 (0.7)	33 (1.3)
1 Lithuania	1 (0.3)	8 (0.8)	29 (1.7)
France	1 (0.2)	11 (0.8)	37 (1.5)
Cyprus	1 (0.2)	7 (0.5)	26 (0.9)
Portugal	1 (0.1)	7 (0.6)	28 (1.2)
Iran, Islamic Rep.	1 (0.1)	5 (0.6)	24 (1.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	16 (0.9)	33 (1.3)	59 (1.6)
Austria	16 (0.9)	35 (1.2)	64 (1.6)
Belgium (Fr)	1 (0.2)	8 (0.6)	29 (1.4)
Bulgaria	21 (1.4)	40 (2.2)	64 (2.3)
Netherlands	12 (1.1)	35 (2.3)	67 (2.4)
Scotland	9 (1.1)	23 (1.8)	48 (2.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	0 (0.1)	1 (0.2)	8 (0.9)
†1 Germany	11 (1.0)	29 (1.6)	54 (2.1)
Romania	5 (0.6)	16 (1.3)	36 (2.0)
Slovenia	14 (0.9)	34 (1.3)	65 (1.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	2 (0.3)	9 (0.7)	32 (1.3)
Greece	4 (0.4)	14 (0.7)	38 (1.3)
Thailand	4 (0.5)	18 (1.7)	51 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
1 Israel	11 (1.2)	25 (2.3)	51 (2.6)
Kuwait	0 (0.0)	2 (0.4)	11 (1.3)
South Africa	1 (0.2)	1 (0.3)	5 (1.3)



The international levels correspond to the percentiles computed from the combined data from all of the participating countries.

Top 10% Level (90th Percentile) = 655
Top Quarter Level (75th Percentile) = 592
Top Half Level (50th Percentile) = 522

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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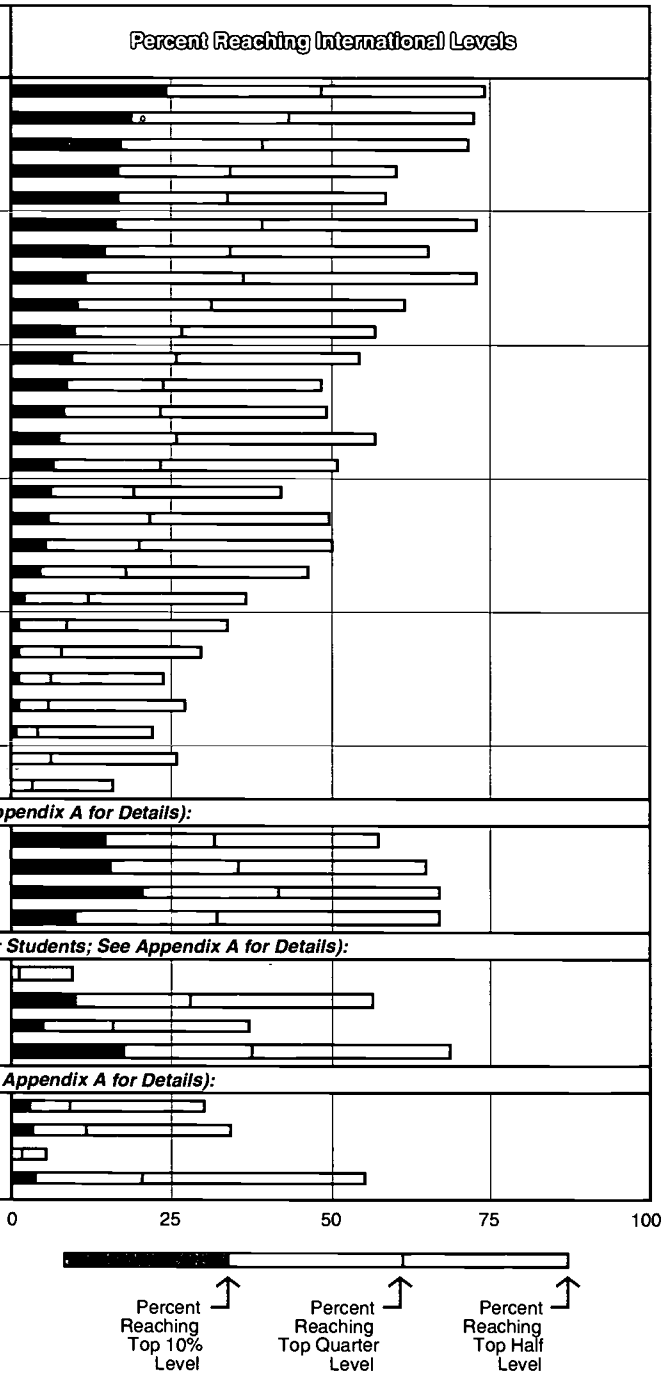
Table 1.5

Percentages of Students Achieving International Marker Levels in the Sciences Lower Grade (Seventh Grade*)

Country	Top 10% Level	Top Quarter Level	Top Half Level
Singapore	24 (2.3)	48 (3.1)	74 (2.3)
Korea	19 (0.8)	43 (1.0)	72 (1.2)
Japan	17 (0.9)	39 (1.0)	72 (0.7)
†2 England	17 (1.4)	34 (1.6)	60 (1.2)
† United States	17 (1.5)	34 (2.2)	58 (2.1)
Czech Republic	16 (1.1)	39 (1.6)	73 (1.4)
Hungary	15 (0.9)	34 (1.4)	65 (1.4)
† Belgium (Fl)	12 (0.8)	36 (1.4)	73 (1.3)
Slovak Republic	10 (0.9)	31 (1.3)	62 (1.4)
Canada	10 (0.6)	27 (1.1)	57 (1.1)
Ireland	9 (0.7)	26 (1.3)	54 (1.7)
Russian Federation	9 (1.1)	24 (1.6)	49 (2.0)
New Zealand	8 (0.8)	23 (1.3)	49 (1.6)
Hong Kong	8 (0.9)	26 (2.0)	57 (2.7)
Sweden	7 (0.5)	24 (1.1)	51 (1.4)
† Scotland	6 (0.6)	19 (1.2)	42 (1.8)
Norway	6 (0.6)	22 (1.2)	50 (1.5)
1 Switzerland	5 (0.4)	20 (0.8)	50 (1.2)
Spain	4 (0.4)	18 (0.8)	46 (1.2)
Iceland	2 (0.3)	12 (1.1)	37 (1.9)
France	1 (0.2)	9 (0.7)	34 (1.4)
† Belgium (Fr)	1 (0.2)	8 (0.8)	30 (1.5)
Cyprus	1 (0.2)	6 (0.4)	24 (0.8)
1 Latvia (LSS)	1 (0.2)	6 (0.6)	27 (1.1)
Portugal	1 (0.1)	4 (0.4)	22 (1.1)
Iran, Islamic Rep.	0 (0.2)	6 (1.4)	26 (1.6)
1 Lithuania	0 (0.1)	3 (0.4)	16 (1.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	15 (0.8)	32 (1.3)	57 (1.4)
Austria	16 (0.8)	36 (1.3)	65 (1.4)
Bulgaria	20 (1.7)	42 (2.3)	67 (2.2)
Netherlands	10 (1.1)	32 (2.0)	67 (2.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	0 (0.0)	1 (0.3)	9 (0.9)
†1 Germany	10 (0.8)	28 (1.6)	57 (1.9)
Romania	5 (0.6)	16 (1.3)	37 (1.8)
Slovenia	17 (0.9)	38 (1.1)	69 (1.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	3 (0.3)	9 (0.7)	30 (1.2)
Greece	3 (0.4)	11 (0.8)	34 (1.2)
† South Africa	0 (0.1)	1 (0.4)	5 (1.1)
Thailand	3 (0.4)	20 (1.4)	55 (1.8)

Percent Reaching International Levels



The international levels correspond to the percentiles computed from the combined data from all of the participating countries.

Top 10% Level (90th Percentile) = 615
Top Quarter Level (75th Percentile) = 553
Top Half Level (50th Percentile) = 483

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Gender Differences in Science Achievement?

Tables 1.6 and 1.7 reveal that boys had significantly higher mean science achievement than girls at both the seventh and eighth grades internationally and in many countries. Each of the two tables, the first one for the eighth grade and the second for the seventh grade, presents mean science achievement separately for boys and girls for each country, as well as the difference between the means. Countries in the upper part of the tables are shown in increasing order of this gender difference. The visual representation of the gender difference for each country, shown by a bar, indicates the amount of the difference, whether the direction of the difference favored girls or boys, and whether or not the difference is statistically significant (indicated by a darkened bar).

In the eighth grade, statistically significant differences favoring boys ranged from 12 points in Canada to 33 points in Israel, with boys averaging 20 or more points higher than girls in 12 countries. For most of these countries, and many others, the seventh-grade gender differences were somewhat smaller. In only seven countries were there no statistically significant differences in science achievement between boys and girls in both grades – Cyprus, the United States, Singapore, Australia, Romania, Thailand, and South Africa. This finding of a pervasive difference favoring boys in science is substantially more pronounced than in the TIMSS mathematics results for seventh and eighth grades, which indicate an international pattern of gender differences favoring males but show few significant differences for individual countries.[10] The TIMSS findings, however, are very consistent with the results from the second IEA science study conducted in 1983-84. For 14-year-olds (or students in the grade with the most 14-year-olds) that study found standard score differences favoring boys in all 23 of the participating countries.[11]

[10] Beaton, A.E., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1996). *Mathematics Achievement in the Middle School Years: The IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

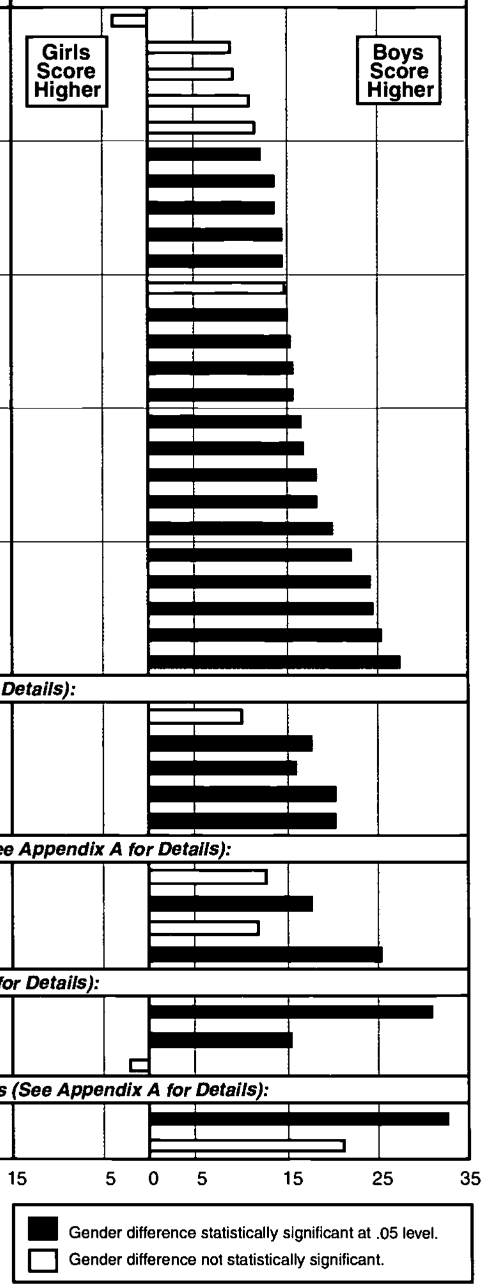
[11] Postlethwaite, T.N. and Wiley, D.E. (1992). *The IEA Study of Science II: Science Achievement in Twenty-Three Countries.* New York, NY: Pergamon Press.

Table 1.6

Gender Differences in Achievement in the Sciences - Upper Grade (Eighth Grade*)

Country	Boys' Mean	Girls' Mean	Difference (Absolute Value)
Cyprus	461 (2.2)	465 (2.7)	4 (3.4)
† United States	539 (4.9)	530 (5.2)	9 (7.2)
Singapore	612 (6.7)	603 (7.0)	9 (9.7)
Russian Federation	544 (4.9)	533 (3.7)	11 (6.2)
Ireland	544 (6.6)	532 (5.2)	12 (8.4)
Canada	537 (3.1)	525 (3.7)	12 (4.8)
Norway	534 (3.2)	520 (2.0)	14 (3.8)
[1] Lithuania	484 (3.8)	470 (4.0)	14 (5.5)
Sweden	543 (3.4)	528 (3.4)	15 (4.8)
[1] Latvia (LSS)	492 (3.3)	478 (3.2)	15 (4.6)
† Belgium (Fl)	558 (6.0)	543 (5.8)	15 (8.4)
[1] Switzerland	529 (3.2)	514 (3.0)	15 (4.4)
Slovak Republic	552 (3.5)	537 (3.9)	15 (5.2)
Iceland	501 (5.1)	486 (4.6)	16 (6.9)
France	506 (2.7)	490 (3.3)	16 (4.3)
Japan	579 (2.4)	562 (2.0)	17 (3.1)
Iran, Islamic Rep.	477 (3.8)	461 (3.2)	17 (4.9)
Spain	526 (2.1)	508 (2.3)	18 (3.1)
Hungary	563 (3.1)	545 (3.4)	18 (4.7)
†[2] England	562 (5.6)	542 (4.2)	20 (7.1)
Portugal	490 (2.8)	468 (2.7)	22 (3.9)
Czech Republic	586 (4.2)	562 (5.8)	24 (7.2)
Korea	576 (2.7)	551 (2.3)	24 (3.6)
New Zealand	538 (5.4)	512 (5.2)	25 (7.6)
Hong Kong	535 (5.5)	507 (5.1)	27 (7.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	550 (5.2)	540 (4.1)	10 (6.6)
Austria	566 (4.0)	549 (4.6)	18 (6.1)
Belgium (Fr)	479 (4.8)	463 (2.9)	16 (5.6)
Netherlands	570 (6.4)	550 (4.9)	20 (8.1)
Scotland	527 (6.4)	507 (4.7)	20 (7.9)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	418 (7.3)	405 (4.6)	13 (8.6)
†[1] Germany	542 (5.9)	524 (4.9)	18 (7.6)
Romania	492 (5.3)	480 (5.0)	12 (7.3)
Slovenia	573 (3.2)	548 (3.2)	25 (4.5)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	494 (3.6)	463 (3.9)	31 (5.3)
Greece	505 (2.6)	489 (3.1)	16 (4.0)
Thailand	524 (3.9)	526 (4.3)	2 (5.8)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
[1] Israel	545 (6.4)	512 (6.1)	33 (8.9)
South Africa	337 (9.5)	315 (6.0)	21 (11.3)

Gender Difference



International Averages		
Boys	Girls	Difference
525	509	17

(Averages of all country means)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

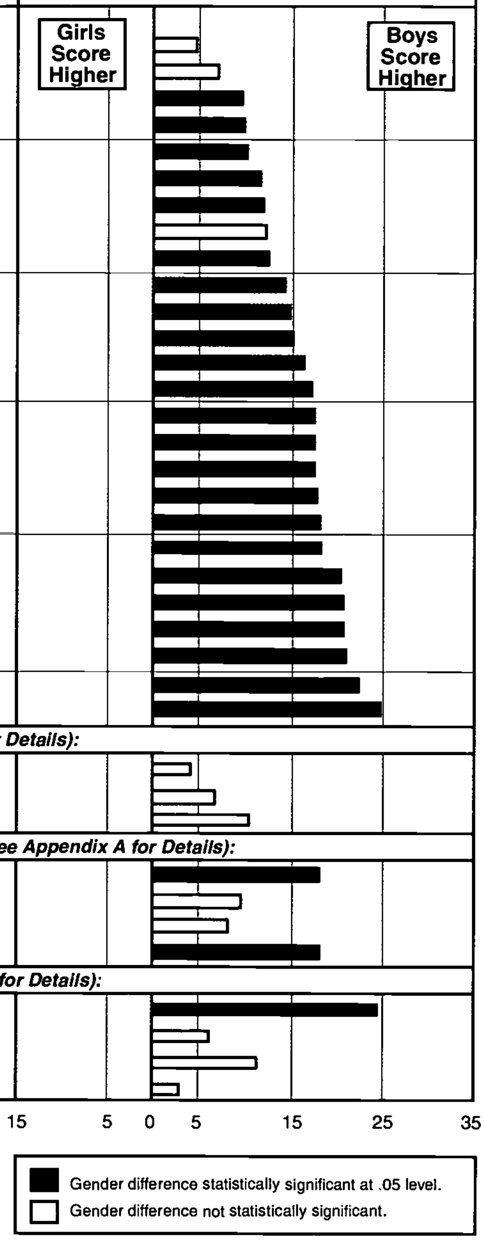
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 1.7

Gender Differences in Achievement in the Sciences - Lower Grade (Seventh Grade*)

Country	Boys' Mean	Girls' Mean	Difference (Absolute Value)
Cyprus	420 (2.8)	420 (2.6)	0 (3.9)
[1] Lithuania	405 (3.5)	401 (4.2)	5 (5.5)
Singapore	548 (7.9)	541 (8.2)	7 (11.4)
[1] Latvia (LSS)	440 (3.6)	430 (3.0)	9 (4.7)
Sweden	493 (2.9)	484 (3.3)	10 (4.4)
Japan	536 (2.6)	526 (1.9)	10 (3.2)
Norway	489 (3.6)	477 (3.6)	12 (5.1)
Iceland	468 (4.4)	456 (2.4)	12 (5.0)
† United States	514 (6.3)	502 (5.8)	12 (8.6)
Canada	505 (2.9)	493 (2.5)	12 (3.8)
† Belgium (Fl)	536 (3.3)	521 (3.1)	14 (4.5)
Hungary	525 (3.9)	510 (3.4)	15 (5.1)
Iran, Islamic Rep.	443 (2.9)	428 (4.1)	15 (5.0)
Portugal	436 (2.4)	420 (2.4)	16 (3.4)
Ireland	504 (4.6)	487 (4.5)	17 (6.4)
New Zealand	489 (4.3)	472 (3.7)	17 (5.7)
Russian Federation	493 (5.3)	475 (3.8)	17 (6.5)
[1] Switzerland	492 (2.9)	475 (2.9)	18 (4.1)
† Scotland	477 (4.4)	459 (4.1)	18 (6.0)
France	461 (3.1)	443 (3.0)	18 (4.3)
Hong Kong	503 (6.6)	485 (5.8)	18 (8.7)
Czech Republic	543 (3.2)	523 (4.1)	20 (5.2)
† Belgium (Fr)	453 (3.6)	432 (3.5)	21 (5.0)
Spain	487 (2.9)	467 (2.3)	21 (3.7)
Slovak Republic	520 (4.0)	499 (3.1)	21 (5.1)
†[2] England	522 (5.6)	500 (4.6)	22 (7.3)
Korea	545 (2.8)	521 (3.2)	25 (4.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	507 (5.2)	502 (4.0)	4 (6.6)
Austria	522 (4.3)	516 (4.1)	7 (6.0)
Netherlands	523 (4.0)	512 (4.4)	11 (5.9)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	396 (3.8)	378 (4.4)	18 (5.8)
†[1] Germany	505 (4.9)	495 (4.5)	10 (6.6)
Romania	456 (4.7)	448 (4.9)	8 (6.7)
Slovenia	539 (3.0)	521 (2.8)	18 (4.1)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	452 (3.0)	427 (2.8)	25 (4.1)
Greece	452 (3.2)	446 (2.8)	6 (4.2)
† South Africa	324 (6.4)	312 (5.2)	11 (8.3)
Thailand	495 (3.3)	492 (3.5)	3 (4.8)

Gender Difference



International Averages		
Boys	Girls	Difference
485	471	14
(Averages of all country means)		

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are the Differences in Median Performance at Age 13?

Testing the two adjacent grades with the most 13-year-olds provides the opportunity to compare achievement on the basis of age. For countries where the two grades tested contained at least 75% of the 13-year-olds, TIMSS estimated the median performance for this age group. Table 1.8 provides the estimated medians as well as the estimated distributions of 13-year-olds across grades.[12] For many countries, the two grades tested included practically all of their 13-year-olds (nine countries have at least 98%), whereas, for some others, there were substantial percentages outside these grades, mostly in the grade below.[13] For countries included in Table 1.8, Hong Kong, French-speaking Belgium, Hungary, France, Ireland, Latvia (LSS), Spain, Lithuania, Portugal, Austria, Romania, and Thailand had 10% or more of their 13-year-olds below the two grades tested.

The median is the point on the science scale that divides the higher-performing 50% of the students from the lower-performing 50%. Like the mean, the median provides a useful summary statistic on which to compare performance across countries. It is used instead of the mean in this table because it can be reliably estimated even when scores from some members of the population are not available[14] (that is, those 13-year-olds outside the tested grades).

Notwithstanding the additional difficulties in obtaining the achievement estimates for the age-based samples, the results for 13-year-olds appear quite consistent with those obtained for the two grade levels. The relative performance of countries in science achievement on the basis of median performance of 13-year-olds was quite similar to that based on average eighth-grade and/or seventh-grade performance, although there are a few exceptions. For example, the Czech Republic and Ireland did relatively less well among 13-year-olds compared to eighth-grade students. In general, however, the higher-performing countries in the eighth and seventh grades generally were those with higher-performing 13-year-olds.

[12] For information about the distribution of 13-year-olds in all countries, not just those with 75% coverage, see Table A.3 in Appendix A.

[13] The number of 13-year-olds below the lower grade and above the upper grade tested were extrapolated from the distribution of 13-year-olds in the tested grades.

[14] Because TIMSS sampled students in the two adjacent grades with the most 13-year-olds within a country, it was possible to estimate the median for the 13-year-old students when the two tested grades included at least an estimated 75% of the 13-year-olds in that country. To compute the median, TIMSS assumed that those 13-year-old students in the grades below the tested grades would score below the median and those in the grades above the tested grades would score above the median. The percentages assumed to be above and below the median were added to the tails of the distribution before calculating the median using the modified distribution.

Table 1.8

Median Achievement in the Sciences - 13-Year-Old Students
Includes Only Countries Where the Grades Tested Contained at Least 75% of the 13-Year-Olds

Country	Median	Lower Grade	Upper Grade	Estimated Distribution of 13-Year-Olds: Percent Below Lower Grade*	Percentage of 13-Year-Old Students Tested: Percent in Lower Grade	Percentage of 13-Year-Old Students Tested: Percent in Upper Grade	Percent Above Upper Grade*
Singapore	555 (6.8)	Secondary 1	Secondary 2	3.1%	82.2%	14.7%	0.0%
Korea	546 (2.3)	1st Grade Middle School	2nd Grade Middle School	1.5%	69.9%	28.2%	0.4%
† Belgium (Fl)	539 (2.4)	1A	2A & 2P	5.4%	45.6%	48.8%	0.2%
Japan	535 (3.0)	1st Grade Lower Secondary	2nd Grade Lower Secondary	0.3%	90.9%	8.8%	0.0%
Czech Republic	530 (3.4)	7	8	9.6%	73.3%	17.1%	0.0%
†2 England	529 (4.2)	Year 8	Year 9	0.6%	57.2%	41.7%	0.5%
Hungary	521 (3.4)	7	8	10.5%	65.1%	24.2%	20.0%
Slovak Republic	513 (3.9)	7	8	4.7%	73.2%	22.1%	0.0%
Canada	511 (4.1)	7	8	8.1%	48.4%	42.9%	0.6%
Sweden	511 (2.8)	6	7	0.8%	44.9%	54.1%	0.1%
† United States	510 (5.1)	7	8	9.0%	57.8%	33.1%	0.2%
Norway	506 (2.9)	6	7	0.3%	42.5%	57.0%	0.2%
† Scotland	504 (4.2)	Secondary 1	Secondary 2	0.3%	24.0%	75.3%	0.5%
Russian Federation	503 (4.2)	7	8	4.5%	50.4%	44.3%	0.7%
Hong Kong	501 (4.9)	Secondary 1	Secondary 2	10.0%	44.2%	45.6%	0.2%
New Zealand	497 (4.6)	Form 2	Form 3	0.5%	51.7%	47.4%	0.4%
1 Switzerland	495 (2.2)	6 or 7	7 or 8	8.3%	47.6%	43.9%	0.2%
Iceland	489 (3.4)	7	8	0.2%	16.5%	83.0%	0.4%
Ireland	486 (3.1)	1st Year	2nd Year	14.1%	69.0%	16.8%	0.2%
Spain	483 (3.1)	7 EGB	8 EGB	14.9%	45.8%	39.0%	0.3%
France	455 (3.7)	5ème	4ème (90%) or 4ème Technologique (10%)	20.5%	43.5%	34.7%	1.3%
† Belgium (Fr)	452 (3.9)	1A	2A & 2P	13.3%	40.6%	46.0%	0.2%
Cyprus	450 (2.9)	7	8	1.7%	27.7%	69.9%	0.7%
1 Latvia (LSS)	436 (3.7)	7	8	14.3%	59.5%	26.0%	0.2%
Portugal	423 (3.4)	Grade 7	Grade 8	23.5%	44.1%	32.1%	0.3%
1 Lithuania	413 (3.4)	7	8	10.1%	64.1%	25.6%	0.2%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix for Details):							
Australia	509 (3.9)	7 or 8	8 or 9	7.5%	63.6%	28.4%	0.5%
Austria	526 (3.4)	3. Klasse	4. Klasse	10.7%	62.4%	26.9%	0.0%
Bulgaria	543 (4.8)	7	8	3.2%	58.1%	36.9%	1.8%
Netherlands	522 (3.8)	Secondary 1	Secondary 2	9.8%	58.7%	31.2%	0.4%
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix for Details):							
Romania	414 (4.5)	7	8	23.9%	66.6%	9.3%	0.3%
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix for Details):							
Denmark	466 (2.8)	6	7	1.0%	34.6%	63.5%	0.9%
Greece	490 (2.9)	Secondary 1	Secondary 2	3.1%	11.2%	84.5%	1.2%
Thailand	485 (3.4)	Secondary 1	Secondary 2	18.0%	58.4%	19.6%	4.0%

*Data are extrapolated; students below the lower grade and above the upper grade were not included in the sample. Denmark, Sweden and Switzerland tested 3 grades.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1 National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2 National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Chapter 2

Average Achievement in the Science Content Areas

Recognizing that curricular differences exist between and within countries is an important aspect of IEA studies, and TIMSS attempted to measure achievement in different areas within the sciences that would be useful in relating achievement to curriculum. After much deliberation, the science test for the seventh and eighth grades was designed to enable reporting by five content areas in accordance with the TIMSS science framework.[1] These five content areas include:

- earth science
- life science
- physics
- chemistry
- environmental issues and the nature of science

Following the discussion in this chapter about differences in average achievement for the TIMSS countries across these content areas, Chapter 3 contains further information about the types of science items, including a range of four to six example items within each content area and the percent of correct responses on those items for each of the TIMSS countries.

How Does Achievement Differ Across Science Content Areas?

The results reported in Chapter 1 revealed substantial achievement differences among the participating countries on the TIMSS science test. This chapter examines the question of whether or not the participating countries achieved at the same level in each of the various content areas as they did on the science test as a whole.

Results in this chapter are based on the average percent of correct responses to items within each content area. Because of the additional resources and time that would have been required to use the more complex IRT scaling methodology that served as the basis for the overall achievement estimates in Chapter 1, TIMSS could not generate scale scores for the five content areas for this report.[2]

Tables 2.1 and 2.2 provide the average percent of correct responses to items in the different content areas for the eighth- and seventh-grade students, respectively. The countries are listed in order of their average percent correct across all items in the test. As indicated by the numbers of items overall and in each content area, the overall test contains the most items in life science and physics (both 30%) and the fewest

[1] Please see the test development section of Appendix A for more information about the process used to develop the TIMSS tests. Appendix B provides an analysis of the match between the test and curriculum in the different TIMSS countries and the effect of this match on the TIMSS results.

[2] TIMSS plans to generate IRT scale scores for the science content areas for future reports.

items in the category of environmental issues and the nature of science (10%). Thus, countries who performed very well in life science and physics were more likely to have higher scores overall.[3]

The results for the average percent correct across all science items are presented for each country primarily to provide a basis of comparison for performance in each of the content areas. For the purpose of comparing overall achievement between countries, it is preferable to use the results presented in Chapter 1.[4] It is interesting to note, however, that even though the relative standings of countries differ somewhat from Tables 1.1 and 1.2, the slight differences are well within the limits expected by sampling error and can be attributed to the differences in the methodologies used.

The data in each column show each country's average percent correct for items in that content area and the international average across all countries for the content area (shown as the last entry in the column). Looking down each of the columns, in turn, two findings become apparent. First, the countries that did well on the overall test generally did well in each of the various content areas, and those that did poorly overall also tended to do so in each of the content areas. There are differences between the relative standing of countries within each of the content areas and their overall standing, but these differences are small when sampling error is considered.

Second, the international averages show that the different content areas in the TIMSS test were not equally difficult for the students taking the test. The life science content area was the least difficult for both grades. On average, the items in this content area were answered correctly by 59% of the eighth-graders and 53% of the seventh-graders across countries. Internationally, the chemistry items (international averages of 51% at eighth grade, 43% at seventh grade) were the most difficult items for the students at both grades.

It is important to keep these differences in average difficulty in mind when reading across the rows of the table. These differences mean that for many countries, students will appear to have higher than average performance in life science and lower than average performance in chemistry. For example, even though the eighth-grade students in Japan performed above the international average in chemistry, they still performed less well in this area than they did on the test as a whole. That is, simply comparing performance across the rows gives an unclear picture of each country's relative performance across the content areas because the varying difficulty level of the items in each area has not been taken into account.

To facilitate more meaningful comparisons across rows, TIMSS has developed profiles of relative performance, which are shown for both grades in Table 2.3. These profiles are designed to show whether participating countries performed better or worse in some

[3] Table A.1 in Appendix A provides details about the distributions of items across the content areas, by format and score points (taking into account multi-part items and items scored for partial credit).

[4] The IRT scale scores provide better estimates of overall achievement, because they take the difficulty of items into account. This is important in a study such as TIMSS, where different students take overlapping but somewhat different sets of items.

Table 2.1

Average Percent Correct by Science Content Areas
Upper Grade (Eighth Grade*)

Country	Science Overall (135 items)	Earth Science (22 items)	Life Science (40 items)	Physics (40 items)	Chemistry (19 items)	Environmental Issues and the Nature of Science (14 items)
Singapore	70 (1.0)	65 (1.1)	72 (1.0)	69 (0.8)	69 (1.2)	74 (1.1)
Korea	66 (0.3)	63 (0.5)	70 (0.4)	65 (0.5)	63 (0.6)	64 (0.8)
Japan	65 (0.3)	61 (0.4)	71 (0.4)	67 (0.3)	61 (0.5)	60 (0.7)
Czech Republic	64 (0.8)	63 (1.2)	69 (0.8)	64 (0.7)	60 (1.2)	59 (1.1)
†2 England	61 (0.6)	59 (0.8)	64 (0.8)	62 (0.6)	55 (0.8)	65 (1.0)
Hungary	61 (0.6)	60 (0.8)	65 (0.7)	60 (0.6)	60 (0.8)	53 (0.8)
† Belgium (Fl)	60 (1.1)	62 (1.2)	64 (1.1)	61 (1.1)	51 (1.3)	58 (1.5)
Slovak Republic	59 (0.6)	60 (0.7)	60 (0.6)	61 (0.6)	57 (0.8)	53 (0.9)
Sweden	59 (0.6)	62 (0.7)	63 (0.7)	57 (0.5)	56 (0.7)	52 (0.8)
Canada	59 (0.5)	58 (0.6)	62 (0.6)	59 (0.4)	52 (0.7)	61 (0.7)
Ireland	58 (0.9)	61 (1.0)	60 (1.1)	56 (0.8)	54 (1.0)	60 (1.1)
† United States	58 (1.0)	58 (1.0)	63 (1.1)	56 (0.8)	53 (1.2)	61 (1.0)
Russian Federation	58 (0.8)	58 (0.8)	62 (0.7)	57 (0.9)	57 (1.3)	50 (0.8)
New Zealand	58 (0.8)	56 (0.9)	60 (1.0)	58 (0.7)	53 (1.1)	59 (1.2)
Norway	58 (0.4)	61 (0.6)	61 (0.5)	57 (0.4)	49 (0.6)	55 (0.8)
Hong Kong	58 (1.0)	54 (1.0)	61 (1.0)	58 (0.9)	55 (1.0)	55 (1.3)
1 Switzerland	56 (0.5)	58 (0.6)	59 (0.6)	58 (0.5)	50 (0.7)	51 (0.8)
Spain	56 (0.4)	57 (0.5)	58 (0.5)	55 (0.4)	51 (0.7)	53 (0.6)
France	54 (0.6)	55 (0.8)	56 (0.8)	54 (0.5)	47 (0.9)	53 (0.9)
Iceland	52 (0.9)	50 (1.2)	58 (1.0)	53 (0.9)	42 (0.8)	49 (1.0)
1 Latvia (LSS)	50 (0.6)	48 (0.8)	53 (0.7)	51 (0.7)	48 (0.8)	47 (1.0)
Portugal	50 (0.6)	50 (0.7)	53 (0.6)	48 (0.5)	50 (0.9)	45 (0.8)
1 Lithuania	49 (0.7)	46 (0.9)	52 (0.9)	51 (0.7)	48 (0.9)	40 (1.0)
Iran, Islamic Rep.	47 (0.6)	45 (0.6)	49 (0.6)	48 (0.7)	52 (0.8)	39 (1.1)
Cyprus	47 (0.4)	46 (0.6)	49 (0.5)	46 (0.4)	45 (0.6)	46 (0.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	60 (0.7)	57 (0.8)	63 (0.8)	60 (0.7)	54 (0.9)	62 (1.0)
Austria	61 (0.7)	62 (0.8)	65 (0.7)	62 (0.7)	58 (1.1)	55 (0.9)
Belgium (Fr)	50 (0.7)	50 (0.9)	55 (0.9)	51 (0.7)	41 (0.8)	46 (1.0)
Bulgaria	62 (1.0)	58 (1.2)	64 (1.0)	60 (1.0)	65 (1.7)	59 (1.5)
Netherlands	62 (1.0)	61 (1.4)	67 (1.4)	63 (0.9)	52 (0.9)	65 (1.6)
Scotland	55 (1.0)	52 (1.0)	57 (1.1)	57 (0.8)	51 (1.3)	57 (1.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	39 (0.8)	37 (0.8)	44 (0.9)	37 (0.8)	32 (1.0)	40 (1.1)
†1 Germany	58 (1.0)	57 (1.0)	63 (1.1)	57 (1.0)	54 (1.3)	51 (1.3)
Romania	50 (0.8)	49 (1.0)	55 (1.0)	49 (0.8)	46 (1.0)	42 (1.0)
Slovenia	62 (0.5)	64 (0.7)	65 (0.6)	61 (0.6)	56 (0.9)	59 (0.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	51 (0.6)	49 (0.7)	56 (0.7)	53 (0.7)	41 (0.8)	47 (1.0)
Greece	52 (0.5)	49 (0.6)	54 (0.6)	53 (0.5)	51 (0.5)	51 (1.0)
Thailand	57 (0.9)	56 (1.0)	66 (0.9)	54 (0.7)	43 (1.2)	62 (1.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	57 (1.1)	55 (1.1)	61 (1.1)	57 (1.1)	53 (1.5)	52 (1.6)
Kuwait	43 (0.9)	43 (1.0)	45 (1.1)	43 (0.7)	40 (1.5)	39 (1.3)
South Africa	27 (1.3)	26 (1.1)	27 (1.3)	27 (1.4)	26 (1.4)	26 (1.3)
International Average Percent Correct	56 (0.1)	55 (0.1)	59 (0.1)	55 (0.1)	51 (0.2)	53 (0.2)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 2.2

Average Percent Correct by Science Content Areas
Lower Grade (Seventh Grade*)

Country	Science Overall (135 items)	Earth Science (22 items)	Life Science (40 items)	Physics (40 items)	Chemistry (19 items)	Environmental Issues and the Nature of Science (14 items)
Singapore	61 (1.2)	60 (1.2)	62 (1.4)	63 (1.0)	57 (1.3)	62 (1.4)
Korea	61 (0.4)	59 (0.6)	65 (0.5)	63 (0.5)	54 (0.6)	61 (0.7)
Japan	59 (0.3)	56 (0.5)	64 (0.4)	63 (0.4)	49 (0.5)	53 (0.6)
Czech Republic	58 (0.8)	57 (0.9)	63 (0.7)	58 (0.7)	54 (1.1)	54 (1.1)
† Belgium (Fl)	57 (0.5)	60 (0.7)	61 (0.7)	58 (0.6)	46 (0.7)	54 (0.9)
†2 England	56 (0.6)	56 (0.8)	57 (0.7)	58 (0.7)	48 (1.0)	56 (0.9)
Hungary	56 (0.6)	54 (0.7)	61 (0.7)	54 (0.6)	54 (0.8)	48 (1.0)
Slovak Republic	54 (0.6)	55 (0.8)	56 (0.7)	55 (0.6)	50 (0.8)	50 (0.8)
† United States	54 (1.1)	54 (1.1)	59 (1.1)	51 (1.0)	48 (1.1)	56 (1.5)
Canada	54 (0.5)	53 (0.7)	57 (0.6)	54 (0.5)	46 (0.7)	56 (0.7)
Hong Kong	53 (1.2)	49 (1.1)	56 (1.2)	55 (1.1)	49 (1.3)	51 (1.6)
Ireland	52 (0.7)	56 (0.8)	52 (0.8)	51 (0.7)	47 (0.9)	54 (0.9)
Sweden	51 (0.5)	53 (0.6)	56 (0.7)	51 (0.6)	45 (0.7)	46 (0.8)
New Zealand	50 (0.7)	49 (0.7)	53 (0.8)	51 (0.7)	42 (0.8)	53 (1.1)
Norway	50 (0.6)	52 (0.8)	55 (0.7)	51 (0.7)	40 (0.8)	48 (0.9)
1 Switzerland	50 (0.4)	52 (0.6)	53 (0.5)	52 (0.5)	41 (0.5)	46 (0.7)
Russian Federation	50 (0.8)	54 (0.7)	54 (1.0)	50 (0.9)	42 (0.9)	43 (0.8)
Spain	49 (0.4)	52 (0.6)	53 (0.5)	48 (0.5)	43 (0.7)	47 (0.7)
† Scotland	48 (0.8)	46 (0.7)	49 (0.9)	51 (0.7)	41 (1.1)	50 (1.1)
Iceland	46 (0.6)	45 (0.7)	51 (0.6)	49 (0.8)	36 (1.0)	42 (1.1)
France	46 (0.6)	45 (0.7)	50 (0.7)	48 (0.6)	38 (0.7)	44 (1.0)
† Belgium (Fr)	45 (0.7)	46 (0.9)	49 (0.8)	46 (0.8)	37 (0.7)	40 (0.9)
Iran, Islamic Rep.	42 (0.6)	41 (0.8)	45 (0.8)	41 (0.7)	46 (0.9)	33 (1.0)
1 Latvia (LSS)	42 (0.5)	42 (0.7)	45 (0.6)	43 (0.6)	34 (0.8)	38 (0.9)
Portugal	41 (0.5)	46 (0.7)	46 (0.6)	39 (0.5)	34 (0.6)	37 (0.7)
Cyprus	40 (0.4)	39 (0.7)	42 (0.5)	39 (0.4)	38 (0.6)	40 (0.7)
1 Lithuania	38 (0.7)	39 (0.9)	40 (0.8)	40 (0.7)	28 (0.9)	32 (0.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	54 (0.7)	52 (0.7)	56 (0.7)	55 (0.7)	46 (0.7)	56 (0.9)
Austria	55 (0.6)	55 (0.8)	60 (0.8)	55 (0.7)	51 (0.7)	49 (1.0)
Bulgaria	56 (1.0)	53 (1.0)	60 (1.1)	57 (1.2)	56 (1.3)	49 (1.3)
Netherlands	56 (0.7)	56 (0.9)	61 (0.8)	55 (0.8)	44 (0.8)	58 (1.3)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	35 (0.7)	33 (0.8)	39 (0.8)	34 (0.8)	29 (0.7)	36 (0.8)
†1 Germany	53 (0.8)	52 (0.9)	58 (0.9)	53 (0.8)	47 (1.0)	46 (1.2)
Romania	45 (0.7)	44 (1.0)	51 (0.9)	44 (0.8)	41 (0.9)	37 (0.8)
Slovenia	57 (0.5)	59 (0.6)	60 (0.6)	55 (0.6)	55 (0.9)	55 (0.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	44 (0.4)	42 (0.7)	49 (0.6)	47 (0.6)	34 (0.6)	39 (0.9)
Greece	45 (0.5)	43 (0.6)	48 (0.7)	44 (0.5)	41 (0.7)	43 (0.8)
† South Africa	26 (1.0)	26 (1.0)	26 (1.1)	26 (1.0)	23 (0.9)	25 (1.1)
Thailand	53 (0.8)	50 (0.8)	62 (0.9)	50 (0.7)	38 (0.8)	57 (1.1)
International Average Percent Correct	50 (0.1)	50 (0.1)	53 (0.1)	50 (0.1)	43 (0.1)	47 (0.2)

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

content areas than they did on the test as a whole, after adjusting for the differing difficulty of the items in each of the content areas.[5] An up-arrow indicates that a country did significantly better in a content area than it did on the test as a whole, a down-arrow indicates significantly lower performance, and a circle indicates that the country's performance in a content area is not very different from its performance on the test as a whole.[6]

Table 2.3 reveals that many countries performed relatively better or worse in some content areas than they did overall. In fact, each country except Latvia, Israel, and Kuwait in the eighth grade and Belgium (French) in the seventh grade had at least one content area in which it did relatively better or worse than it did on the test as a whole. Although countries that did well in one content area tended to do well in others, there were still significant performance differences by content area among countries. For example, Japan, Hungary, Iceland, Germany, Romania, Denmark, and Thailand all performed relatively better in life science than they did on the test as a whole at both grades. Japan, Switzerland, Iceland, Lithuania, and Denmark performed relatively better in physics at both grades. A quite different set of countries – Hungary, the Slovak Republic, Hong Kong, Iran, Cyprus, and Greece – performed relatively better at both grades in chemistry. This is consistent with the existence of differing curricular patterns and approaches among countries as discussed in the curriculum analysis report, *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.*[7]

[5] Since the items in the different content areas varied in difficulty, the first step was to adjust the average percents to make all content areas equally difficult so that the comparisons would not reflect the various difficulties of the items in the content areas. The next step was to subtract these adjusted percentages for each content area from a country's average percentage over all five content areas. If the overall percentage of correct items by students in a country was the same as the adjusted average for that country for each of the content areas, then these differences would all be zero. The standard errors for these differences were computed, and then each difference was examined for statistical significance. This approach is similar to testing interaction terms in the analysis of variance. The jackknife method was used to compute the standard error of each interaction term. The significance level was adjusted using the Bonferroni method, assuming 5x41 (content areas by countries) comparisons at the eighth grade and 5x39 at the seventh grade.

[6] The statistics are not independent. That is, a country cannot do better (or worse) than its average on all scales, since a country's differences must add up to zero. However, it is possible for a country to have no statistically significant differences in performance.

[7] Schmidt, W.H., Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, The Netherlands: Kluwer Academic Publishers.

Table 2.3

Profiles of Relative Performance in Science Content Areas - Lower and Upper Grades (Seventh and Eighth Grades*) - Indicators of Statistically Significant Differences from Overall Percent Correct Adjusted for the Difficulty of the Content Areas

Seventh Grade: Country	Earth Science	Life Science	Physics	Chemistry	Environmental Issues and the Nature of Science	Eighth Grade: Country	Earth Science	Life Science	Physics	Chemistry	Environmental Issues and the Nature of Science
Singapore	▼	▼	●	●	▲	Singapore	▼	▼	▼	▲	▲
Korea	▼	●	▲	●	▲	Korea	▼	●	●	▲	●
Japan	▼	▲	▲	▼	▼	Japan	▼	▲	▲	●	▼
Czech Republic	●	▲	●	▲	▼	Czech Republic	●	●	●	●	▼
† Belgium (Fl)	▲	●	●	▼	●	†2 England	●	●	●	▼	▲
†2 England	●	▼	●	●	▲	Hungary	●	▲	●	▲	▼
Hungary	●	▲	▼	▲	▼	† Belgium (Fl)	▲	●	●	▼	●
Slovak Republic	●	▼	●	▲	▼	Slovak Republic	●	▼	▲	▲	▼
† United States	●	●	▼	●	▲	Sweden	▲	●	▼	●	▼
Canada	●	●	●	▼	▲	Canada	●	●	●	▼	▲
Hong Kong	▼	●	▲	▲	●	Ireland	▲	▼	▼	●	▲
Ireland	▲	▼	▼	●	▲	† United States	●	●	▼	▼	▲
Sweden	▲	●	●	●	▼	Russian Federation	●	●	●	▲	▼
New Zealand	●	▼	●	▼	▲	New Zealand	▼	●	●	●	▲
Norway	▲	●	●	▼	●	Norway	▲	●	●	▼	●
1 Switzerland	▲	●	▲	▼	●	Hong Kong	▼	●	●	▲	●
Russian Federation	▲	●	●	●	▼	1 Switzerland	▲	●	▲	▼	▼
Spain	▲	●	▼	●	●	Spain	▲	●	●	●	●
† Scotland	▼	▼	▲	●	▲	France	▲	▼	●	▼	●
Iceland	●	▲	▲	▼	●	Iceland	●	▲	▲	▼	●
France	●	●	▲	●	●	1 Latvia (LSS)	●	●	●	●	●
† Belgium (Fr)	●	●	●	●	●	Portugal	●	●	▼	▲	▼
Iran, Islamic Rep.	●	●	●	▲	▼	1 Lithuania	●	●	▲	▲	▼
1 Latvia (LSS)	●	●	▲	●	●	Iran, Islamic Rep.	▼	▼	●	▲	▼
Portugal	▲	●	▼	●	▼	Cyprus	●	▼	▼	▲	●
Cyprus	●	▼	▼	▲	●						
1 Lithuania	▲	●	▲	▼	▼						
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):											
Australia	▼	▼	●	▼	▲	Australia	▼	●	●	▼	▲
Austria	●	●	●	▲	▼	Austria	●	●	●	●	▼
Bulgaria	▼	●	●	▲	▼	Belgium (Fr)	●	▲	▲	▼	●
Netherlands	●	▲	●	▼	▲	Bulgaria	▼	●	▼	▲	●
						Netherlands	●	●	●	▼	▲
						Scotland	▼	▼	●	●	▲
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):											
Colombia	▼	●	●	●	▲	Colombia	●	▲	▼	▼	▲
†1 Germany	●	▲	●	●	▼	†1 Germany	●	▲	●	●	▼
Romania	●	▲	●	▲	▼	Romania	●	▲	●	●	▼
Slovenia	●	●	▼	▲	●	Slovenia	▲	●	●	●	●
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):											
Denmark	●	▲	▲	▼	●	Denmark	●	▲	▲	▼	●
Greece	▼	●	▼	▲	●	Greece	▼	▼	●	▲	●
† South Africa	●	▼	●	▲	●	Thailand	●	▲	▼	▼	▲
Thailand	▼	▲	▼	▼	▲						
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):											
						1 Israel	●	●	●	●	●
						Kuwait	●	●	●	●	●
						South Africa	●	▼	●	▲	●

▲ = Significantly higher than overall average ● = No significant difference from overall average ▼ = Significantly lower than overall average

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

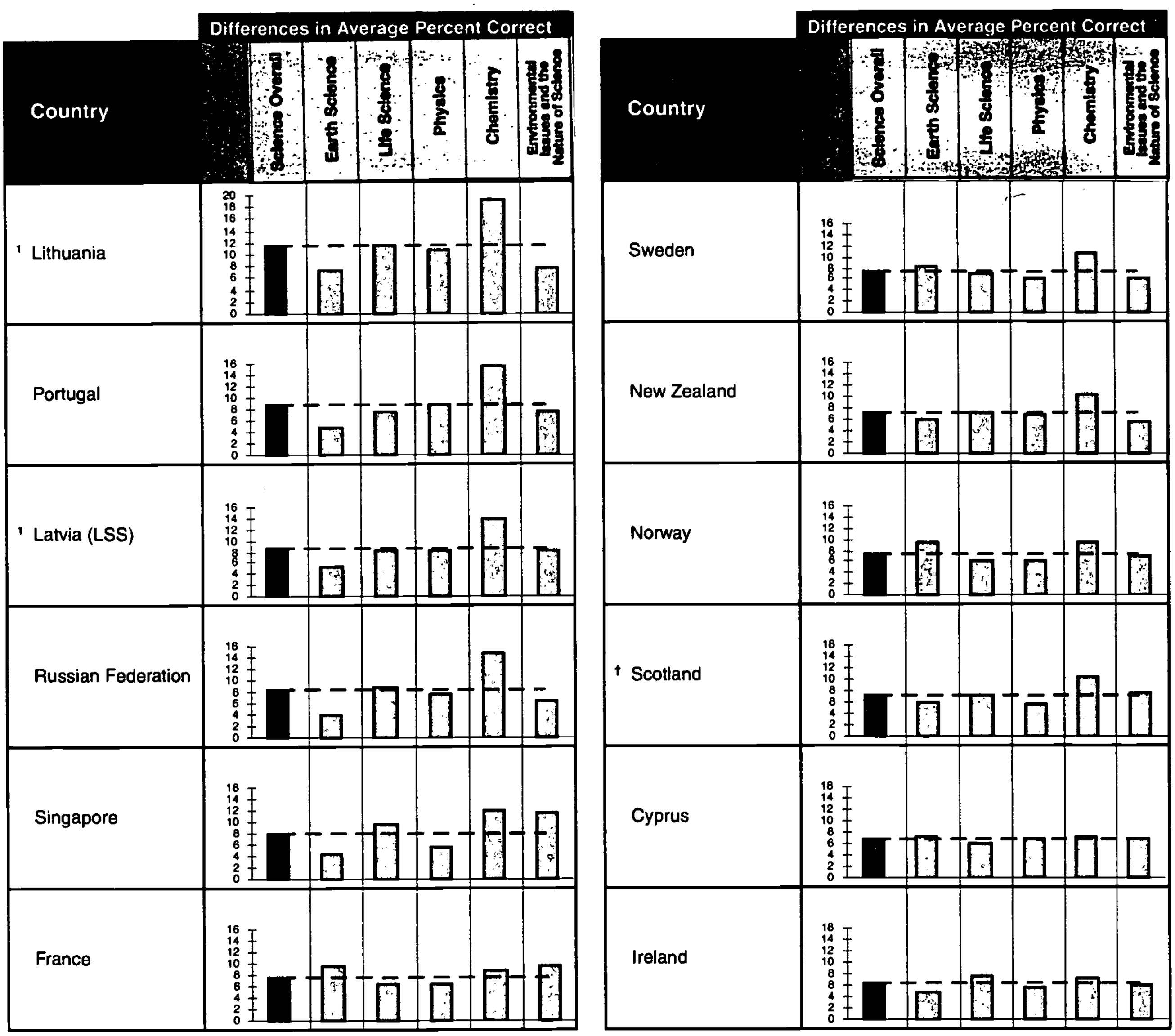
What Are the Increases in Achievement Between the Lower and Upper Grades?

Figure 2.1, which profiles the increases in average percent correct between the seventh and eighth grade for each country across content areas, also reflects these curricular differences. The countries are presented in descending order by the amount of overall increase between the grades, starting with Lithuania, Portugal, Latvia (LSS), and the Russian Federation, all of which had increases of 8% to 11% in overall percentage correct. As an aid in the comparison between the increase for the science test overall and each of the five content areas, a dashed line indicating the overall between-grade increase is shown in each country's profile.

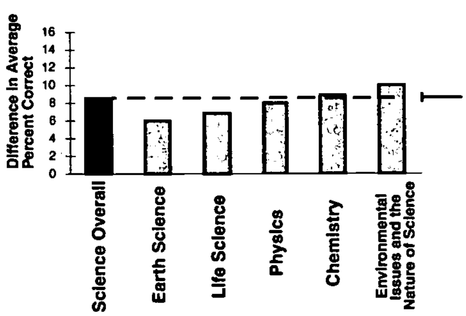
These results show that for the majority of countries, the performance differences between grades vary across content areas, most likely reflecting a greater emphasis in the eighth-grade curriculum on some areas compared to others. There were several countries, however, with moderate between-grade increases that were more comparable across all content areas, including Cyprus, the Czech Republic, Hungary, Canada, the United States, and Denmark, for example. The chemistry content area has the largest increase from seventh to eighth grade for a large number of countries. This is particularly noticeable for Lithuania, Portugal, Latvia (LSS), and the Russian Federation, where large increases between 14% and 20% were observed for chemistry. For most countries, the increases in life science were similar to the overall between-grade increases in science as were the increases for the environmental issues and nature of science items. Several lower increases than overall were observed in earth science and physics, indicating that some countries may place less emphasis on these content areas in the eighth grade.

Figure 2.1

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Science Content Areas



Legend:

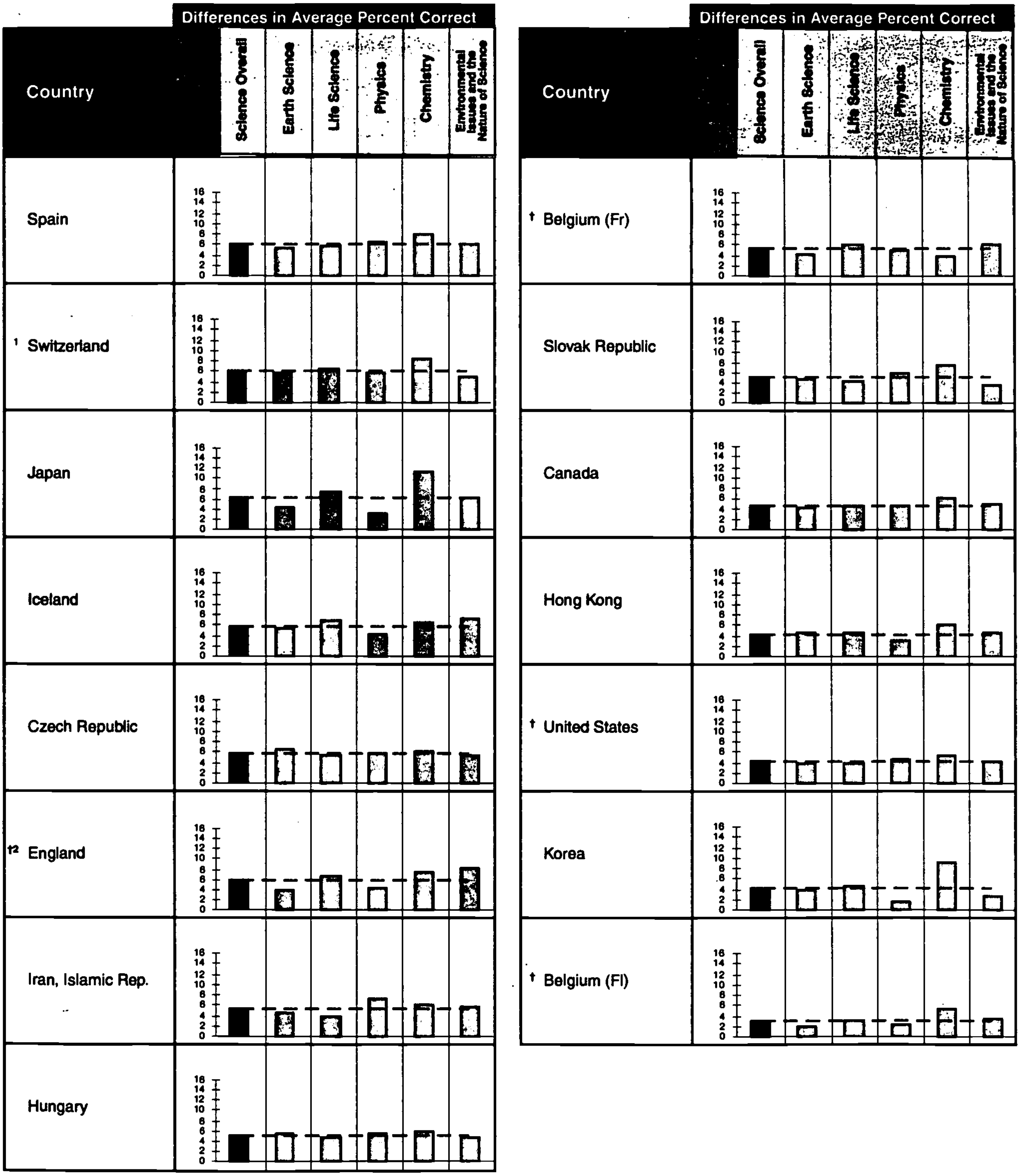


*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
¹National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
²National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 2.1 (Continued-2)

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Science Content Areas



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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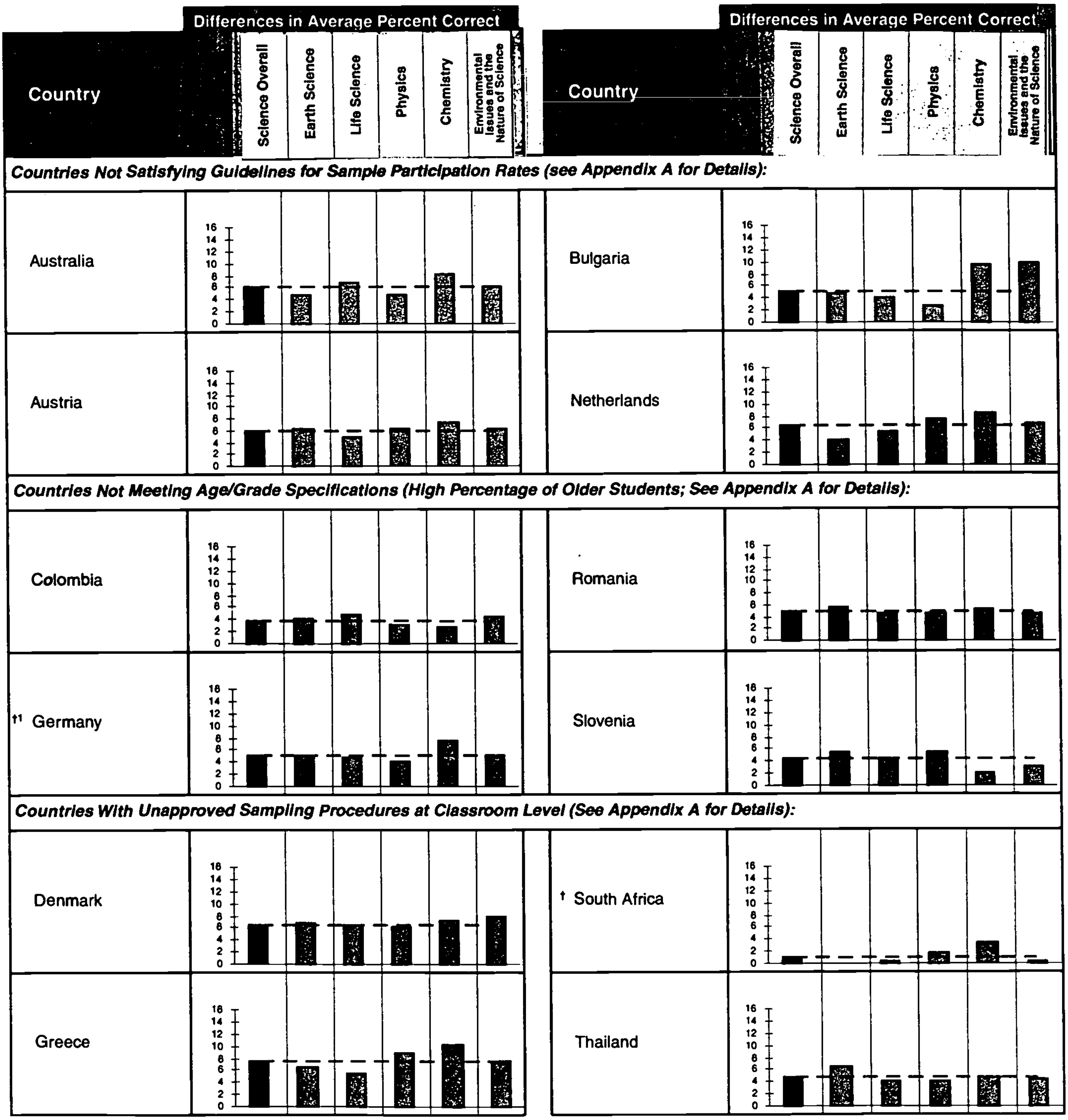
Figure 2.1 (Continued-3)

Difference in Average Percent Correct Between Lower and Upper Grades (Seventh and Eighth Grades*) Overall and in Science Content Areas



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are the Gender Differences in Achievement for the Content Areas?

Tables 2.4 and 2.5 present the gender differences for the science content areas for eighth-grade students and seventh grade-students, respectively. The countries are listed in descending order by overall percent correct. Although these overall differences are comparable to those for the TIMSS science scale discussed in Chapter 1, the reduced number of statistically significant differences reinforces the idea of less precision in the percent-correct metric.

The science content area data reveal that the gender differences vary depending on the science subject. In both the seventh and eighth grades, gender differences in earth science, physics, and chemistry reflected advantages for boys. In earth science, the boys had significantly higher averages than girls in 18 countries at the eighth grade and in 19 countries at the seventh grade. In physics, the corresponding results revealed advantages for boys in 25 and 23 countries. In chemistry, boys out-performed girls in 16 countries at the eighth grade and 20 countries at the seventh grade. For the remaining countries except Thailand, even though the differences were not statistically significant, the direction of the differences favored boys in all three content areas at both grades.

In life science and for the items covering environmental issues and the nature of science, girls and boys had similar performances at both grades. In life science, there were very few gender differences in average performance. In Spain, boys had significantly higher achievement than girls at both grades. Also, seventh-grade boys did better than girls in Korea. However, at the eighth grade, girls did better than boys in Cyprus. For the items in the area of environmental issues and the nature of science, eighth-grade boys had higher achievement than girls in two countries – the Czech Republic and Korea. At the seventh grade, there were no significant differences in average performance for this content area.

IEA's second science study conducted in 1983-84 found similar results for 14-year-olds in the content areas. There were negligible gender differences in biology, larger, but still small differences favoring boys in chemistry and earth science, and moderate to large advantages for boys in physics.[8]

[8] Keeves, J.P. and Kotte, D. (1992). "Disparities Between the Sexes in Science Education: 1970-84" in J.P. Keeves (ed.), *The IEA Study of Science (Vol.) III: Changes in Science Education and Achievement: 1970 to 1984.* New York, NY: Pergamon Press.

Table 2.4

Average Percent Correct for Boys and Girls by Science Content Areas Upper Grade (Eighth Grade*)

Country	Science Overall		Earth Science		Life Science	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	62 (1.7)	59 (1.5)	64 (2.0)	60 (1.5)	64 (1.7)	64 (1.5)
Canada	60 (0.6)	58 (0.6)	59 (0.8)	56 (0.8)	62 (0.8)	63 (0.8)
Cyprus	46 (0.4)	47 (0.6)	47 (0.7)	46 (0.9)	47 (0.6)	▲ 51 (0.7)
Czech Republic	▲ 67 (0.8)	61 (1.1)	66 (1.1)	60 (1.6)	70 (0.9)	67 (1.2)
†2 England	63 (1.0)	60 (0.7)	61 (1.2)	58 (0.9)	65 (1.2)	63 (1.1)
France	▲ 55 (0.7)	52 (0.7)	57 (0.9)	53 (1.0)	57 (0.8)	55 (0.9)
Hong Kong	▲ 60 (1.1)	55 (1.1)	▲ 57 (1.2)	51 (1.1)	63 (1.2)	59 (1.2)
Hungary	▲ 63 (0.7)	59 (0.7)	▲ 62 (1.0)	57 (0.9)	66 (0.8)	65 (0.8)
Iceland	53 (1.2)	51 (0.9)	52 (1.5)	48 (1.3)	58 (1.2)	58 (1.2)
Iran, Islamic Rep.	▲ 49 (0.8)	45 (0.8)	▲ 47 (0.8)	42 (0.9)	50 (0.9)	47 (0.9)
Ireland	60 (1.3)	57 (1.0)	64 (1.4)	59 (1.2)	60 (1.4)	60 (1.3)
Japan	▲ 67 (0.5)	64 (0.4)	▲ 64 (0.5)	58 (0.6)	71 (0.5)	70 (0.5)
Korea	▲ 67 (0.5)	64 (0.5)	▲ 65 (0.7)	60 (0.7)	71 (0.7)	69 (0.7)
1 Latvia (LSS)	▲ 52 (0.8)	48 (0.6)	▲ 51 (1.1)	45 (1.0)	54 (0.9)	52 (0.8)
1 Lithuania	▲ 51 (0.8)	47 (0.8)	▲ 49 (1.1)	44 (1.1)	52 (1.0)	52 (1.0)
New Zealand	60 (1.0)	56 (1.0)	▲ 59 (1.1)	52 (1.1)	61 (1.2)	60 (1.1)
Norway	59 (0.6)	56 (0.4)	▲ 64 (0.8)	59 (0.7)	60 (0.8)	62 (0.6)
Portugal	▲ 52 (0.7)	48 (0.6)	▲ 53 (1.0)	47 (0.8)	55 (0.8)	52 (0.8)
Russian Federation	60 (0.9)	57 (0.7)	61 (0.9)	57 (0.9)	62 (0.9)	63 (0.7)
Singapore	71 (1.2)	69 (1.1)	66 (1.4)	63 (1.3)	72 (1.2)	71 (1.2)
Slovak Republic	▲ 62 (0.6)	57 (0.7)	▲ 62 (0.9)	58 (0.9)	61 (0.7)	59 (0.8)
Spain	▲ 58 (0.5)	54 (0.5)	▲ 59 (0.7)	54 (0.7)	▲ 60 (0.7)	57 (0.6)
Sweden	▲ 60 (0.6)	57 (0.6)	63 (0.8)	60 (0.8)	63 (0.7)	63 (0.8)
1 Switzerland	▲ 58 (0.6)	54 (0.5)	60 (0.9)	56 (0.7)	59 (0.8)	59 (0.7)
† United States	59 (1.0)	57 (1.0)	60 (1.0)	56 (1.1)	63 (1.2)	63 (1.1)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	61 (1.0)	59 (0.8)	59 (1.0)	55 (0.9)	62 (1.0)	64 (0.8)
Austria	63 (0.8)	60 (0.8)	▲ 65 (0.9)	59 (1.0)	65 (0.8)	64 (0.9)
Belgium (Fr)	52 (1.0)	49 (0.7)	52 (1.3)	48 (0.9)	55 (1.1)	55 (1.0)
Netherlands	64 (1.2)	60 (1.1)	64 (1.6)	58 (1.4)	67 (1.4)	66 (1.6)
Scotland	57 (1.2)	53 (0.9)	▲ 56 (1.2)	48 (1.0)	58 (1.3)	55 (1.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	40 (1.4)	37 (0.8)	39 (1.4)	35 (1.1)	45 (1.6)	42 (1.0)
†1 Germany	59 (1.2)	57 (1.0)	58 (1.1)	56 (1.3)	63 (1.3)	63 (1.1)
Romania	51 (0.9)	49 (0.9)	50 (1.1)	48 (1.1)	55 (1.1)	55 (1.1)
Slovenia	▲ 64 (0.6)	59 (0.7)	▲ 67 (0.8)	62 (0.9)	66 (0.7)	63 (0.8)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▲ 54 (0.6)	48 (0.8)	▲ 53 (0.9)	44 (0.9)	57 (0.9)	55 (1.0)
Greece	▲ 54 (0.6)	50 (0.6)	▲ 51 (0.8)	46 (0.7)	55 (0.7)	53 (0.7)
Thailand	57 (0.9)	58 (1.0)	56 (1.2)	56 (1.1)	65 (1.0)	67 (1.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	▲ 61 (1.2)	54 (1.1)	▲ 59 (1.4)	52 (1.3)	63 (1.5)	59 (1.4)
South Africa	28 (1.8)	25 (1.2)	28 (1.6)	24 (1.0)	29 (1.9)	25 (1.3)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Eighth grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.4 (Continued)

Average Percent Correct for Boys and Girls by Science Content Areas Upper Grade (Eighth Grade*)

Country	Physics		Chemistry		Environmental Issues and the Nature of Science	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	63 (1.7)	58 (1.4)	53 (1.6)	50 (1.8)	59 (1.6)	57 (2.3)
Canada	▲ 61 (0.6)	57 (0.5)	53 (0.9)	50 (0.9)	62 (0.8)	60 (1.0)
Cyprus	47 (0.6)	45 (0.7)	45 (0.9)	44 (0.8)	45 (1.0)	47 (0.9)
Czech Republic	▲ 67 (0.8)	60 (0.9)	▲ 64 (1.2)	56 (1.7)	▲ 64 (1.2)	55 (1.6)
†2 England	63 (1.0)	60 (0.8)	57 (1.2)	53 (1.4)	65 (1.6)	64 (1.2)
France	▲ 57 (0.7)	52 (0.7)	49 (1.2)	45 (1.2)	54 (1.3)	53 (1.1)
Hong Kong	▲ 62 (0.9)	54 (1.1)	▲ 57 (1.3)	52 (1.2)	57 (1.6)	53 (1.5)
Hungary	▲ 63 (0.7)	56 (0.8)	▲ 62 (0.9)	58 (1.0)	55 (1.2)	52 (1.1)
Iceland	54 (1.6)	52 (0.9)	43 (1.1)	41 (1.4)	49 (1.8)	48 (1.2)
Iran, Islamic Rep.	▲ 51 (1.0)	44 (0.8)	53 (1.0)	51 (1.1)	40 (1.4)	37 (1.5)
Ireland	▲ 59 (1.3)	54 (1.0)	56 (1.5)	52 (1.2)	60 (1.6)	60 (1.3)
Japan	▲ 68 (0.5)	65 (0.4)	▲ 62 (0.7)	59 (0.6)	61 (0.9)	58 (0.8)
Korea	▲ 67 (0.7)	62 (0.6)	65 (0.8)	61 (0.9)	▲ 66 (1.0)	61 (1.1)
1 Latvia (LSS)	▲ 55 (1.0)	48 (0.7)	50 (1.2)	46 (1.1)	48 (1.3)	46 (1.2)
1 Lithuania	▲ 56 (0.9)	48 (0.7)	50 (1.1)	45 (1.1)	41 (1.4)	38 (1.2)
New Zealand	▲ 60 (0.8)	55 (0.8)	▲ 56 (1.3)	50 (1.4)	60 (1.5)	58 (1.3)
Norway	▲ 59 (0.6)	55 (0.5)	▲ 52 (0.9)	47 (0.8)	56 (1.0)	55 (1.1)
Portugal	▲ 52 (0.6)	45 (0.6)	▲ 54 (1.1)	46 (1.0)	45 (1.1)	45 (1.1)
Russian Federation	▲ 60 (1.0)	55 (0.9)	60 (1.6)	55 (1.2)	49 (1.1)	50 (1.0)
Singapore	71 (1.0)	67 (1.0)	70 (1.6)	68 (1.5)	74 (1.3)	74 (1.4)
Slovak Republic	▲ 65 (0.7)	58 (0.8)	▲ 61 (1.0)	54 (1.0)	55 (1.1)	52 (1.1)
Spain	▲ 58 (0.5)	52 (0.6)	▲ 54 (0.9)	49 (0.8)	53 (0.8)	53 (1.0)
Sweden	▲ 60 (0.6)	54 (0.7)	▲ 59 (1.0)	52 (0.7)	53 (1.0)	51 (0.9)
1 Switzerland	▲ 60 (0.7)	55 (0.6)	▲ 53 (0.9)	46 (0.9)	53 (1.0)	49 (1.0)
† United States	57 (0.9)	54 (0.9)	55 (1.3)	51 (1.2)	59 (1.2)	62 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	62 (0.9)	58 (0.8)	56 (1.2)	52 (1.0)	62 (1.3)	63 (1.1)
Austria	▲ 64 (0.8)	59 (0.9)	61 (1.3)	56 (1.5)	56 (1.1)	54 (1.3)
Belgium (Fr)	53 (1.1)	50 (0.6)	44 (1.1)	39 (1.1)	47 (1.6)	46 (1.1)
Netherlands	▲ 65 (1.2)	60 (1.0)	▲ 56 (1.0)	49 (1.1)	66 (2.1)	65 (1.9)
Scotland	59 (1.0)	55 (0.9)	▲ 55 (1.7)	47 (1.1)	58 (1.7)	56 (1.6)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	39 (1.5)	35 (0.9)	34 (1.6)	30 (1.0)	41 (2.0)	40 (1.0)
†1 Germany	60 (1.1)	55 (1.0)	57 (1.6)	52 (1.6)	50 (1.6)	52 (1.3)
Romania	51 (0.9)	46 (1.0)	48 (1.2)	45 (1.1)	42 (1.2)	41 (1.3)
Slovenia	▲ 64 (0.7)	58 (0.8)	59 (1.1)	54 (1.1)	60 (1.1)	57 (1.1)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▲ 57 (0.7)	49 (0.9)	▲ 44 (1.1)	38 (1.1)	50 (1.4)	44 (1.3)
Greece	▲ 55 (0.6)	50 (0.6)	▲ 54 (0.7)	49 (0.7)	51 (1.1)	51 (1.1)
Thailand	54 (0.8)	54 (0.9)	42 (1.2)	44 (1.5)	62 (1.2)	62 (1.3)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	▲ 62 (1.1)	54 (1.1)	▲ 58 (1.7)	50 (1.6)	57 (2.1)	49 (1.9)
South Africa	29 (1.9)	25 (1.3)	28 (2.0)	25 (1.2)	27 (1.9)	24 (1.5)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Eighth grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 2.5

Average Percent Correct for Boys and Girls by Science Content Areas Lower Grade (Seventh Grade*)

Country	Science Overall		Earth Science		Life Science	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	▲ 59 (0.7)	55 (0.7)	▲ 63 (0.9)	58 (0.9)	62 (0.9)	59 (0.8)
† Belgium (Fr)	▲ 47 (0.8)	43 (0.7)	▲ 49 (1.2)	43 (1.1)	49 (1.0)	48 (0.9)
Canada	55 (0.6)	53 (0.5)	55 (0.9)	52 (0.7)	57 (0.7)	58 (0.6)
Cyprus	40 (0.6)	40 (0.5)	40 (1.0)	38 (0.7)	42 (0.8)	43 (0.7)
Czech Republic	▲ 60 (0.7)	56 (0.9)	▲ 60 (1.0)	55 (1.1)	64 (0.7)	62 (0.9)
†2 England	57 (1.0)	54 (0.9)	58 (1.3)	53 (1.1)	58 (1.1)	56 (1.2)
France	▲ 48 (0.7)	44 (0.7)	▲ 48 (0.8)	42 (0.8)	51 (0.9)	49 (0.8)
Hong Kong	54 (1.5)	52 (1.2)	51 (1.4)	47 (1.2)	57 (1.5)	56 (1.3)
Hungary	57 (0.8)	54 (0.7)	▲ 56 (0.9)	52 (0.9)	61 (1.0)	61 (0.7)
Iceland	47 (0.9)	45 (0.6)	▲ 47 (0.9)	43 (0.8)	51 (0.9)	51 (0.8)
Iran, Islamic Rep.	43 (0.7)	40 (0.9)	▲ 43 (1.0)	38 (0.9)	46 (1.0)	43 (1.1)
Ireland	▲ 54 (1.0)	50 (0.8)	▲ 59 (1.2)	54 (0.9)	53 (1.1)	52 (1.1)
Japan	▲ 60 (0.4)	58 (0.3)	▲ 58 (0.7)	55 (0.5)	64 (0.6)	64 (0.4)
Korea	▲ 63 (0.5)	59 (0.6)	▲ 61 (0.6)	55 (0.9)	▲ 67 (0.7)	62 (0.8)
1 Latvia (LSS)	43 (0.7)	40 (0.6)	44 (1.0)	41 (0.8)	45 (0.8)	44 (0.8)
1 Lithuania	38 (0.7)	37 (0.8)	40 (0.9)	38 (1.1)	39 (0.9)	42 (1.0)
New Zealand	51 (0.8)	49 (0.7)	▲ 52 (1.0)	47 (0.9)	53 (1.0)	53 (1.0)
Norway	51 (0.7)	49 (0.8)	53 (1.0)	51 (1.0)	55 (0.9)	55 (0.8)
Portugal	▲ 43 (0.5)	39 (0.5)	47 (0.8)	44 (0.8)	47 (0.6)	44 (0.7)
Russian Federation	52 (1.0)	48 (0.7)	▲ 56 (1.0)	52 (0.7)	54 (1.2)	53 (0.9)
† Scotland	50 (0.9)	47 (0.8)	▲ 49 (1.0)	44 (0.9)	50 (1.0)	48 (1.0)
Singapore	62 (1.4)	61 (1.5)	62 (1.4)	58 (1.6)	62 (1.7)	63 (1.7)
Slovak Republic	▲ 57 (0.8)	52 (0.6)	▲ 58 (0.9)	53 (0.9)	58 (0.9)	54 (0.7)
Spain	▲ 51 (0.6)	47 (0.5)	▲ 54 (0.8)	49 (0.8)	▲ 54 (0.7)	51 (0.6)
Sweden	52 (0.6)	50 (0.7)	54 (0.8)	53 (0.9)	56 (0.8)	56 (0.8)
1 Switzerland	▲ 52 (0.5)	48 (0.5)	▲ 55 (0.7)	50 (0.7)	53 (0.6)	53 (0.6)
† United States	55 (1.3)	53 (1.1)	56 (1.3)	52 (1.3)	59 (1.2)	59 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	54 (1.0)	54 (0.7)	54 (1.2)	51 (0.8)	55 (1.1)	57 (0.8)
Austria	56 (0.9)	55 (0.7)	57 (1.0)	54 (1.0)	59 (1.1)	61 (0.9)
Netherlands	57 (0.9)	55 (0.8)	58 (1.1)	55 (1.1)	61 (1.1)	61 (0.9)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	▲ 37 (0.9)	33 (0.8)	▲ 36 (1.0)	30 (1.0)	40 (1.0)	38 (0.9)
†1 Germany	55 (1.0)	51 (0.9)	53 (0.9)	50 (1.2)	58 (1.0)	58 (1.0)
Romania	46 (0.8)	44 (0.8)	45 (1.0)	43 (1.1)	51 (1.0)	51 (0.9)
Slovenia	59 (0.6)	56 (0.6)	▲ 61 (0.7)	57 (0.8)	60 (0.8)	60 (0.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▲ 46 (0.6)	42 (0.6)	▲ 44 (1.0)	39 (0.9)	50 (0.8)	49 (0.8)
Greece	45 (0.7)	44 (0.5)	44 (0.8)	42 (0.6)	48 (0.8)	49 (0.7)
† South Africa	27 (1.3)	25 (0.9)	27 (1.4)	26 (1.0)	27 (1.4)	26 (1.1)
Thailand	53 (0.8)	52 (0.9)	51 (0.9)	49 (1.0)	61 (0.9)	62 (1.0)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 2.5 (Continued)

Average Percent Correct for Boys and Girls by Science Content Areas Lower Grade (Seventh Grade*)

Country	Physics		Chemistry		Environmental Issues and the Nature of Science	
	Boys	Girls	Boys	Girls	Boys	Girls
† Belgium (Fl)	▲ 60 (0.8)	56 (0.7)	▲ 49 (0.8)	43 (0.9)	54 (1.4)	54 (1.2)
† Belgium (Fr)	▲ 49 (0.9)	44 (0.9)	▲ 41 (0.9)	34 (0.9)	40 (1.2)	40 (1.1)
Canada	▲ 56 (0.7)	52 (0.6)	▲ 48 (1.0)	43 (0.7)	56 (1.0)	56 (1.0)
Cyprus	40 (0.6)	38 (0.6)	38 (0.8)	37 (0.8)	38 (1.1)	41 (0.9)
Czech Republic	▲ 60 (0.7)	56 (0.9)	▲ 57 (1.1)	51 (1.4)	56 (1.2)	51 (1.3)
†2 England	59 (1.0)	55 (1.0)	▲ 51 (1.4)	44 (1.5)	57 (1.3)	56 (1.7)
France	▲ 50 (0.8)	46 (0.7)	▲ 41 (1.0)	36 (0.9)	43 (1.4)	44 (1.1)
Hong Kong	57 (1.5)	53 (1.1)	50 (1.5)	47 (1.5)	51 (2.0)	50 (1.9)
Hungary	▲ 57 (0.7)	51 (0.7)	56 (1.0)	52 (0.9)	48 (1.4)	49 (1.2)
Iceland	51 (1.2)	47 (0.8)	38 (1.5)	34 (1.0)	42 (1.3)	42 (1.5)
Iran, Islamic Rep.	▲ 43 (0.9)	38 (1.0)	46 (1.0)	46 (1.3)	34 (1.2)	33 (1.4)
Ireland	▲ 54 (1.0)	48 (0.8)	▲ 51 (1.1)	44 (1.1)	56 (1.3)	53 (1.1)
Japan	▲ 65 (0.4)	62 (0.5)	▲ 51 (0.7)	48 (0.6)	55 (0.8)	52 (0.8)
Korea	▲ 65 (0.6)	60 (0.7)	55 (0.6)	52 (0.8)	63 (1.0)	59 (0.9)
1 Latvia (LSS)	▲ 46 (0.9)	41 (0.7)	▲ 36 (0.9)	31 (1.0)	38 (1.4)	38 (1.1)
1 Lithuania	▲ 43 (0.8)	38 (0.9)	29 (1.0)	28 (1.1)	31 (1.2)	33 (1.1)
New Zealand	52 (0.9)	50 (0.7)	44 (0.9)	40 (1.1)	54 (1.2)	53 (1.2)
Norway	▲ 53 (0.9)	48 (1.0)	40 (1.1)	39 (1.1)	48 (1.3)	49 (1.3)
Portugal	▲ 43 (0.6)	37 (0.6)	▲ 38 (0.8)	31 (0.8)	37 (1.1)	37 (1.0)
Russian Federation	52 (1.1)	47 (0.9)	▲ 46 (1.2)	39 (1.0)	45 (1.3)	41 (0.8)
† Scotland	53 (0.9)	50 (0.8)	▲ 44 (1.3)	38 (1.1)	50 (1.2)	49 (1.3)
Singapore	65 (1.2)	62 (1.4)	57 (1.6)	56 (1.6)	61 (1.7)	64 (1.7)
Slovak Republic	▲ 58 (0.8)	53 (0.8)	▲ 54 (1.1)	46 (1.0)	51 (1.1)	49 (1.0)
Spain	▲ 51 (0.7)	46 (0.5)	▲ 46 (0.8)	41 (0.9)	47 (1.0)	47 (0.9)
Sweden	▲ 53 (0.7)	48 (0.8)	▲ 47 (0.8)	43 (1.0)	45 (1.1)	46 (0.9)
1 Switzerland	▲ 55 (0.6)	49 (0.5)	▲ 45 (0.8)	38 (0.7)	47 (1.0)	45 (0.8)
† United States	52 (1.3)	50 (1.0)	50 (1.6)	46 (1.1)	55 (1.9)	57 (1.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):						
Australia	56 (1.0)	54 (0.8)	46 (1.1)	45 (1.0)	56 (1.3)	58 (1.1)
Austria	57 (0.9)	54 (0.9)	53 (1.3)	49 (1.0)	49 (1.4)	48 (1.1)
Netherlands	57 (0.9)	53 (1.0)	46 (1.2)	42 (1.1)	59 (1.7)	58 (1.6)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	▲ 37 (1.0)	32 (0.9)	▲ 32 (1.0)	27 (0.8)	36 (1.1)	35 (1.0)
†1 Germany	▲ 56 (1.0)	51 (0.9)	▲ 51 (1.3)	43 (1.2)	47 (1.6)	45 (1.3)
Romania	46 (0.9)	42 (0.9)	43 (1.0)	40 (1.1)	37 (1.1)	37 (1.0)
Slovenia	▲ 57 (0.7)	53 (0.7)	▲ 57 (1.1)	52 (1.0)	55 (1.1)	56 (0.8)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	▲ 50 (0.8)	43 (0.7)	▲ 37 (0.9)	31 (0.9)	39 (1.2)	39 (1.2)
Greece	▲ 46 (0.7)	42 (0.5)	42 (0.9)	40 (0.9)	43 (1.1)	44 (1.1)
† South Africa	28 (1.3)	24 (0.9)	23 (1.3)	23 (0.8)	25 (1.5)	25 (1.2)
Thailand	51 (0.8)	50 (0.8)	40 (1.1)	37 (1.0)	57 (1.3)	58 (1.2)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons
*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Chapter 3

Performance on Items Within Each Science Content Area

This chapter presents four to six example items within each of the science content areas, including the performance on these items for each of the TIMSS countries. The example items were selected to illustrate the different topics covered within each content area as well as the different performance expectations. The items also were chosen to show the range of item formats used within each area. To provide some sense of what types of items were answered correctly by higher-performing as compared to lower-performing students, the items show a range of difficulty within each content area. Finally, it should be noted that all these items and others have been released for use by the public.[1]

The presentation for each of the content areas begins with a brief description of the major topics included in the content area and a discussion of student performance in that content area. The discussion is followed by a table showing the percent correct on the example items for each of the TIMSS countries at both the seventh and eighth grades. After the table showing the country-by-country results, there is a figure relating achievement on each of the example items to performance on the TIMSS international science scale. This "difficulty map" provides a pictorial representation of achievement on the scale in relation to achievement on the items. Following the difficulty map, each item is presented in its entirety. The correct answer is circled for multiple-choice items and shown in the answer space for short-answer items. For extended-response questions, the answer shown exemplifies the type of student responses that were given full credit. All of the responses shown have been reproduced from students' actual test booklets.

What Have Students Learned About Earth Science?

Items in the earth science category measure students' knowledge of the scientific principles related to earth features, earth processes, and the earth in the universe. Table 3.1 shows the percent correct across the TIMSS countries for each of five example items (Example Items 1 - 5).

The international item difficulty map shown in Figure 3.1 presents a pictorial representation of the relationship between performance on the TIMSS international science scale and achievement on the five example items for earth science.[2] The international achievement on each example item is indicated both by the seventh- and eighth-grade international average percent correct and by the international

[1] The IEA retained about one-third of the TIMSS items as secure for possible future use in measuring international trends in mathematics and science achievement. All remaining items are available for general use.

[2] The three-digit item label shown in the lower right corner of the box locating each example item on the item difficulty map refers to the original item identification number used in the student test booklets.

Table 3.1

Percent Correct for Earth Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 1A River on the plain: Good place for farming.		Example 1B River on the plain: Bad place for farming.		Example 2 Fossil fuels.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	83 (1.4)	86 (1.8)	60 (2.3)	57 (3.2)	67 (2.8)	70 (3.5)
† Belgium (Fr)	53 (2.2)	62 (2.8)	30 (2.4)	34 (2.3)	39 (3.0)	47 (3.2)
Canada	83 (1.2)	88 (1.1)	44 (1.9)	47 (1.8)	67 (2.6)	69 (2.4)
Cyprus	76 (1.9)	77 (1.8)	21 (1.7)	23 (1.8)	42 (3.1)	33 (2.7)
Czech Republic	80 (2.1)	84 (1.9)	35 (2.0)	42 (2.5)	41 (3.3)	60 (3.1)
†2 England	91 (1.4)	92 (1.5)	68 (2.8)	74 (2.2)	76 (2.8)	85 (2.6)
France	67 (2.0)	76 (1.8)	30 (1.9)	37 (2.4)	36 (2.7)	61 (2.1)
Hong Kong	65 (2.1)	70 (2.0)	29 (2.0)	42 (2.4)	73 (3.1)	74 (2.6)
Hungary	73 (1.9)	77 (1.7)	39 (2.1)	45 (1.9)	42 (2.4)	55 (2.9)
Iceland	71 (2.5)	81 (2.2)	24 (2.5)	26 (2.9)	42 (3.9)	46 (6.4)
Iran, Islamic Rep.	81 (2.3)	82 (1.6)	19 (3.9)	25 (2.0)	68 (3.0)	75 (2.8)
Ireland	89 (1.5)	91 (1.2)	73 (2.0)	71 (1.8)	84 (2.4)	87 (2.3)
Japan	90 (1.0)	91 (0.7)	25 (1.3)	25 (1.3)	49 (2.1)	53 (2.3)
Korea	91 (1.0)	92 (1.2)	27 (2.0)	35 (2.1)	75 (2.4)	84 (2.2)
1 Latvia (LSS)	73 (1.9)	71 (2.2)	25 (1.9)	30 (2.1)	37 (3.0)	46 (3.6)
1 Lithuania	62 (2.7)	68 (1.9)	25 (1.9)	39 (2.4)	37 (3.3)	34 (3.4)
New Zealand	87 (1.2)	89 (1.3)	62 (1.7)	68 (1.8)	46 (2.9)	60 (2.1)
Norway	83 (2.0)	86 (1.3)	39 (2.6)	42 (1.8)	55 (3.1)	69 (2.6)
Portugal	67 (1.8)	79 (1.6)	14 (1.2)	24 (1.6)	76 (2.3)	78 (2.3)
Russian Federation	70 (1.9)	74 (1.6)	34 (2.0)	39 (2.3)	56 (3.3)	62 (3.3)
† Scotland	77 (1.8)	81 (1.7)	51 (2.2)	52 (2.0)	57 (2.8)	65 (2.8)
Singapore	91 (1.4)	94 (0.8)	52 (2.4)	62 (1.9)	83 (2.3)	85 (1.6)
Slovak Republic	79 (1.6)	83 (1.8)	39 (2.0)	40 (2.1)	34 (3.0)	55 (3.0)
Spain	81 (1.3)	87 (1.2)	33 (1.5)	35 (1.8)	60 (2.6)	73 (2.2)
Sweden	80 (1.7)	83 (1.4)	34 (2.3)	44 (2.0)	64 (2.8)	70 (2.0)
1 Switzerland	79 (1.7)	81 (1.5)	45 (1.8)	53 (1.6)	48 (2.7)	52 (2.5)
† United States	88 (1.4)	91 (0.8)	56 (1.7)	58 (1.7)	65 (3.1)	71 (2.0)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	81 (1.5)	83 (1.4)	55 (1.7)	58 (1.8)	54 (2.3)	62 (2.2)
Austria	74 (2.3)	78 (2.0)	39 (2.2)	44 (2.3)	70 (2.9)	83 (2.2)
Bulgaria	70 (2.8)	65 (3.9)	28 (2.5)	36 (3.5)	65 (4.2)	68 (3.8)
Netherlands	73 (1.8)	78 (2.3)	55 (2.2)	54 (2.5)	61 (3.4)	71 (3.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	54 (3.0)	62 (3.0)	22 (2.1)	26 (2.0)	46 (3.5)	51 (3.7)
†1 Germany	71 (2.2)	72 (2.1)	44 (1.9)	47 (3.0)	56 (2.8)	59 (3.1)
Romania	64 (2.2)	68 (2.3)	28 (2.2)	33 (2.5)	55 (2.8)	71 (2.7)
Slovenia	86 (1.4)	90 (1.2)	46 (2.2)	49 (2.1)	64 (2.7)	82 (2.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	55 (2.7)	62 (2.2)	25 (2.4)	29 (2.3)	38 (3.2)	46 (3.2)
Greece	76 (1.8)	86 (1.2)	22 (1.3)	31 (1.8)	18 (1.7)	29 (2.6)
† South Africa	42 (2.7)	38 (2.5)	12 (1.8)	14 (2.0)	27 (2.3)	24 (2.4)
Thailand	94 (0.7)	95 (0.7)	72 (1.7)	75 (1.6)	44 (2.6)	58 (2.6)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	84 (2.4)	–	35 (3.8)	–	54 (4.1)
Kuwait	–	59 (4.3)	–	20 (2.6)	–	55 (3.8)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.1 (Continued)

Percent Correct for Earth Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

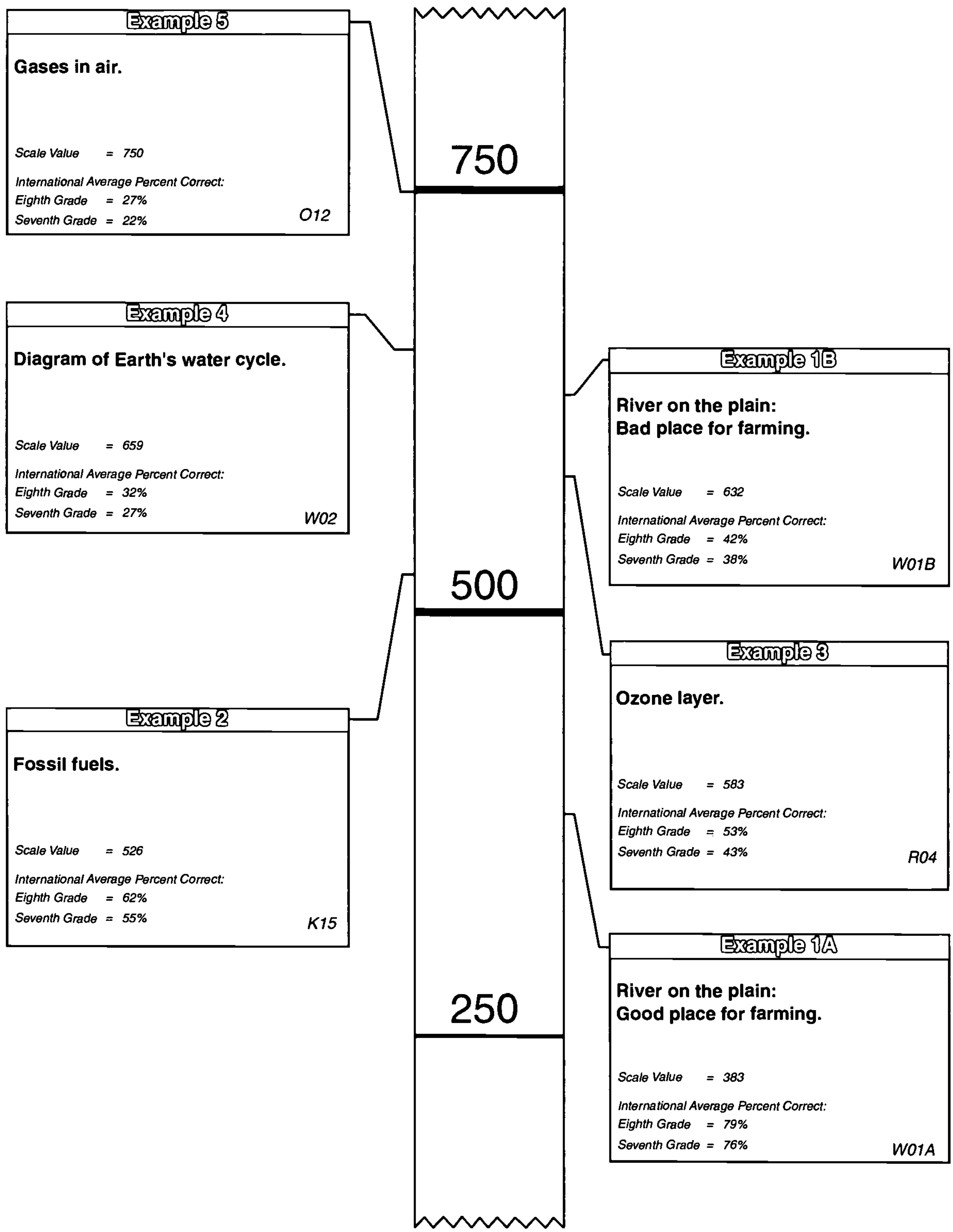
Country	Example 3 Ozone layer.		Example 4 Diagram of Earth's water cycle.		Example 5 Gases in air.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	40 (2.7)	47 (3.1)	56 (2.2)	60 (3.4)	10 (1.9)	17 (2.1)
† Belgium (Fr)	38 (3.2)	48 (3.5)	24 (2.1)	32 (2.0)	22 (3.1)	20 (4.5)
Canada	53 (2.5)	63 (2.2)	36 (1.8)	39 (1.7)	9 (1.0)	21 (2.0)
Cyprus	25 (2.5)	42 (3.0)	17 (1.7)	24 (2.0)	23 (2.9)	33 (3.3)
Czech Republic	62 (3.7)	74 (2.7)	22 (2.3)	27 (2.9)	55 (3.1)	38 (3.8)
†2 England	35 (2.7)	38 (3.1)	44 (2.4)	53 (2.3)	21 (3.7)	17 (2.6)
France	29 (2.7)	42 (3.0)	25 (1.7)	32 (1.9)	11 (1.8)	13 (2.0)
Hong Kong	47 (3.3)	56 (3.2)	23 (1.9)	25 (1.7)	21 (2.3)	50 (3.3)
Hungary	52 (2.5)	63 (2.7)	24 (1.8)	22 (1.6)	42 (3.0)	43 (3.0)
Iceland	47 (3.6)	56 (4.2)	25 (2.8)	33 (3.3)	3 (1.1)	14 (2.3)
Iran, Islamic Rep.	16 (2.5)	20 (3.0)	15 (4.3)	11 (1.4)	7 (1.6)	4 (1.3)
Ireland	39 (2.4)	53 (3.1)	41 (2.1)	51 (2.2)	16 (2.3)	30 (3.0)
Japan	45 (2.2)	60 (2.0)	35 (1.5)	43 (1.6)	57 (2.2)	54 (2.2)
Korea	45 (2.9)	57 (2.5)	26 (1.6)	23 (1.7)	59 (3.2)	41 (3.2)
1 Latvia (LSS)	20 (2.5)	36 (3.4)	20 (1.9)	19 (2.0)	13 (2.5)	18 (2.6)
1 Lithuania	20 (2.7)	38 (3.6)	8 (1.2)	9 (1.4)	10 (1.9)	22 (2.7)
New Zealand	53 (2.9)	64 (2.7)	25 (1.9)	29 (1.9)	6 (1.1)	18 (2.2)
Norway	54 (4.6)	71 (2.5)	40 (3.3)	55 (2.0)	4 (1.1)	27 (2.7)
Portugal	40 (3.0)	50 (2.9)	17 (1.6)	24 (1.5)	17 (2.3)	8 (1.5)
Russian Federation	30 (3.1)	39 (3.3)	56 (1.8)	59 (2.0)	21 (2.4)	27 (3.4)
† Scotland	29 (2.3)	42 (2.7)	31 (2.4)	40 (2.2)	12 (2.3)	25 (2.9)
Singapore	71 (2.9)	78 (2.4)	45 (2.3)	57 (2.4)	72 (2.9)	58 (3.1)
Slovak Republic	67 (2.3)	71 (2.0)	24 (1.9)	25 (1.8)	51 (3.2)	32 (2.9)
Spain	63 (2.6)	68 (2.4)	24 (1.8)	34 (1.8)	9 (1.6)	9 (1.5)
Sweden	54 (2.9)	69 (2.0)	34 (2.0)	49 (2.0)	10 (1.9)	25 (2.5)
1 Switzerland	39 (2.9)	51 (2.6)	26 (1.6)	38 (1.9)	9 (1.4)	20 (2.5)
† United States	40 (3.7)	52 (2.7)	35 (2.4)	40 (2.3)	20 (2.6)	20 (1.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	45 (2.8)	51 (1.8)	26 (1.7)	33 (1.7)	16 (2.3)	16 (1.6)
Austria	54 (2.7)	65 (3.1)	31 (2.0)	43 (2.3)	13 (1.8)	42 (3.6)
Bulgaria	64 (5.0)	67 (3.7)	21 (2.5)	19 (2.8)	31 (4.7)	45 (5.1)
Netherlands	47 (3.7)	57 (4.1)	47 (2.5)	57 (2.7)	15 (2.1)	31 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	51 (3.4)	55 (4.0)	12 (1.7)	15 (1.9)	–	–
†1 Germany	53 (3.2)	64 (2.9)	29 (1.9)	35 (2.5)	23 (2.6)	27 (3.2)
Romania	31 (2.4)	41 (3.0)	18 (1.8)	21 (2.0)	27 (3.0)	40 (2.9)
Slovenia	47 (3.2)	61 (2.8)	25 (2.0)	24 (1.9)	51 (3.6)	31 (3.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	24 (3.4)	29 (3.1)	27 (2.5)	39 (2.3)	10 (2.8)	11 (1.8)
Greece	40 (2.3)	56 (2.5)	16 (1.5)	17 (1.4)	26 (2.2)	34 (2.7)
† South Africa	10 (2.3)	6 (1.8)	7 (1.3)	6 (1.2)	16 (1.6)	11 (1.5)
Thailand	32 (2.6)	45 (2.6)	13 (1.4)	16 (1.4)	19 (2.5)	18 (2.3)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	63 (4.9)	–	17 (2.3)	–	33 (4.6)
Kuwait	–	65 (4.5)	–	25 (2.7)	–	37 (3.9)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Colombia on Example 5.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.1

International Difficulty Map for Earth Science Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

science scale value, or item difficulty level, for each item. Since the scale was developed based on the performance of students at both grades in all countries, the international scale values apply to both grades and to all countries.

For the figure, the items results are placed on the scale at the point where students at the corresponding achievement level were more likely than not (65% probability) to answer the question correctly. Items at higher scale values are the more difficult items. For example, students scoring at or above 383 on the science scale were likely to correctly answer the question about advantages of farming by a river (Example Item 1A) but not the question about the source of fossil fuels (Example Item 2), while students scoring at or above 526 were also likely to answer this second item.

The international average on the science scale of 516 at the eighth grade indicates that students from many countries at this grade would be likely to correctly answer the lowest-difficulty items, such as Example Item 1A, but would not be likely to answer the more difficult items. These results, however, varied dramatically across countries. In Singapore, with an average scale value of 607, students were likely to respond correctly to more of the earth science example items than did students in other, lower-performing countries. This is reflected in Singapore's average percent correct at the eighth grade for the earth science items, which was 65% compared to 55% internationally.

The five earth science example items are presented in their entirety beginning on the next page. Example Item 1 asks students to apply scientific principles of water sources and physical cycles to explain why a plain containing a river might be both a good place (Part A) and a bad place (Part B) for farming. Most seventh- and eighth-graders were able to answer the first part of this open-ended item (international averages of 76% and 79%). Students were given credit for mentioning that the soil was fertile, good, or abundant; that the river would provide irrigation or water for animals; that there was plenty of space or flat areas for farmland; or any other acceptable reason related to facilitating farming. For the majority of countries, more than 70% of both seventh- and eighth-grade students provided a correct response, and several countries had more than 90% correct responses. Substantially fewer students were able to provide a correct response to the second part of this item. Reasons given credit for Part B included the possibility of flooding, wind or water erosion, or other acceptable problems related to farming. The international average percent correct levels were 38% and 42% for seventh and eighth grade. In addition, a much broader range of performance was observed across countries for this part of the item, with the percent of correct responses at the eighth grade ranging from 14% in South Africa to more than 70% in England, Ireland, and Thailand.

Example Item 2 is a multiple-choice item requiring knowledge of the source of fossil fuels. On average, 55% of seventh-graders and 62% of eighth-graders responded correctly to this item, but the across-country differences ranged widely. Eighth-grade students in several countries had 80% or more correct responses, with Ireland and England having two of the highest performances, together with Korea, Singapore, Austria, and Slovenia. The across-grade differences for many countries were greater for Example Item 2 than Example Item 1, with fewer than half of seventh-grade students answering correctly in 17 countries.

Example Item 3 required students to write down a reason for the importance of the ozone layer. Internationally, about half of the students in both grades provided a correct response related to protection from the sun's ultraviolet radiation. Ultraviolet radiation did not need to be mentioned specifically; responses that included the idea of the ozone layer protecting humans from sunburn or skin cancer also were given credit. The between-grade increase in average percent correct, from 43% to 53%, represents one of the larger increases among the example items.

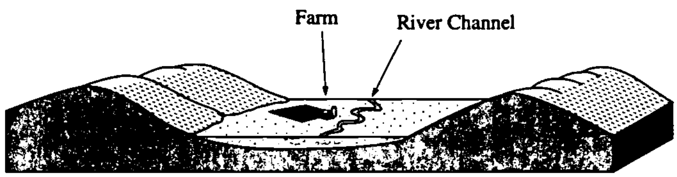
Example Item 4 is an extended-response item that required students to apply scientific principles and use a diagram to explain the earth's water cycle. A fully-correct response to this item needed to depict or otherwise indicate all three steps in the water cycle – evaporation, transportation, and precipitation. On average, students found this item to be rather difficult, with fewer than one-third in both the seventh (27%) and eighth grade (32%) providing a fully-correct drawing or diagram. For the majority of countries, performance at the eighth grade was not substantially better than at the seventh grade. The performance across countries ranged from less than 10% to 60%, with South Africa posting seventh- and eighth-grade percentages of 7% and 6% and Belgium (Flemish), percentages of 56% and 60%.

Example Item 5, requiring students to identify the most abundant gas found in air, was the most difficult earth science item. Only about one-quarter of students at either grade could identify the correct response of nitrogen gas (international averages of 22% and 27%). The most common misconception, chosen by more than 50% of students, was that oxygen is the most abundant gas in air. Performance patterns were very inconsistent for this item. The across-country performance varied dramatically at both grades, ranging from below 10% correct in several countries to 72% correct at the seventh grade and 58% at the eighth grade in Singapore. Across-grade comparisons revealed that in several countries, the seventh-grade students out-performed those in the eighth grade by a substantial margin.

EXAMPLE ITEM 1
EARTH SCIENCE

River on the plain

The diagram shows a river flowing through a wide plain. The plain is covered with several layers of soil and sediment.



a. Write down one reason why this plain is a good place for farming.

This is a good place because the Soil is Soft, and fertile.

b. Write down one reason why this plain is NOT a good place for farming.

This is not a good place because the river might flood.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 2
EARTH SCIENCE

Fossil fuels

Fossil fuels were formed from

A. uranium

B. sea water

C. sand and gravel

(D.) dead plants and animals

Performance Category: Understanding Simple Information

EXAMPLE ITEM 3
EARTH SCIENCE

Ozone layer

Write down one reason why the ozone layer is important for all living things on Earth.

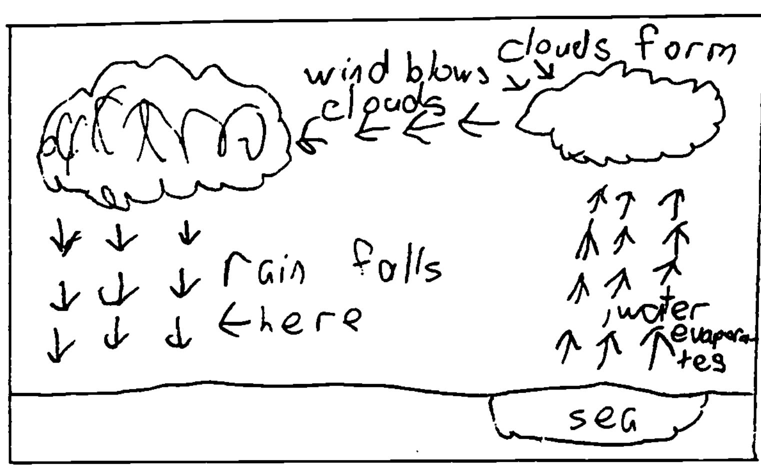
It protects a living thing from over-exposure to the sun's harmful rays.

Performance Category: Understanding Complex Information

EXAMPLE ITEM 4
EARTH SCIENCE

Diagram of Earth's water cycle

Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.



Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 5
EARTH SCIENCE

Gases in air

Air is made up of many gases. Which gas is found in the greatest amount?

(A.) Nitrogen

B. Oxygen

C. Carbon dioxide

D. Hydrogen

Performance Category: Understanding Simple Information

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What Have Students Learned About Life Science?

Items in the life science category cover a broad range of content areas related to the structure, diversity, classification, processes, cycles, and interactions of plant and animal life. To answer these items, students were required to demonstrate and apply their knowledge of both simple and complex information. The percent correct values for five example items (Example Items 6 - 10) illustrating the life science content area are shown in Table 3.2, and Figure 3.2 presents the international difficulty map for these items.

Nearly three-quarters of both the seventh- and eighth-grade students correctly answered Example Item 6 about the growth and development of trees (international averages of 72% and 74% at the seventh and eighth grades). Belgium (Flemish), Korea, the Slovak Republic, Austria, the Netherlands, and all three Scandinavian countries had 90% or more correct responses at both grades.

Explaining the importance of plants and light in an aquarium ecosystem in Example Item 7 was more difficult for students. On average, Part A of this item, related to the importance of plants, was answered correctly by more than half of both seventh- and eighth-grade students (58% and 64%), with the majority identifying oxygen production. However, responses that mentioned that plants clean the water, provide food for fish, or provide a place to hide or to hide eggs, or other appropriate benefits also were counted as correct. One-third or fewer of the students, on average, provided a correct explanation for the importance of light (26% and 33% for Part B), with these students most frequently referring to photosynthesis or energy production. Other more general responses, such as "it helps to keep the plants alive," also were given credit.

Example Item 8 also measures students' knowledge of photosynthesis. On average, about half of the students at both grades (50% and 54%) correctly identified the function of chloroplasts in plant cells. Students in Hong Kong, Japan, Korea, and the Russian Federation did particularly well (75% or greater in both grades). In general, there was little increase in performance between seventh and eighth grades on this item.

Internationally, fewer than half of the students at both grades selected the correct response to Example Item 9 about insect features (45% at seventh grade and 43% at eighth grade, on average). Across countries, the percent correct for eighth-graders ranged from 20% in Colombia to 82% in Japan. In many countries, seventh- and eighth-grade students performed similarly. In fact, in a few countries, seventh-grade students performed somewhat better than did eighth-grade students, most notably Belgium (Flemish).

Example Item 10 required students to design and communicate a scientific investigation in the area of human biology. More specifically, students were asked to investigate how the heart rate changes with changes in activity. Fully-correct responses described a procedure in which the pulse is measured at rest using a timer or watch, the individual does an exercise or engages in some type of physical activity, and then the pulse is remeasured during or after the exercise. Across countries, students found this item to be quite difficult, with only 8% of seventh- and 14% of eighth-grade students, on average, providing a fully-correct extended response. A fully correct response required the student to include the use of a timer and describe the measurement of pulse rate both before and after exercise. In only seven countries did one-fourth or more of eighth-grade students receive full credit for their responses (Flemish-speaking Belgium, England, New Zealand, Scotland, Singapore, the Netherlands, and Israel).

Table 3.2

Percent Correct for Life Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 6 Tree rings.		Example 7A Aquarium: Importance of plant.		Example 7B Aquarium: Importance of light.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	95 (1.2)	92 (2.2)	62 (2.2)	75 (2.5)	26 (1.6)	43 (2.1)
† Belgium (Fr)	61 (3.5)	63 (3.5)	43 (2.8)	47 (2.4)	15 (1.6)	27 (2.2)
Canada	85 (1.5)	86 (1.7)	57 (1.7)	62 (1.6)	19 (1.7)	26 (1.5)
Cyprus	49 (2.7)	62 (3.1)	56 (1.9)	57 (1.7)	42 (2.2)	38 (2.4)
Czech Republic	89 (1.8)	88 (2.5)	69 (1.8)	74 (2.0)	34 (2.5)	42 (2.9)
†[2] England	78 (3.1)	79 (2.6)	64 (2.2)	69 (2.5)	14 (2.1)	22 (2.1)
France	60 (2.6)	66 (2.5)	51 (2.4)	63 (1.7)	22 (1.6)	27 (2.0)
Hong Kong	38 (2.5)	39 (2.5)	33 (1.8)	53 (2.6)	10 (1.3)	26 (2.0)
Hungary	84 (2.0)	81 (2.4)	66 (1.8)	65 (2.2)	39 (2.0)	40 (2.2)
Iceland	84 (2.7)	90 (2.4)	42 (3.1)	61 (3.9)	7 (1.6)	17 (2.2)
Iran, Islamic Rep.	77 (3.1)	81 (3.1)	37 (2.1)	44 (2.6)	23 (2.7)	32 (2.7)
Ireland	88 (1.5)	89 (1.8)	51 (2.2)	60 (2.3)	11 (1.2)	22 (2.0)
Japan	89 (1.3)	88 (1.5)	82 (1.2)	85 (1.0)	56 (1.6)	56 (1.8)
Korea	93 (1.7)	95 (1.2)	55 (2.2)	67 (1.9)	48 (2.4)	56 (1.7)
[1] Latvia (LSS)	80 (2.7)	87 (2.2)	48 (2.0)	53 (2.6)	8 (1.2)	13 (1.3)
[1] Lithuania	76 (3.1)	85 (2.5)	40 (2.9)	57 (2.9)	23 (2.6)	38 (2.6)
New Zealand	87 (1.9)	86 (2.0)	69 (2.1)	78 (1.4)	10 (1.5)	20 (1.9)
Norway	94 (1.3)	96 (1.0)	66 (2.5)	72 (1.6)	18 (1.9)	35 (1.9)
Portugal	46 (3.0)	45 (2.8)	55 (2.2)	56 (1.8)	27 (2.0)	27 (1.8)
Russian Federation	87 (1.3)	89 (1.6)	52 (2.5)	65 (2.4)	30 (2.4)	41 (2.6)
† Scotland	79 (2.2)	81 (2.1)	44 (1.8)	54 (2.3)	6 (1.0)	13 (1.9)
Singapore	45 (2.7)	59 (2.7)	91 (1.4)	96 (0.7)	65 (2.7)	78 (2.0)
Slovak Republic	94 (1.2)	96 (0.9)	61 (2.9)	67 (2.8)	22 (1.9)	34 (2.5)
Spain	66 (2.5)	73 (1.9)	52 (1.8)	57 (2.1)	26 (1.7)	35 (1.9)
Sweden	90 (1.7)	93 (1.1)	62 (1.9)	68 (1.6)	17 (1.5)	24 (1.4)
[1] Switzerland	87 (2.2)	86 (1.9)	66 (1.7)	73 (2.1)	16 (1.1)	33 (1.8)
† United States	76 (2.7)	81 (2.1)	61 (1.9)	63 (1.6)	21 (1.9)	26 (1.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	60 (2.2)	67 (2.0)	55 (1.9)	63 (1.5)	12 (0.9)	24 (1.4)
Austria	91 (1.7)	92 (2.0)	80 (1.9)	85 (1.8)	45 (2.7)	45 (2.8)
Bulgaria	88 (2.4)	87 (2.7)	65 (3.0)	66 (4.5)	53 (3.7)	55 (4.7)
Netherlands	92 (1.5)	95 (1.3)	63 (4.0)	70 (2.3)	18 (2.0)	27 (3.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	22 (3.3)	20 (3.0)	48 (3.2)	55 (3.4)	14 (2.2)	20 (2.3)
†[1] Germany	85 (2.4)	87 (2.1)	72 (2.1)	74 (2.3)	38 (2.3)	43 (2.2)
Romania	58 (3.0)	59 (2.9)	50 (2.5)	62 (2.1)	30 (2.2)	43 (2.4)
Slovenia	87 (1.8)	90 (1.6)	75 (2.0)	74 (2.0)	36 (2.5)	45 (2.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	92 (1.7)	91 (1.8)	62 (2.6)	69 (2.4)	21 (1.9)	32 (2.1)
Greece	61 (2.4)	62 (2.5)	46 (1.9)	47 (1.6)	28 (2.0)	33 (1.8)
† South Africa	16 (2.7)	17 (2.9)	26 (2.1)	34 (2.8)	5 (0.8)	9 (1.7)
Thailand	40 (2.5)	48 (2.7)	77 (1.6)	79 (1.6)	45 (2.1)	49 (2.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
[1] Israel	–	63 (2.8)	–	59 (3.0)	–	29 (2.9)
Kuwait	–	31 (4.1)	–	48 (4.2)	–	22 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.2 (Continued)

Percent Correct for Life Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

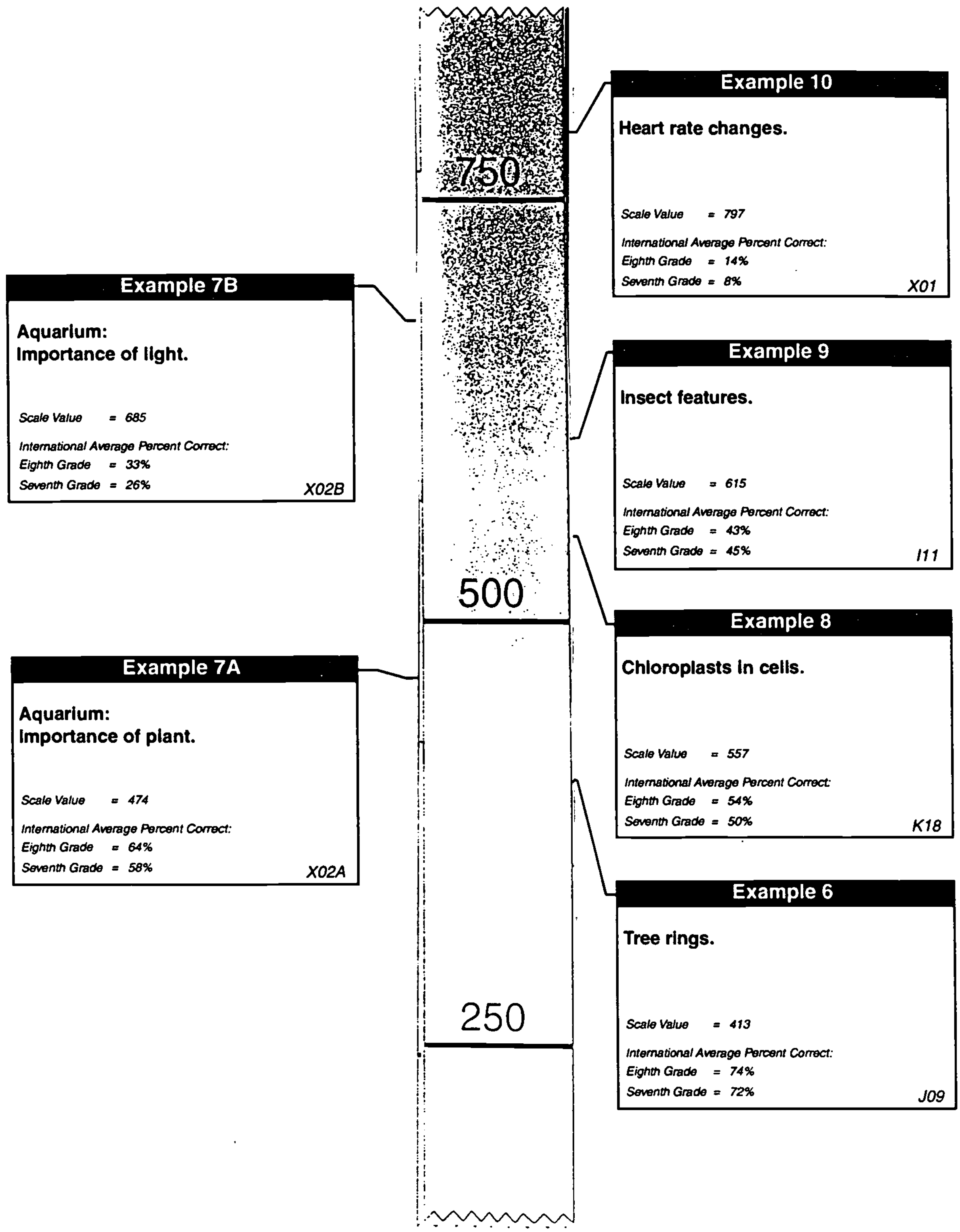
Country	Example 8 Chloroplasts in cells.		Example 9 Insect features.		Example 10 Heart rate changes.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	46 (3.1)	65 (4.9)	62 (2.8)	50 (3.5)	16 (1.8)	27 (1.7)
† Belgium (Fr)	38 (2.6)	49 (3.2)	39 (3.4)	53 (3.2)	8 (1.6)	13 (1.4)
Canada	44 (2.0)	50 (1.9)	47 (1.8)	49 (2.3)	12 (0.9)	21 (1.6)
Cyprus	51 (2.4)	52 (2.5)	42 (2.4)	36 (3.1)	2 (0.6)	6 (1.1)
Czech Republic	51 (2.5)	64 (2.6)	52 (2.7)	47 (3.0)	12 (1.6)	19 (1.6)
†[2] England	55 (3.2)	58 (3.3)	47 (3.7)	50 (3.4)	17 (1.9)	26 (2.3)
France	46 (3.4)	48 (3.0)	42 (2.7)	35 (2.8)	5 (0.9)	10 (1.2)
Hong Kong	85 (1.9)	86 (1.8)	62 (2.5)	57 (2.7)	5 (0.8)	6 (0.9)
Hungary	25 (2.5)	26 (2.9)	50 (2.8)	53 (2.6)	5 (0.8)	8 (1.1)
Iceland	42 (3.6)	63 (3.2)	37 (3.6)	31 (3.4)	4 (0.9)	8 (1.5)
Iran, Islamic Rep.	43 (4.3)	38 (3.5)	29 (3.3)	28 (3.0)	4 (0.9)	4 (1.1)
Ireland	41 (3.0)	47 (2.6)	29 (2.3)	35 (2.7)	8 (1.1)	16 (1.5)
Japan	85 (1.3)	89 (1.3)	69 (1.9)	82 (1.6)	15 (1.1)	20 (1.4)
Korea	78 (2.3)	86 (2.0)	79 (2.2)	74 (2.4)	23 (2.0)	23 (1.9)
[1] Latvia (LSS)	33 (3.2)	39 (3.4)	29 (2.6)	44 (2.8)	2 (0.6)	3 (0.6)
† Lithuania	55 (3.4)	66 (2.8)	19 (2.5)	41 (3.3)	2 (1.0)	5 (0.9)
New Zealand	42 (3.0)	48 (2.3)	52 (3.0)	56 (2.6)	16 (1.8)	26 (1.9)
Norway	37 (3.0)	43 (2.6)	51 (3.5)	57 (2.3)	9 (1.2)	24 (1.8)
Portugal	36 (2.6)	39 (2.2)	20 (2.1)	27 (2.5)	1 (0.3)	3 (0.6)
Russian Federation	75 (2.1)	79 (1.3)	34 (2.5)	53 (2.2)	3 (0.7)	5 (1.2)
† Scotland	40 (2.9)	49 (2.7)	34 (3.2)	36 (3.0)	14 (1.4)	25 (2.4)
Singapore	56 (2.8)	57 (2.7)	61 (2.7)	68 (1.9)	19 (1.9)	32 (1.8)
Slovak Republic	43 (2.5)	55 (2.3)	40 (2.2)	47 (3.0)	9 (1.1)	12 (1.4)
Spain	46 (2.2)	54 (2.4)	29 (2.5)	30 (2.1)	5 (0.8)	10 (1.1)
Sweden	50 (3.1)	67 (2.2)	51 (2.9)	61 (2.1)	7 (1.0)	18 (1.6)
[1] Switzerland	47 (2.8)	48 (2.7)	47 (2.7)	49 (2.2)	8 (0.8)	14 (1.2)
† United States	52 (3.0)	54 (2.3)	45 (3.6)	44 (2.1)	11 (1.4)	14 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	49 (2.7)	54 (1.9)	52 (2.7)	52 (2.3)	8 (0.8)	15 (1.2)
Austria	50 (3.2)	54 (3.2)	56 (2.9)	52 (3.1)	6 (1.0)	9 (1.3)
Bulgaria	57 (4.2)	58 (4.2)	34 (4.7)	42 (4.3)	8 (1.9)	7 (2.6)
Netherlands	68 (4.2)	72 (3.6)	55 (2.9)	53 (4.5)	13 (1.6)	25 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	38 (3.6)	31 (2.8)	18 (2.6)	20 (2.5)	3 (1.0)	6 (2.1)
†[1] Germany	48 (3.1)	60 (3.4)	47 (3.1)	54 (3.1)	10 (1.6)	16 (2.0)
Romania	54 (2.9)	48 (3.0)	30 (2.3)	33 (2.7)	4 (0.7)	9 (1.6)
Slovenia	67 (2.4)	72 (3.1)	38 (2.7)	45 (3.2)	15 (1.6)	20 (1.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	50 (3.4)	60 (3.3)	32 (2.7)	41 (3.4)	3 (0.9)	12 (1.8)
Greece	48 (2.7)	52 (2.8)	49 (2.8)	44 (2.6)	5 (0.7)	10 (1.0)
† South Africa	26 (2.0)	30 (2.4)	26 (2.7)	27 (2.5)	2 (0.6)	5 (1.4)
Thailand	48 (2.5)	47 (2.2)	44 (2.6)	43 (2.5)	4 (0.6)	18 (1.7)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
[1] Israel	–	42 (4.4)	–	36 (4.0)	–	26 (3.0)
Kuwait	–	37 (3.6)	–	37 (3.8)	–	8 (1.1)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.2

International Difficulty Map for Life Science Example Items Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 6
LIFE SCIENCE

Tree rings

How could you find out how old a tree is after it is cut?

You could find out how old a tree was after it is cut by counting the rings. Every ring equals one year

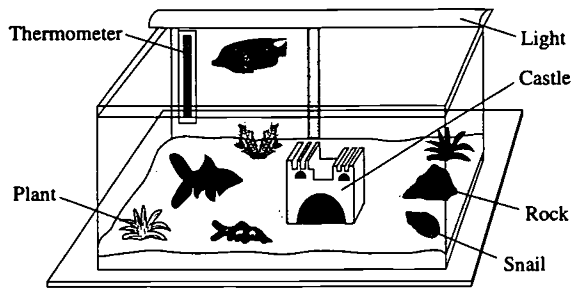
Performance Category: Understanding Complex Information

643

EXAMPLE ITEM 7
LIFE SCIENCE

Aquarium

In the picture of an aquarium, six items are labeled.



Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

to give off oxegn and take in carbon dioxide which the animals breath out

(b) the light

to help the plant make photosynthesis and make its own food

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 8
LIFE SCIENCE

Chloroplasts in cells

What is the main function of chloroplasts in a plant cell?

(A) To absorb light energy and manufacture food

B. To remove waste materials by active transport

C. To manufacture chemical energy from food

D. To control the shape of the cell

Performance Category: Understanding Simple Information

EXAMPLE ITEM 9
LIFE SCIENCE

Insect features

What features do all insects have?

	Number of LEGS	Number of BODY PARTS
A.	2	4
B.	4	2
(C.)	6	3
D.	8	3

Performance Category: Understanding Complex Information

EXAMPLE ITEM 10
LIFE SCIENCE

Heart rate changes

Suppose you want to investigate how the human heart rate changes with changes in activity. What materials would you use and what procedures would you follow?

materials: stopwatch

procedures: I would have a person sit and then take their pulse.
I would have the person walk, then take their pulse again.
Finally, I would ~~to~~ have the person run and take their pulse.
Each time I took their pulse I would time how many ~~beats~~ times per minute their heart was beating

Performance Category: Investigating the Natural World

What Have Students Learned About Physics?

Major topics covered by the physics items include different energy forms, physical transformations, forces and motion, and the properties of matter. Students were asked to solve problems and demonstrate their knowledge of scientific principles. Six example items (Example Items 11 - 16) are included to illustrate the range of item types and content areas as well as student performance in physics. The percent correct results for these items are shown in Table 3.3. The international difficulty map showing the physics example items is shown in Figure 3.3. The item positions and the international averages for correct responses indicate that for most countries, the majority of students had considerable difficulty on the more complex physics items.

Example Item 11 required extrapolating from a simple linear distance-versus-time graph, which proved to be an easy problem for most students. On average, more than three-fourths of the students across countries at both grades answered correctly (78% and 83%). Students' performance was quite high in most countries, with only three countries having performance below 50% at either grade – Kuwait (45%) at the eighth grade as well as Iran (47%) and Colombia (46%) at the seventh grade.

Students also did well on Example Item 12, which measured their knowledge of complete electronic circuits and conductive materials. The international average percent correct values of 69% and 78% at the seventh and eighth grades indicate a somewhat larger average between-grade difference than was generally observed. Several countries had a between-grade increase of 10% or more; the most notable was the increase from 48% to 74% for Portugal.

Student performance across countries on Example Item 13, measuring knowledge about the transmission of sound waves, averaged nearly 70% correct responses for both grades (67% and 70%). The variability across countries was moderately low on this item, with very few countries having percent correct levels below 60%. Korea and Japan had very high performances, with 88% to 90% correct at both grades.

Fewer students across countries demonstrated a knowledge of gravitational force as measured by Example Item 14. On average, only approximately half the students at either grade responded correctly (49% and 55%). The most commonly chosen incorrect option (B) reflected the misconception that the earth's gravitational force does not act upon a stationary object when it is on the ground. The top-performing country was the Czech Republic, where more than 80% of the students responded correctly at both grades.

Example Item 15 asked students to interpret data presented in a table to determine which of two machines would be more efficient. This is a relatively complex problem that required understanding the concepts of energy conversion and efficiency, recognizing and calculating the appropriate ratios, and explaining the results. In their explanations, students needed to choose machine A because it uses less gas per hectare, or to document this fact with the idea that 3/8 is less than 1/2, or a similar expression. On average, only 29% of seventh-grade and 36% of eighth-grade students answered correctly, and in only nine countries did half or more of the eighth-grade students give a fully-correct response.

Internationally, students also found Example Item 16 to be very difficult. This is a practical problem related to the nature of light requiring students to apply scientific principles to provide an explanation. Essentially, students needed to communicate that the same amount of light reaches the wall regardless of the distance the flashlight is from the wall. They may or may not have included the idea that the light becomes more or less spread out. On average, fewer than one-fourth of the students across countries correctly answered this item (18% and 23%). For most countries, performance at the eighth grade was not better than at the seventh grade. A common misconception identified in more than 30% of the student responses was that a larger area of illumination means there is more light.

Table 3.3

Percent Correct for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 11 Distance versus time graph.		Example 12 Light bulb in circuit.		Example 13 Sound in space.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	93 (1.5)	84 (5.2)	86 (2.0)	87 (2.8)	64 (3.4)	62 (3.3)
† Belgium (Fr)	86 (2.3)	86 (2.6)	54 (3.7)	62 (3.0)	66 (3.1)	74 (2.6)
Canada	88 (1.9)	92 (1.2)	76 (1.9)	79 (1.9)	71 (2.4)	72 (1.7)
Cyprus	53 (3.4)	64 (2.5)	64 (3.2)	73 (2.6)	57 (2.5)	62 (2.4)
Czech Republic	88 (2.0)	90 (1.7)	87 (1.6)	89 (1.4)	73 (1.9)	76 (2.8)
†2 England	87 (2.4)	88 (2.2)	89 (2.6)	90 (1.9)	76 (2.8)	76 (3.0)
France	90 (1.9)	97 (0.9)	67 (2.6)	79 (1.9)	70 (2.3)	72 (2.4)
Hong Kong	86 (2.2)	89 (1.7)	78 (2.7)	88 (1.7)	77 (2.1)	81 (2.2)
Hungary	81 (2.1)	83 (1.9)	74 (2.4)	85 (2.0)	73 (2.5)	82 (2.2)
Iceland	79 (3.6)	86 (3.1)	60 (4.3)	66 (4.2)	68 (4.3)	65 (4.8)
Iran, Islamic Rep.	47 (4.6)	65 (3.4)	59 (3.7)	59 (3.0)	62 (4.0)	65 (4.1)
Ireland	84 (2.1)	92 (1.4)	56 (2.4)	69 (2.6)	75 (2.4)	75 (2.3)
Japan	92 (1.0)	94 (0.9)	88 (1.6)	92 (1.1)	88 (1.4)	90 (1.2)
Korea	88 (1.7)	90 (1.7)	86 (1.9)	93 (1.3)	90 (1.7)	90 (1.5)
1 Latvia (LSS)	75 (2.6)	82 (2.6)	54 (3.3)	60 (3.5)	65 (3.2)	80 (2.9)
1 Lithuania	69 (3.1)	77 (2.9)	50 (3.4)	64 (3.0)	65 (3.3)	64 (2.9)
New Zealand	81 (2.2)	92 (1.6)	74 (2.5)	82 (1.7)	67 (2.8)	74 (2.0)
Norway	81 (2.9)	89 (1.8)	65 (3.6)	74 (2.4)	70 (2.7)	74 (2.6)
Portugal	72 (2.4)	89 (1.5)	48 (2.3)	74 (2.3)	57 (3.6)	71 (2.1)
Russian Federation	82 (2.2)	83 (2.4)	61 (2.5)	74 (2.3)	60 (3.3)	69 (2.4)
† Scotland	87 (1.7)	92 (1.5)	70 (2.4)	82 (2.6)	68 (2.6)	77 (2.2)
Singapore	94 (1.2)	96 (1.0)	95 (1.1)	97 (0.8)	66 (2.9)	86 (1.9)
Slovak Republic	78 (2.3)	86 (1.9)	83 (2.2)	91 (1.5)	71 (2.7)	73 (2.2)
Spain	78 (2.0)	85 (1.7)	77 (2.3)	82 (1.8)	63 (2.3)	69 (2.8)
Sweden	81 (2.4)	88 (1.6)	75 (2.7)	88 (1.8)	72 (2.3)	71 (2.3)
1 Switzerland	83 (2.2)	90 (1.5)	67 (2.4)	77 (2.1)	77 (2.2)	76 (2.3)
† United States	83 (1.6)	87 (1.8)	75 (2.3)	78 (2.0)	59 (3.0)	65 (2.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	87 (1.5)	90 (1.2)	73 (2.2)	83 (1.4)	69 (2.3)	73 (2.0)
Austria	78 (2.4)	87 (2.0)	84 (2.4)	91 (1.7)	76 (2.6)	80 (2.5)
Bulgaria	75 (4.5)	78 (2.5)	72 (2.9)	75 (3.1)	85 (3.2)	74 (4.4)
Netherlands	94 (1.3)	95 (1.7)	74 (3.0)	81 (4.1)	49 (3.4)	58 (3.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	46 (3.6)	59 (3.9)	47 (3.9)	63 (3.2)	51 (3.7)	52 (4.0)
†1 Germany	79 (2.6)	84 (2.3)	78 (2.5)	83 (2.7)	78 (2.1)	74 (2.4)
Romania	64 (2.3)	67 (2.6)	60 (3.0)	69 (2.6)	51 (2.7)	53 (2.8)
Slovenia	87 (2.0)	92 (1.4)	78 (2.2)	88 (1.7)	71 (2.5)	76 (2.5)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	80 (2.6)	86 (2.0)	60 (3.1)	74 (2.9)	61 (3.4)	60 (3.0)
Greece	60 (2.3)	71 (2.3)	62 (2.5)	69 (2.4)	72 (2.1)	82 (1.8)
† South Africa	57 (2.8)	59 (2.8)	28 (2.1)	42 (3.2)	29 (1.9)	32 (2.6)
Thailand	81 (2.2)	83 (1.6)	73 (1.9)	78 (1.7)	65 (2.1)	70 (2.0)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	83 (3.6)	–	86 (1.9)	–	76 (3.4)
Kuwait	–	45 (4.1)	–	65 (3.3)	–	64 (3.2)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

JRCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.3 (Continued)

Percent Correct for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

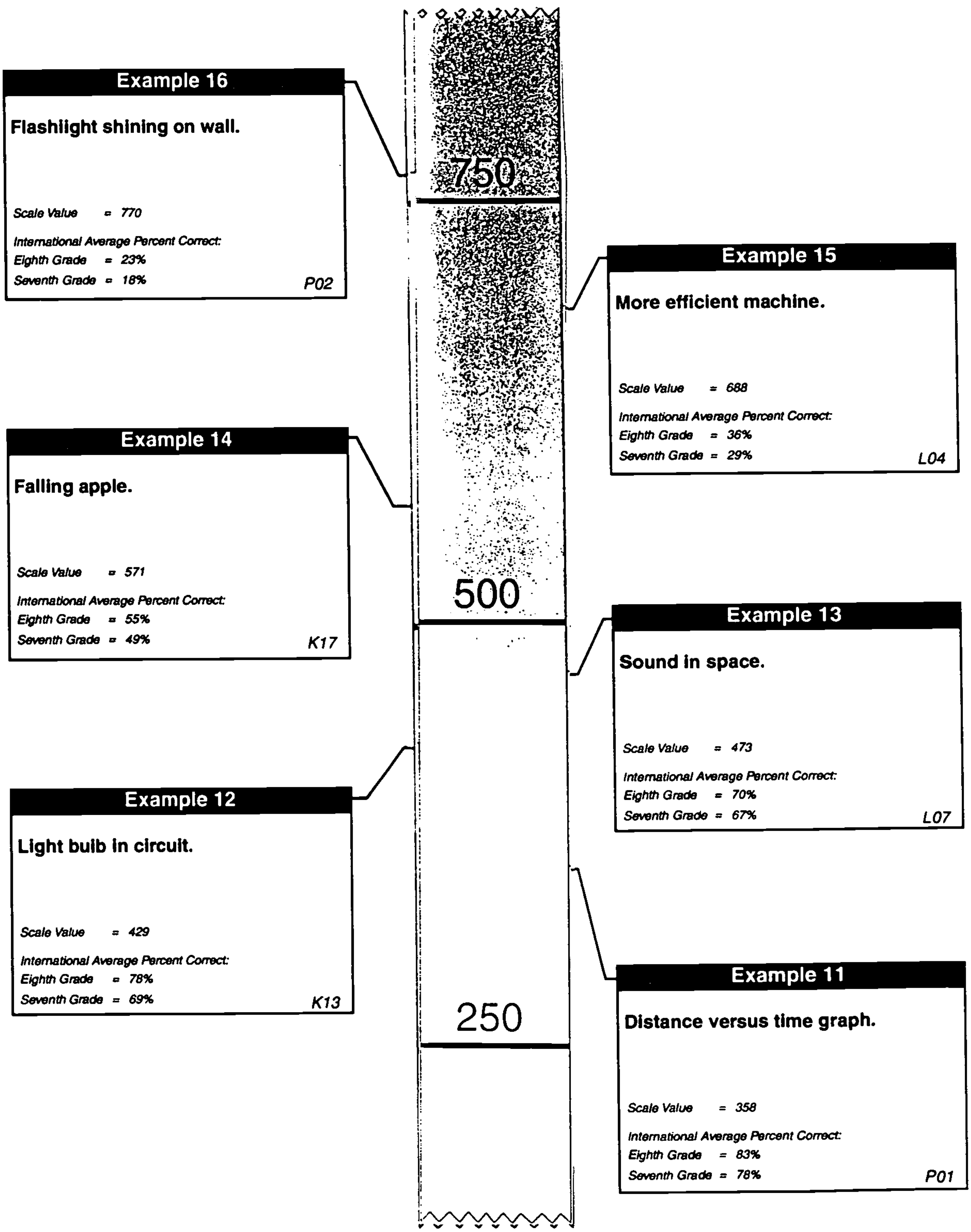
Country	Example 14 Falling apple.		Example 15 More efficient machine.		Example 16 Flashlight shining on wall.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	63 (2.6)	62 (2.3)	44 (2.8)	49 (2.3)	22 (2.1)	31 (3.1)
† Belgium (Fr)	48 (3.4)	52 (3.3)	37 (3.3)	42 (3.2)	14 (2.8)	15 (2.2)
Canada	59 (2.4)	63 (2.7)	42 (2.2)	49 (2.2)	23 (2.1)	29 (1.7)
Cyprus	25 (2.2)	36 (2.6)	22 (2.1)	36 (2.6)	7 (1.6)	6 (1.4)
Czech Republic	84 (2.0)	81 (2.6)	34 (3.0)	48 (3.2)	12 (1.9)	23 (2.7)
†2 England	51 (3.4)	51 (3.4)	42 (3.3)	51 (4.1)	23 (3.3)	35 (3.6)
France	36 (2.7)	51 (3.0)	21 (2.7)	29 (2.4)	11 (1.9)	19 (2.3)
Hong Kong	69 (2.8)	74 (2.2)	17 (2.2)	26 (2.5)	14 (1.7)	17 (2.2)
Hungary	69 (2.6)	72 (2.3)	22 (2.3)	36 (3.0)	38 (3.0)	40 (2.7)
Iceland	41 (3.0)	40 (5.0)	22 (2.7)	33 (4.4)	11 (2.1)	14 (2.6)
Iran, Islamic Rep.	51 (4.5)	51 (3.6)	28 (2.7)	25 (3.4)	40 (3.0)	37 (2.8)
Ireland	49 (3.1)	55 (2.7)	41 (3.0)	54 (2.7)	18 (1.9)	21 (2.1)
Japan	59 (2.0)	58 (2.2)	30 (2.0)	36 (2.0)	27 (1.9)	37 (2.0)
Korea	63 (2.6)	72 (2.6)	46 (2.8)	47 (2.6)	38 (3.1)	37 (2.5)
1 Latvia (LSS)	35 (2.8)	41 (3.3)	10 (1.8)	18 (2.5)	15 (2.3)	20 (2.4)
1 Lithuania	46 (3.4)	61 (3.1)	6 (1.4)	13 (2.1)	8 (1.8)	13 (2.5)
New Zealand	47 (3.0)	54 (2.7)	37 (2.5)	49 (2.6)	28 (2.4)	31 (2.5)
Norway	43 (3.8)	49 (2.9)	20 (2.4)	37 (2.4)	19 (2.6)	25 (2.4)
Portugal	43 (3.0)	53 (2.7)	20 (2.3)	21 (2.4)	9 (1.5)	17 (2.1)
Russian Federation	48 (3.3)	42 (2.4)	21 (2.1)	25 (2.8)	11 (2.3)	10 (1.6)
† Scotland	39 (3.2)	48 (2.6)	40 (3.0)	51 (2.7)	19 (2.2)	22 (2.6)
Singapore	50 (2.8)	59 (2.4)	41 (3.5)	48 (2.7)	20 (2.4)	28 (2.4)
Slovak Republic	77 (2.4)	72 (2.5)	34 (2.6)	48 (2.8)	29 (2.4)	28 (2.4)
Spain	48 (2.5)	55 (2.4)	17 (2.0)	24 (2.1)	19 (2.2)	20 (2.2)
Sweden	37 (2.7)	59 (2.6)	25 (2.2)	42 (2.8)	26 (2.9)	29 (1.8)
1 Switzerland	42 (2.8)	53 (2.9)	33 (2.2)	50 (2.5)	11 (1.3)	11 (1.2)
† United States	55 (3.2)	64 (2.2)	36 (3.2)	48 (2.6)	21 (2.0)	27 (2.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	55 (2.9)	57 (2.0)	36 (2.5)	51 (2.1)	25 (2.1)	28 (1.6)
Austria	51 (3.3)	61 (2.9)	54 (3.1)	62 (3.2)	9 (1.9)	11 (2.3)
Bulgaria	37 (3.6)	41 (5.0)	25 (3.9)	19 (3.3)	38 (3.6)	29 (3.6)
Netherlands	41 (2.8)	58 (2.9)	50 (4.0)	58 (4.2)	22 (3.0)	30 (3.8)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	43 (3.2)	48 (3.6)	10 (1.7)	10 (2.1)	4 (1.2)	6 (1.2)
†1 Germany	46 (3.1)	55 (3.2)	37 (2.9)	42 (3.2)	16 (2.1)	22 (2.9)
Romania	46 (2.7)	50 (2.6)	16 (1.9)	19 (2.4)	14 (2.0)	15 (2.3)
Slovenia	53 (3.4)	57 (2.9)	41 (2.7)	52 (2.7)	18 (2.1)	27 (2.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	47 (3.8)	51 (3.3)	23 (2.6)	36 (3.3)	19 (2.3)	26 (2.7)
Greece	28 (2.1)	30 (2.2)	17 (1.8)	24 (2.2)	17 (1.7)	28 (2.7)
† South Africa	34 (2.4)	36 (2.5)	5 (1.5)	8 (1.8)	6 (1.1)	4 (1.2)
Thailand	59 (2.4)	57 (2.3)	3 (0.8)	5 (1.0)	4 (1.0)	5 (1.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	61 (2.9)	–	53 (3.9)	–	43 (5.2)
Kuwait	–	50 (4.1)	–	19 (4.0)	–	24 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.3

International Difficulty Map for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)



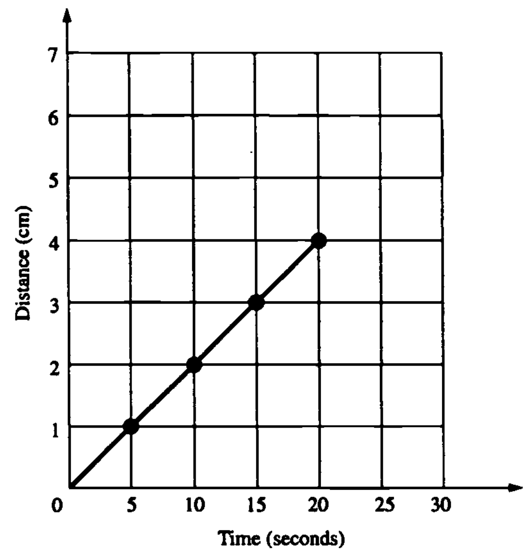
*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

650

EXAMPLE ITEM 11
PHYSICS

Distance versus time graph

The graph shows the progress made by an ant moving along a straight line.



If the ant keeps moving at the same speed, how far will it have traveled at the end of 30 seconds?

A. 5 cm

B. 6 cm

C. 20 cm

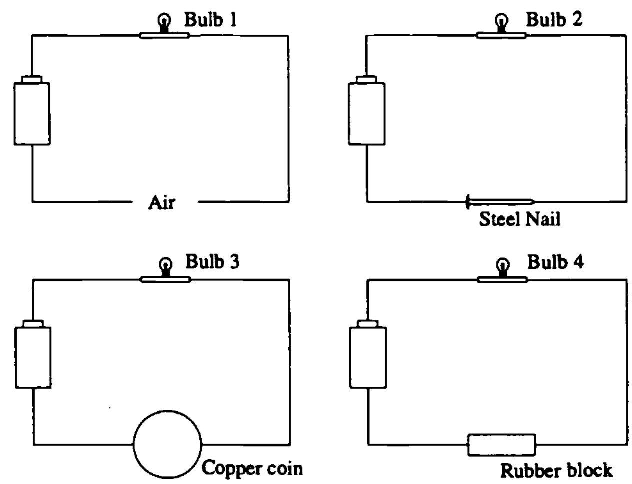
D. 30 cm

Performance Category: Using Tools, Routine Procedures, and Science Processes

EXAMPLE ITEM 12
PHYSICS

Light bulb in circuit

The following diagrams show a flashlight battery and a bulb connected by wires to various substances.



Which of the bulbs will light?

A. 1 and 2 only

(B.) 2 and 3 only

C. 3 and 4 only

D. 1, 2, and 3 only

E. 2, 3, and 4 only

Performance Category: Understanding Complex Information

EXAMPLE ITEM 13
PHYSICS

Sound in space

The crews of two boats at sea can communicate with each other by shouting. Why is it impossible for the crews of two spaceships a similar distance apart in space to do this?

A. The sound is reflected more in space.

B. The pressure is too high inside the spaceships.

C. The spaceships are traveling faster than sound.

(D.) There is no air in space for the sound to travel through.

Performance Category: Understanding Complex Information

EXAMPLE ITEM 14
PHYSICS

Falling apple

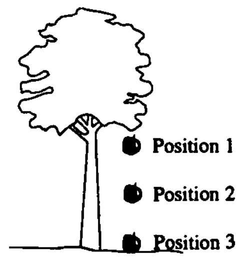
The drawing shows an apple falling to the ground. In which of the three positions does gravity act on the apple?

A. 2 only

B. 1 and 2 only

C. 1 and 3 only

(D.) 1, 2, and 3



Performance Category: Understanding Simple Information

EXAMPLE ITEM 15
PHYSICS

More efficient machine

Machine A and Machine B are each used to clear a field. The table shows how large an area each cleared in 1 hour and how much gasoline each used.

	Area of field cleared in 1 hour	Gasoline used in 1 hour
Machine A	2 hectares	3/4 liter
Machine B	1 hectare	1/2 liter

Which machine is more efficient in converting the energy in gasoline to work? Explain your answer.

Machine A because it did double the amount of work but didn't use ~~dob~~ double the amount of gasoline.

Performance Category: Theorizing, Analyzing, and Solving Problems

653

EXAMPLE ITEM 16
PHYSICS

Flashlight shining on wall

A flashlight close to a wall produces a small circle of light compared to the circle it makes when the flashlight is far from the wall. Does more light reach the wall when the flashlight is further away?

___ Yes

✓ No (Check one)

Explain your answer.

The same amount of light reaches the wall except when it is close it's all on a smaller area.

Performance Category: Theorizing, Analyzing, and Solving Problems

WHAT HAVE STUDENTS LEARNED ABOUT CHEMISTRY?

The chemistry items measured students' knowledge of topics related to chemical transformations as well as the chemical properties and classification of matter. The country-by-country results for the five example items (Examples 17 - 21) are shown in Table 3.4. The item difficulty map for the chemistry example items is portrayed in Figure 3.4. As discussed in Chapter 2, the items covering chemistry were the most difficult for students compared to the other science content areas (international averages correct across all chemistry items of 51% for eighth grade and 43% for seventh grade).

Both Example Items 17 and 18 required students to supply explanations that demonstrated knowledge of the necessity of oxygen for combustion, but performance was very different on the two items. On average, nearly 90% of both seventh- and eighth-grade students (86% and 89%) explained the loss of oxygen or air (using either scientific or non-scientific language) in Example Item 17, which directly indicates the isolation of the flame from the air in the provided diagram. In most countries, seventh- and eighth-grade students performed comparably, with all except Colombia and South Africa having more than 70% correct responses at both grades.

Compared to Example Item 17, Example Item 18 was more complicated, requiring students to explain that carbon dioxide in fire extinguishers displaces oxygen and prevents it from reaching the fire. As might be expected, this item was much more difficult for students, which is reflected in the international averages of 42% and 50%

correct responses for seventh and eighth grades. Across countries, correct responses on 70% or more of the items were achieved on average by eighth-grade students in England (71%), Singapore (70%), Sweden (70%), and Austria (74%). In general, the eighth-grade students performed better than the seventh-grade students, with the most notable increase observed in Scotland (40% to 59%).

Across countries, especially at the seventh-grade, students found Example Item 19 to be rather difficult. On average, 43% of the eighth-grade students across countries, but only 28% of the seventh-grade students, identified ion formation as the correct response. At both grades, about one-third of the students, on average, incorrectly identified the formation of molecules as the result of electron loss. Dramatic across-country variations in performance point to differences in the stage at which atomic structure is first introduced into the curriculum.[3] Many countries had relatively low performance in both seventh and eighth grades, indicating that this topic had not been taught by the eighth grade (Iceland, Norway, and Denmark, for example). For other countries, such as Lithuania and Greece, the substantial increases between seventh and eighth grades indicate curriculum coverage of this topic in the eighth grade. Topic coverage by the seventh grade is indicated by relatively high performances in both grades for several countries, including the eastern European countries of the Czech Republic, Hungary, the Slovak Republic, Bulgaria, Romania, and Slovenia.

In Example Item 20, students were required to use knowledge of the difference between chemical and physical transformations. International averages were low (26% and 31%), and only three countries had more than 50% correct responses at the eighth grade (Iran, Japan, and Singapore). The largest between-grade increase was seen for Japan, from 19% to 54%. As was observed with Example Item 19, Lithuania also had a substantial increase for Example Item 20, from 10% to 37%. Large between-grade differences for Lithuania are also reflected in their achievement on the overall science scale (Table 1.3) and on chemistry, in particular (Table 2.3).

Example Item 21 measured knowledge about the chemical make-up of cells. Internationally, students found this short-answer-format item to be quite difficult, with about one-third (32%) of the eighth-grade and only 21% of seventh-grade students providing the correct response, on average. The highest performance on this item was achieved in Bulgaria, with 50% of seventh- and 68% of eighth-grade students responding correctly. In a few countries, there were large increases in performance between the seventh and eighth grades. This was most pronounced for Singapore, with an increase from 21% to 66%.

3 These results are supported, in most cases, by review of the reports provided by NRCs for the Test-Curriculum Matching Analysis (Appendix B), identifying whether the topic covered by this item was in the intended curriculum at the seventh or eighth grade.

Table 3.4

Percent Correct for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 17 Glass over candle flame.		Example 18 Carbon dioxide fire extinguisher.		Example 19 Atom loses electron.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	92 (1.7)	97 (1.3)	44 (2.8)	58 (4.1)	23 (2.2)	20 (2.7)
† Belgium (Fr)	87 (2.2)	84 (2.5)	30 (3.3)	33 (3.5)	19 (2.8)	25 (4.6)
Canada	91 (1.4)	93 (1.2)	52 (2.9)	61 (2.0)	19 (1.6)	25 (2.1)
Cyprus	78 (1.8)	82 (1.8)	29 (2.4)	41 (3.3)	19 (3.0)	22 (2.8)
Czech Republic	97 (0.9)	98 (1.0)	47 (3.3)	57 (2.8)	72 (2.4)	73 (3.0)
[†2] England	92 (1.7)	97 (1.1)	59 (3.3)	71 (3.1)	14 (2.1)	28 (2.9)
France	85 (1.9)	86 (2.0)	34 (2.7)	50 (3.6)	18 (2.1)	40 (3.6)
Hong Kong	90 (1.7)	91 (1.9)	32 (2.6)	37 (2.6)	56 (2.6)	58 (2.2)
Hungary	94 (1.4)	98 (0.6)	60 (3.1)	62 (2.4)	67 (2.5)	73 (2.7)
Iceland	94 (1.7)	91 (2.6)	45 (4.0)	57 (4.5)	8 (2.0)	9 (2.5)
Iran, Islamic Rep.	93 (1.6)	94 (1.2)	63 (3.9)	63 (2.7)	19 (2.9)	40 (3.8)
Ireland	89 (1.8)	93 (1.5)	54 (2.7)	66 (3.2)	20 (2.4)	46 (2.9)
Japan	86 (1.6)	90 (1.2)	36 (1.9)	45 (2.0)	27 (2.0)	33 (2.0)
Korea	90 (1.8)	93 (1.3)	52 (2.4)	54 (2.5)	20 (2.1)	45 (3.0)
[1] Latvia (LSS)	81 (2.4)	86 (2.8)	28 (3.0)	42 (3.0)	15 (2.1)	39 (3.0)
[1] Lithuania	85 (2.2)	95 (1.7)	17 (2.7)	29 (3.2)	8 (1.9)	65 (3.4)
New Zealand	89 (1.9)	93 (1.3)	48 (3.1)	65 (2.4)	12 (1.9)	18 (2.2)
Norway	93 (1.8)	95 (1.1)	52 (4.3)	63 (2.2)	9 (1.7)	19 (1.9)
Portugal	77 (2.0)	89 (1.5)	24 (2.4)	35 (2.7)	19 (2.2)	68 (2.5)
Russian Federation	92 (1.4)	93 (1.5)	43 (2.5)	54 (3.2)	36 (3.0)	75 (2.4)
† Scotland	79 (2.1)	93 (1.4)	40 (2.6)	59 (3.5)	15 (1.9)	21 (2.1)
Singapore	92 (1.6)	96 (0.7)	56 (3.3)	70 (2.3)	23 (2.5)	51 (2.9)
Slovak Republic	96 (1.0)	95 (1.4)	48 (2.6)	46 (2.8)	69 (2.6)	77 (2.6)
Spain	85 (1.9)	89 (1.7)	36 (2.6)	43 (2.9)	51 (3.5)	70 (2.3)
Sweden	94 (1.2)	97 (0.9)	70 (2.7)	70 (2.3)	10 (1.8)	44 (3.1)
[1] Switzerland	95 (1.0)	96 (1.0)	48 (2.6)	57 (2.5)	15 (1.7)	22 (2.2)
† United States	86 (2.0)	90 (1.3)	53 (3.0)	62 (2.7)	30 (2.8)	47 (2.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	89 (1.8)	91 (1.2)	57 (2.4)	61 (1.9)	13 (1.4)	31 (2.2)
Austria	95 (1.3)	95 (1.5)	63 (3.1)	74 (2.9)	64 (3.2)	64 (3.1)
Bulgaria	92 (2.7)	92 (2.5)	44 (4.5)	46 (4.0)	64 (3.5)	70 (4.4)
Netherlands	93 (1.7)	96 (1.3)	41 (3.4)	56 (3.3)	12 (2.1)	21 (3.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	54 (3.1)	58 (3.1)	13 (2.4)	23 (4.1)	31 (3.6)	40 (4.1)
[†1] Germany	92 (1.6)	92 (2.0)	62 (3.3)	69 (3.0)	24 (3.0)	38 (4.0)
Romania	84 (1.9)	87 (1.7)	34 (2.9)	33 (2.5)	60 (3.0)	74 (2.6)
Slovenia	97 (1.0)	99 (0.4)	49 (3.2)	52 (3.2)	81 (2.5)	80 (2.1)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	90 (2.0)	97 (1.0)	21 (2.4)	33 (3.0)	8 (2.4)	17 (2.2)
Greece	79 (2.0)	86 (1.8)	31 (2.3)	37 (2.3)	15 (1.8)	53 (2.6)
† South Africa	35 (3.5)	35 (3.3)	12 (2.2)	15 (2.9)	14 (1.4)	13 (1.7)
Thailand	78 (2.0)	81 (1.8)	27 (2.7)	34 (2.4)	10 (1.2)	15 (1.6)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
[1] Israel	–	82 (2.9)	–	63 (4.5)	–	72 (4.9)
Kuwait	–	71 (4.8)	–	49 (4.6)	–	31 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.4 (Continued)

Percent Correct for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

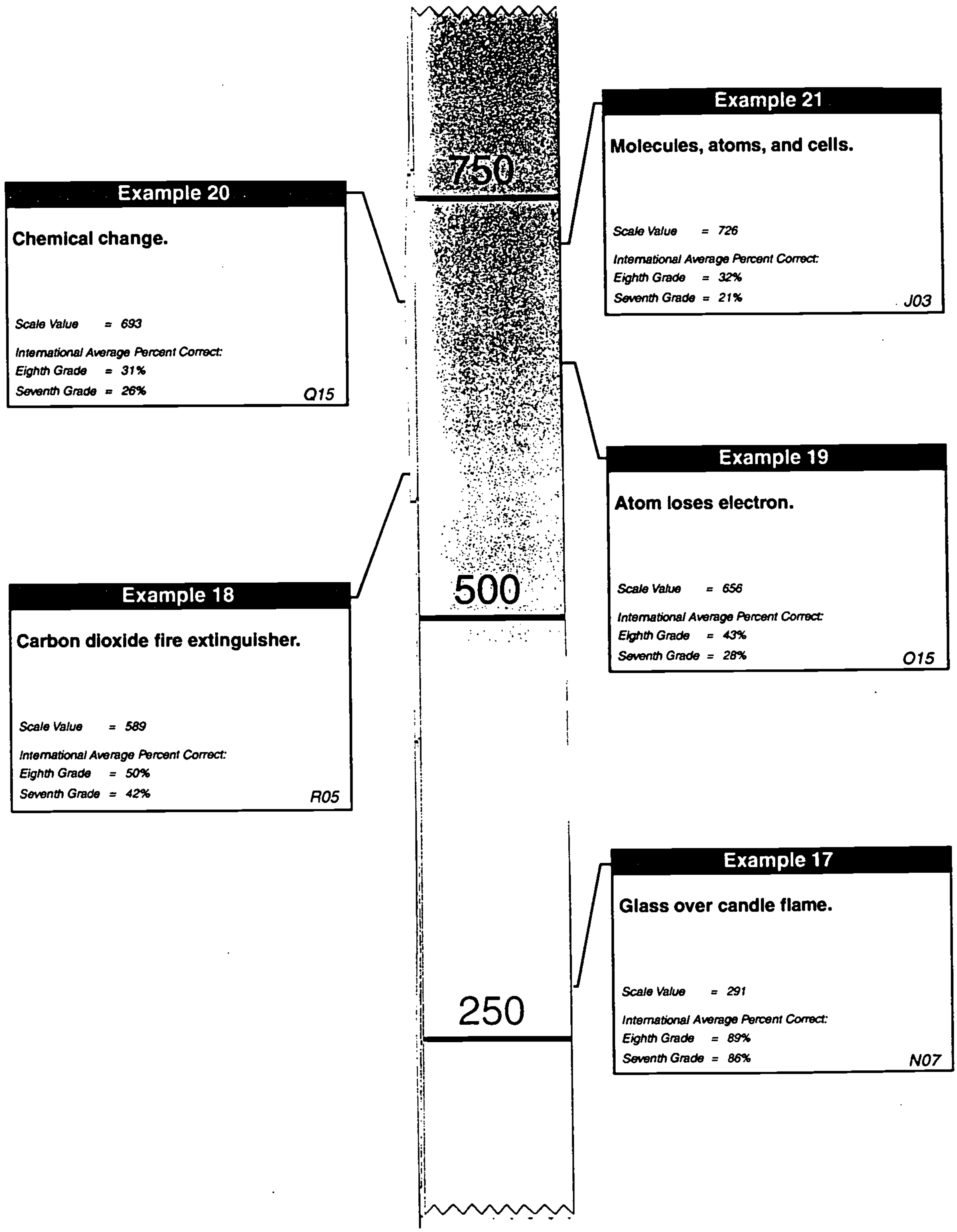
Country	Example 20 Chemical change.		Example 21 Molecules, atoms, and cells.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	25 (2.4)	31 (3.0)	17 (1.8)	19 (2.3)
† Belgium (Fr)	11 (2.2)	13 (1.9)	9 (1.7)	20 (2.8)
Canada	37 (2.1)	38 (2.6)	23 (2.3)	24 (1.6)
Cyprus	–	–	11 (1.6)	35 (2.9)
Czech Republic	31 (3.2)	34 (4.0)	32 (3.0)	43 (3.9)
†2 England	37 (3.4)	41 (3.5)	25 (2.9)	34 (3.0)
France	21 (2.1)	19 (2.8)	17 (2.0)	25 (2.6)
Hong Kong	24 (2.6)	30 (2.5)	26 (2.5)	32 (2.5)
Hungary	17 (2.1)	18 (2.2)	32 (2.2)	42 (3.1)
Iceland	21 (2.6)	20 (2.9)	9 (1.8)	12 (2.8)
Iran, Islamic Rep.	46 (2.8)	52 (2.5)	14 (2.2)	23 (2.4)
Ireland	35 (2.3)	39 (2.9)	25 (2.3)	25 (2.4)
Japan	19 (1.8)	54 (1.9)	32 (2.0)	47 (2.2)
Korea	24 (2.8)	48 (3.0)	17 (1.9)	30 (2.3)
1 Latvia (LSS)	15 (2.4)	26 (3.0)	12 (1.8)	38 (2.9)
1 Lithuania	10 (2.1)	37 (3.4)	14 (2.1)	39 (2.9)
New Zealand	33 (2.6)	42 (2.4)	16 (2.0)	27 (2.5)
Norway	6 (1.5)	12 (1.7)	12 (1.8)	29 (1.9)
Portugal	20 (2.1)	40 (2.7)	18 (1.7)	37 (2.4)
Russian Federation	15 (1.8)	31 (4.6)	41 (3.4)	53 (3.6)
† Scotland	24 (2.3)	33 (2.9)	21 (2.1)	27 (2.8)
Singapore	62 (3.0)	62 (2.1)	21 (2.2)	66 (2.6)
Slovak Republic	31 (2.1)	31 (2.4)	28 (2.3)	42 (2.6)
Spain	13 (1.9)	17 (2.2)	30 (2.4)	41 (2.2)
Sweden	16 (2.0)	22 (1.9)	21 (2.7)	39 (2.6)
1 Switzerland	19 (1.8)	25 (2.4)	9 (1.3)	20 (1.6)
† United States	40 (2.7)	43 (2.7)	27 (2.7)	29 (1.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	37 (2.4)	47 (2.3)	18 (1.4)	27 (2.0)
Austria	28 (2.4)	34 (3.5)	17 (2.2)	28 (3.6)
Bulgaria	33 (3.2)	33 (4.1)	50 (4.9)	68 (4.7)
Netherlands	31 (4.1)	35 (3.7)	15 (2.8)	24 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	17 (2.0)	18 (3.9)	17 (2.6)	21 (2.5)
†1 Germany	21 (2.4)	25 (2.7)	16 (2.1)	21 (2.5)
Romania	25 (2.2)	21 (2.4)	29 (2.5)	31 (3.2)
Slovenia	28 (2.6)	22 (2.6)	24 (2.1)	28 (2.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	31 (3.2)	32 (3.1)	14 (2.3)	29 (2.8)
Greece	21 (2.0)	27 (2.0)	32 (2.2)	44 (2.5)
† South Africa	21 (1.5)	26 (2.1)	7 (1.3)	7 (1.6)
Thailand	23 (1.6)	16 (1.9)	21 (2.0)	31 (2.8)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	23 (3.5)	–	26 (3.6)
Kuwait	–	31 (3.3)	–	20 (3.3)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Cyprus on Example 20.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.4

International Difficulty Map for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

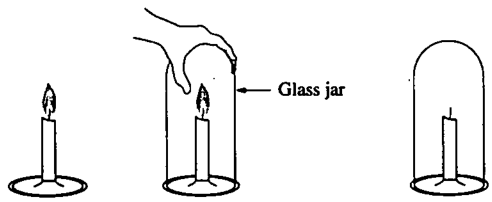


*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 17
CHEMISTRY

Glass over candle flame

When a glass jar is placed over a lighted candle, the flame goes out.



Why does this happen? The flame needs a supply of oxygen to stay alive. The jar cuts off the supply and when it is all burnt by the candle the candle cannot burn anymore so it goes out.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 18
CHEMISTRY

Carbon dioxide fire extinguisher

Carbon dioxide is the active material in some fire extinguishers. How does carbon dioxide extinguish a fire?

A fire needs oxygen to burn so a fire extinguisher sprays out the carbon dioxide to replace the presence of oxygen. without oxygen, a fire can't burn.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 19
CHEMISTRY

Atom loses electron

If a neutral atom loses an electron, what is formed?

A. A gas

(B.) An ion

C. An acid

D. A molecule

Performance Category: Understanding Simple Information

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EXAMPLE ITEM 20
CHEMISTRY

Chemical change

Which is NOT an example of a chemical change?

(A.) Boiling water

B. Rusting iron

C. Burning wood

D. Baking bread

Performance Category: Understanding simple Information

EXAMPLE ITEM 21
CHEMISTRY

Molecules, atoms, and cells

The words *cloth, thread,* and *fiber* can be used in the following sentence: *cloth* consists of *threads* which are made of *fiber.*

Use the words *molecules, atoms,* and *cells* to complete the following sentence:

cells consist of molecules which are made of atoms.

Performance Category: Understanding Simple Information

What Have Students Learned About Environmental Issues and the Nature of Science?

The fifth science category includes six items about environmental and resource issues, six items covering the nature of scientific knowledge, and two items involving the interaction of science and technology. Table 3.5 shows the percent correct and Figure 3.5 the international difficulty map for four example items (Example Items 22 - 25), illustrating the types of items and student performance expectations covered in these science areas.

Example Items 22, 23, and 24 are all related to the nature of scientific knowledge. Item 22, requiring deductive reasoning to draw conclusions based on experimental observations, was the easiest of the three internationally. On average, nearly two-thirds of the eighth-grade and more than half of the seventh-grade students answered this item correctly (62% and 55%). Performances for individual countries ranged from a low of 23% to 30% correct at both grades in Japan, South Africa, and Kuwait, to more than 75% correct at both grades in Bulgaria. In comparison to Example Item 22, Example Item 23, requiring knowledge of the precision of replicated scientific measurements, was slightly more difficult. On average, it was answered correctly by about half of the students at both the seventh and eighth grades (49% and 53%). Even a little more difficult for students was Example Item 24, which involved the design of experiments and required choosing the experimental procedure required to test a hypothesis. Internationally, at both grades, fewer than half of the students, on average, chose the correct response (40% at seventh grade and 45% at eighth grade). There was little between-grade improvement in most of the individual countries.

Example Item 25, measuring knowledge of the principal cause of acid rain, was related to environmental issues. Across countries, about one-third or fewer students in both grades selected the correct response related to the burning of fossil fuels (on average, 31% at seventh grade and 35% at eighth grade). There was little variation across countries, and in only two countries (Slovenia and Thailand) did 50% or more of the students respond correctly at both grades.

Table 3.5

Percent Correct for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grade (Seventh and Eighth Grades*)

Country	Example 22 Liquid evaporation experiment.		Example 23 Replication of measurements.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	71 (2.5)	76 (3.4)	47 (2.5)	42 (3.4)
† Belgium (Fr)	68 (2.6)	77 (3.2)	42 (3.1)	45 (2.9)
Canada	70 (2.1)	78 (1.8)	61 (2.4)	58 (2.0)
Cyprus	49 (2.6)	65 (2.5)	46 (2.8)	51 (3.3)
Czech Republic	46 (3.2)	59 (2.9)	61 (2.9)	64 (2.7)
†2 England	59 (3.3)	72 (3.4)	62 (2.7)	64 (3.5)
France	65 (2.6)	75 (2.3)	42 (2.6)	51 (2.6)
Hong Kong	63 (2.7)	68 (2.6)	70 (3.5)	70 (2.5)
Hungary	68 (2.5)	68 (2.7)	29 (2.4)	39 (2.9)
Iceland	48 (4.2)	56 (2.8)	52 (3.6)	59 (3.5)
Iran, Islamic Rep.	63 (4.8)	67 (2.7)	32 (3.9)	39 (3.0)
Ireland	62 (2.2)	74 (2.3)	55 (2.3)	54 (2.7)
Japan	27 (1.7)	30 (2.1)	30 (2.1)	39 (2.0)
Korea	76 (2.6)	79 (2.4)	78 (2.7)	85 (1.8)
1 Latvia (LSS)	54 (2.8)	69 (3.0)	45 (3.0)	49 (3.4)
1 Lithuania	39 (3.1)	58 (3.4)	48 (3.1)	50 (3.1)
New Zealand	63 (2.7)	68 (2.5)	49 (2.9)	63 (2.8)
Norway	53 (3.3)	57 (2.8)	54 (3.6)	53 (2.7)
Portugal	34 (2.6)	54 (2.9)	35 (2.7)	35 (1.9)
Russian Federation	48 (2.3)	59 (2.7)	60 (3.0)	61 (2.0)
† Scotland	67 (3.0)	72 (2.8)	53 (2.6)	63 (2.8)
Singapore	68 (2.4)	80 (1.8)	58 (2.9)	65 (2.2)
Slovak Republic	33 (2.6)	50 (3.3)	65 (2.5)	70 (2.6)
Spain	53 (2.7)	60 (2.8)	24 (2.1)	28 (2.3)
Sweden	51 (2.9)	61 (2.3)	62 (2.7)	68 (2.1)
1 Switzerland	43 (2.7)	52 (2.7)	26 (2.2)	25 (1.9)
† United States	69 (2.4)	75 (2.0)	58 (3.0)	61 (1.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	66 (2.3)	70 (2.5)	62 (2.5)	63 (1.9)
Austria	57 (2.9)	58 (2.8)	29 (2.5)	36 (2.7)
Bulgaria	77 (3.2)	84 (2.8)	50 (4.1)	56 (4.4)
Netherlands	72 (3.7)	77 (3.0)	55 (3.3)	58 (4.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	44 (4.2)	42 (3.7)	32 (3.1)	39 (4.0)
†1 Germany	42 (3.0)	60 (3.1)	32 (2.9)	33 (2.9)
Romania	48 (2.6)	53 (2.9)	46 (2.8)	54 (2.7)
Slovenia	73 (2.4)	77 (2.7)	77 (2.2)	73 (2.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	48 (2.9)	61 (3.4)	48 (3.7)	58 (3.1)
Greece	44 (2.4)	57 (2.5)	56 (2.0)	63 (3.3)
† South Africa	23 (2.8)	25 (3.1)	26 (2.0)	23 (2.1)
Thailand	47 (2.4)	45 (2.1)	70 (2.5)	77 (2.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	64 (3.9)	–	28 (3.8)
Kuwait	–	28 (3.0)	–	60 (3.5)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.5 (Continued)

Percent Correct for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grade (Seventh and Eighth Grades*)

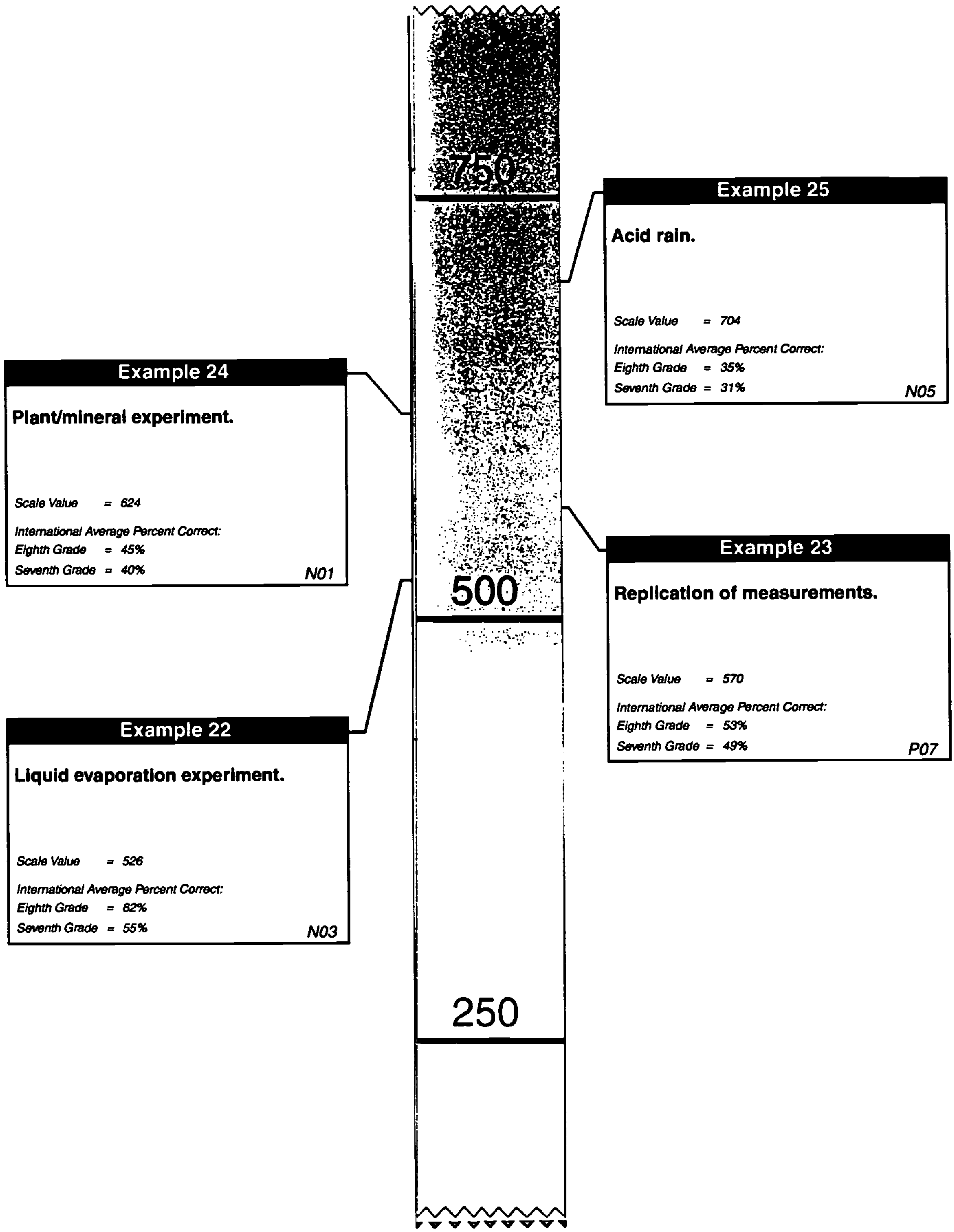
Country	Example 24 Plant/mineral experiment. Seventh Grade	Example 24 Eighth Grade	Example 25 Acid rain. Seventh Grade	Example 25 Eighth Grade
† Belgium (Fl)	42 (2.7)	47 (4.1)	30 (2.6)	30 (3.1)
† Belgium (Fr)	40 (3.2)	40 (2.9)	–	–
Canada	46 (2.5)	50 (2.1)	27 (2.3)	31 (2.3)
Cyprus	30 (2.7)	31 (2.9)	25 (2.5)	23 (2.2)
Czech Republic	39 (3.1)	42 (2.5)	38 (3.3)	45 (3.0)
†2 England	40 (2.7)	44 (3.2)	29 (3.3)	44 (3.5)
France	43 (2.4)	43 (2.6)	–	–
Hong Kong	52 (2.4)	57 (2.7)	34 (2.3)	38 (2.6)
Hungary	25 (2.4)	30 (2.6)	40 (2.6)	41 (2.7)
Iceland	33 (4.0)	47 (4.1)	36 (2.9)	35 (4.5)
Iran, Islamic Rep.	22 (2.3)	31 (3.5)	24 (5.3)	23 (2.7)
Ireland	38 (2.3)	36 (2.4)	36 (2.6)	43 (2.6)
Japan	58 (2.2)	57 (1.9)	37 (1.8)	46 (2.0)
Korea	30 (2.5)	36 (2.8)	48 (2.9)	50 (3.0)
1 Latvia (LSS)	37 (2.9)	45 (3.3)	21 (2.5)	25 (2.8)
1 Lithuania	29 (2.8)	26 (3.1)	23 (2.7)	24 (2.8)
New Zealand	44 (2.7)	47 (2.6)	26 (2.4)	31 (2.0)
Norway	47 (3.0)	50 (2.7)	24 (2.4)	31 (2.3)
Portugal	36 (2.4)	49 (2.2)	25 (2.3)	32 (2.2)
Russian Federation	26 (2.3)	35 (4.0)	19 (2.1)	21 (2.5)
† Scotland	39 (2.4)	40 (2.8)	28 (2.2)	32 (3.0)
Singapore	64 (2.6)	71 (1.8)	31 (2.2)	31 (2.3)
Slovak Republic	44 (2.8)	43 (3.0)	21 (2.7)	14 (1.9)
Spain	45 (2.5)	49 (2.7)	37 (2.4)	34 (2.5)
Sweden	59 (2.8)	63 (2.1)	26 (2.5)	31 (1.9)
1 Switzerland	46 (2.8)	51 (3.0)	35 (2.4)	39 (2.6)
† United States	41 (2.6)	47 (2.5)	32 (2.5)	32 (1.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	42 (2.1)	48 (1.5)	32 (2.0)	42 (2.0)
Austria	43 (2.8)	52 (3.1)	40 (2.2)	55 (3.1)
Bulgaria	42 (4.2)	71 (3.7)	20 (2.8)	47 (4.5)
Netherlands	62 (3.4)	71 (2.9)	38 (3.6)	44 (3.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	44 (3.5)	44 (4.4)	25 (2.6)	31 (3.9)
†1 Germany	40 (3.1)	42 (2.8)	38 (2.8)	40 (2.8)
Romania	30 (2.7)	35 (2.7)	25 (2.5)	26 (2.4)
Slovenia	35 (2.8)	41 (2.9)	59 (2.6)	55 (3.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	39 (2.8)	36 (3.6)	22 (2.5)	27 (2.6)
Greece	42 (2.1)	44 (2.3)	21 (1.8)	21 (1.9)
† South Africa	35 (2.2)	33 (2.2)	23 (1.9)	22 (2.1)
Thailand	28 (2.3)	29 (2.6)	51 (2.5)	62 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	52 (4.6)	–	30 (3.4)
Kuwait	–	36 (3.7)	–	46 (4.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Belgium (Fr), France, and Japan on Example 25.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.5

International Difficulty Map for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)



*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 22
ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Liquid evaporation experiment

A cupful of water and a similar cupful of gasoline were placed on a table near a window on a hot sunny day. A few hours later it was observed that both the cups had less liquid in them but that there was less gasoline left than water. What does this experiment show?

A. All liquids evaporate.

B. Gasoline gets hotter than water.

C. Some liquids evaporate faster than others.

D. Liquids will only evaporate in sunshine.

E. Water gets hotter than gasoline

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 23
ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Replication of measurements

Whenever scientists carefully measure any quantity many times, they expect that

A. all of the measurements will be exactly the same

B. only two of the measurements will be exactly the same

C. all but one of the measurements will be exactly the same

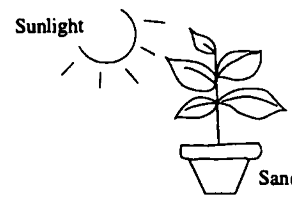
D. most of the measurements will be close but not exactly the same

Performance Category: Understanding Simple Information

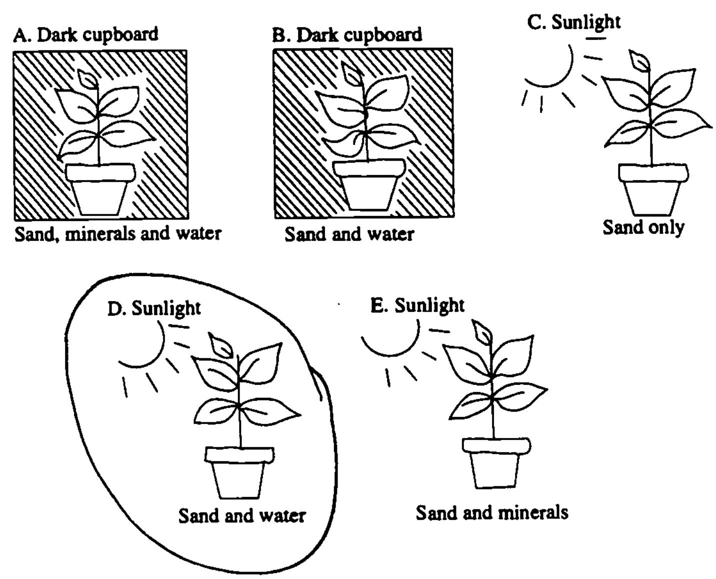
Example Item 24
Environmental Issues and the Nature of Science

Plant/mineral experiment

A girl had an idea that plants needed minerals from the soil for healthy growth. She placed a plant in the Sun, as shown in the diagram below.



In order to check her idea she also needed to use another plant. Which of the following should she use?



Performance Category: Investigating the Natural World

Example Item 25
Environmental Issues and the Nature of Science

Acid rain

One of the principal causes of acid rain is

A. waste acid from chemical factories being pumped into rivers

B. acid from chemical laboratories evaporating into the air

C. gases from burning coal and oil dissolving in water in the atmosphere

D. gases from air conditioners and refrigerators escaping into the atmosphere

Performance Category: Understanding Simple Information

Chapter 4

Students' Backgrounds and Attitudes Toward the Sciences

To provide an educational context for interpreting the science achievement results, TIMSS collected a full range of descriptive information from students about their backgrounds as well as their activities in and out of school. This chapter presents eighth-grade students' responses to a selected subset of these questions. In an effort to explore the degree to which the students' home and social environment fostered academic development, some of the questions presented herein address the availability of educational resources in the home. Another group of questions is provided to help examine whether or not students typically spend their out-of-school time in ways that support their in-school academic performance. Because students' attitudes and opinions about science reflect what happens in school and their perceptions of the value of science in broader social contexts, results also are described for several questions from the affective domain. More specifically, these questions asked students to express their opinions about the abilities necessary for success in science, provide information about what motivates them to do well in science, and indicate their attitudes towards science.

Student and teacher questionnaire data for two countries are unavailable for this report and thus do not appear in this chapter – Bulgaria and South Africa. Bulgaria had complications with data entry, and South Africa joined the study later than the other countries.

What Educational Resources Do Students Have in Their Homes?

Students specifically were asked about the availability at home of three types of educational resources – a dictionary, a study desk or table for their own use, and a computer. Table 4.1 reveals that in most countries, eighth-grade students with all three of these educational study aids had higher science achievement than students who did not have ready access to these study aids. In almost all the countries, nearly all students reported having a dictionary in their homes. There was more variation among countries in the percentages of students reporting their own study desk or table. Of the three study aids, the most variation was in the number of eighth-grade students reporting having a home computer. In several countries, more than 70% of students reported having a computer in the home, including the more than 85% who so reported in England, the Netherlands, and Scotland. For these three countries, it is likely that these high percentages include computers used for entertainment purposes, such as computer games.

The number of books in the home can be an indicator of a home environment that values literacy, the acquisition of knowledge, and general academic support. Table 4.2 presents eighth-grade students' reports about the number of books in their homes in relation to their achievement on the TIMSS science test. In most countries, the

Table 4.1

Students' Reports on Educational Aids in the Home: Dictionary, Study Desk/Table and Computer - Science - Upper Grade (Eighth Grade*)

Country	Have All Three Educational Aids		Do Not Have All Three Educational Aids		Have Dictionary	Have Study Desk/Table for Own Use	Have Computer
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Percent of Students	Percent of Students
Australia	66 (1.2)	557 (4.3)	34 (1.2)	524 (4.2)	88 (0.7)	97 (0.4)	73 (1.2)
Austria	56 (1.5)	566 (4.1)	44 (1.5)	547 (4.5)	98 (0.3)	93 (0.8)	59 (1.5)
Belgium (Fl)	64 (1.3)	559 (3.9)	36 (1.3)	536 (5.2)	99 (0.5)	96 (0.5)	67 (1.3)
Belgium (Fr)	58 (1.4)	483 (3.1)	42 (1.4)	456 (3.6)	97 (0.5)	96 (0.5)	60 (1.4)
Canada	57 (1.4)	545 (2.5)	43 (1.4)	514 (3.0)	97 (0.4)	89 (0.6)	61 (1.3)
Colombia	10 (1.2)	431 (10.3)	90 (1.2)	410 (3.9)	96 (0.5)	84 (1.0)	11 (1.2)
Cyprus	37 (0.9)	475 (3.0)	63 (0.9)	458 (2.5)	97 (0.3)	96 (0.5)	39 (0.9)
Czech Republic	33 (1.3)	596 (6.6)	67 (1.3)	563 (3.3)	94 (0.6)	90 (0.6)	36 (1.2)
Denmark	66 (1.5)	487 (3.2)	34 (1.5)	465 (4.4)	85 (1.1)	98 (0.3)	76 (1.2)
England	80 (1.0)	558 (3.8)	20 (1.0)	534 (5.3)	98 (0.4)	90 (0.8)	89 (0.8)
France	49 (1.3)	505 (2.9)	51 (1.3)	492 (3.1)	99 (0.2)	96 (0.4)	50 (1.3)
Germany	66 (1.1)	542 (4.3)	34 (1.1)	514 (6.5)	98 (0.4)	93 (0.6)	71 (1.0)
Greece	28 (1.0)	513 (4.3)	72 (1.0)	493 (2.2)	97 (0.3)	93 (0.5)	29 (1.0)
Hong Kong	33 (1.8)	540 (5.2)	67 (1.8)	516 (4.8)	99 (0.1)	80 (1.1)	39 (1.9)
Hungary	32 (1.2)	586 (3.3)	68 (1.2)	540 (3.1)	77 (1.2)	92 (0.7)	37 (1.2)
Iceland	72 (1.6)	495 (5.1)	28 (1.6)	488 (2.9)	95 (0.5)	96 (0.6)	77 (1.4)
Iran, Islamic Rep.	1 (0.3)	~ ~	99 (0.3)	472 (2.3)	54 (1.5)	40 (2.0)	4 (0.4)
Ireland	67 (1.2)	548 (4.4)	33 (1.2)	522 (6.1)	99 (0.3)	86 (0.9)	78 (1.1)
Israel	75 (2.1)	540 (5.9)	25 (2.1)	495 (4.7)	100 (0.2)	98 (0.4)	76 (2.1)
Japan	- -	- -	- -	- -	- -	- -	- -
Korea	38 (1.2)	585 (2.7)	62 (1.2)	553 (2.2)	98 (0.2)	95 (0.4)	39 (1.2)
Kuwait	38 (2.0)	434 (6.9)	62 (2.0)	429 (3.4)	84 (1.1)	73 (2.0)	53 (2.1)
Latvia (LSS)	13 (0.8)	487 (5.4)	87 (0.8)	486 (2.6)	94 (0.6)	98 (0.3)	13 (0.9)
Lithuania	35 (1.3)	481 (4.3)	65 (1.3)	474 (3.9)	88 (1.0)	95 (0.6)	42 (1.4)
Netherlands	83 (1.3)	563 (6.4)	17 (1.3)	548 (6.1)	100 (0.1)	99 (0.2)	85 (1.2)
New Zealand	56 (1.4)	541 (4.9)	44 (1.4)	509 (4.9)	99 (0.2)	91 (0.6)	60 (1.3)
Norway	63 (1.1)	535 (2.3)	37 (1.1)	516 (3.0)	97 (0.3)	98 (0.2)	64 (1.1)
Portugal	35 (1.8)	496 (3.1)	65 (1.8)	471 (2.1)	98 (0.4)	84 (0.9)	39 (1.8)
Romania	8 (1.0)	534 (9.5)	92 (1.0)	483 (4.7)	60 (1.6)	69 (1.3)	19 (1.2)
Russian Federation	30 (1.4)	545 (4.9)	70 (1.4)	536 (4.3)	88 (1.1)	95 (0.7)	35 (1.5)
Scotland	74 (1.2)	527 (5.4)	26 (1.2)	494 (6.5)	96 (0.5)	84 (1.2)	90 (0.6)
Singapore	47 (1.5)	627 (6.1)	53 (1.5)	591 (5.5)	99 (0.1)	92 (0.5)	49 (1.5)
Slovak Republic	27 (1.2)	567 (4.0)	73 (1.2)	536 (3.5)	96 (0.5)	86 (0.9)	31 (1.2)
Slovenia	43 (1.4)	581 (3.2)	57 (1.4)	544 (2.8)	94 (0.5)	93 (0.6)	47 (1.3)
Spain	40 (1.3)	529 (2.7)	60 (1.3)	509 (2.0)	99 (0.1)	93 (0.5)	42 (1.2)
Sweden	58 (1.3)	549 (2.9)	42 (1.3)	518 (3.7)	94 (0.4)	100 (0.1)	60 (1.3)
Switzerland	63 (1.2)	532 (2.8)	37 (1.2)	507 (3.1)	97 (0.4)	95 (0.4)	66 (1.2)
Thailand	4 (0.8)	545 (11.0)	96 (0.8)	525 (3.7)	68 (2.1)	66 (2.1)	4 (0.9)
United States	56 (1.7)	559 (4.1)	44 (1.7)	505 (5.2)	97 (0.4)	90 (0.7)	59 (1.7)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.2

Students' Reports on the Number of Books in the Home
Science - Upper Grade (Eighth Grade*)

Country	None or Very Few (0-10 Books)		About One Shelf (11–25 Books)		About One Bookcase (26-100 Books)		About Two Bookcases (101-200 Books)		Three or More Bookcases (More than 200 Books)	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	3 (0.3)	460 (7.8)	7 (0.6)	492 (7.5)	24 (0.8)	524 (4.3)	25 (0.6)	549 (3.8)	42 (1.4)	573 (4.2)
Austria	11 (1.0)	509 (6.5)	17 (1.1)	528 (7.5)	31 (1.2)	554 (5.1)	17 (0.9)	582 (4.9)	24 (1.4)	590 (4.7)
Belgium (Fl)	11 (1.2)	515 (6.5)	18 (0.8)	537 (6.0)	33 (1.0)	552 (5.2)	18 (1.0)	566 (4.9)	21 (0.9)	563 (5.0)
Belgium (Fr)	7 (0.7)	408 (11.0)	10 (0.7)	433 (4.5)	28 (1.1)	462 (4.7)	21 (0.9)	482 (4.0)	34 (1.5)	497 (3.3)
Canada	4 (0.3)	482 (8.0)	10 (0.7)	493 (4.0)	28 (1.0)	522 (3.5)	25 (0.8)	542 (3.5)	33 (1.4)	550 (3.6)
Colombia	26 (1.5)	397 (4.5)	31 (1.1)	404 (5.3)	27 (1.3)	424 (4.4)	9 (0.7)	426 (8.4)	7 (1.0)	434 (9.9)
Cyprus	6 (0.6)	425 (6.5)	18 (0.8)	438 (3.7)	34 (0.8)	465 (3.4)	23 (0.8)	486 (3.6)	20 (0.8)	480 (4.5)
Czech Republic	1 (0.2)	~ ~	4 (0.5)	520 (7.1)	30 (1.5)	552 (3.9)	32 (0.9)	577 (4.3)	34 (1.8)	597 (6.6)
Denmark	3 (0.6)	425 (12.6)	9 (0.8)	446 (8.6)	30 (1.2)	467 (4.1)	21 (0.9)	484 (3.9)	37 (1.5)	499 (4.0)
England	6 (0.6)	472 (8.9)	13 (1.0)	502 (4.4)	27 (1.3)	536 (5.3)	22 (0.8)	564 (6.2)	32 (1.5)	596 (4.6)
France	5 (0.5)	460 (8.6)	17 (1.0)	477 (4.0)	36 (1.1)	497 (3.8)	21 (1.0)	514 (3.9)	20 (1.2)	511 (4.5)
Germany	8 (0.8)	456 (7.4)	14 (1.1)	483 (6.9)	26 (1.0)	519 (4.4)	19 (0.9)	555 (6.8)	33 (1.7)	569 (5.1)
Greece	5 (0.4)	467 (6.1)	22 (0.9)	475 (2.9)	43 (0.9)	499 (2.5)	18 (0.7)	515 (4.8)	12 (0.7)	525 (4.8)
Hong Kong	21 (1.2)	500 (6.7)	29 (1.0)	525 (4.5)	29 (0.9)	529 (5.2)	10 (0.7)	542 (6.8)	10 (0.9)	536 (7.0)
Hungary	4 (0.6)	487 (12.8)	8 (0.7)	510 (5.8)	25 (1.0)	534 (3.8)	21 (1.0)	559 (4.2)	42 (1.4)	579 (3.0)
Iceland	1 (0.2)	~ ~	5 (0.8)	463 (10.9)	29 (1.4)	482 (4.8)	28 (1.2)	491 (5.1)	37 (1.7)	510 (6.7)
Iran, Islamic Rep.	37 (1.8)	457 (3.5)	32 (0.9)	475 (3.3)	17 (0.9)	478 (5.9)	6 (0.5)	481 (10.1)	7 (0.7)	487 (6.7)
Ireland	7 (0.6)	471 (7.4)	16 (0.8)	504 (5.2)	34 (1.0)	538 (4.5)	21 (0.7)	560 (4.5)	22 (1.2)	568 (5.9)
Israel	4 (0.6)	487 (12.5)	13 (1.6)	495 (8.3)	31 (1.9)	517 (7.2)	26 (1.4)	541 (6.4)	25 (2.0)	555 (7.7)
Japan	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Korea	10 (0.6)	510 (5.2)	12 (0.8)	531 (3.9)	33 (0.9)	562 (2.9)	23 (0.8)	581 (2.8)	21 (0.9)	597 (4.1)
Kuwait	22 (1.4)	424 (5.3)	27 (1.5)	428 (4.8)	28 (1.6)	443 (4.3)	10 (1.0)	443 (6.9)	13 (0.9)	428 (6.0)
Latvia (LSS)	1 (0.3)	~ ~	4 (0.6)	434 (7.3)	17 (1.0)	474 (4.1)	21 (1.1)	477 (4.7)	57 (1.4)	496 (3.0)
Lithuania	3 (0.4)	429 (9.9)	17 (0.9)	451 (5.6)	35 (1.2)	469 (4.0)	21 (0.9)	491 (4.5)	24 (1.1)	501 (4.4)
Netherlands	8 (1.0)	523 (8.5)	16 (1.3)	533 (8.9)	34 (1.3)	553 (5.8)	19 (0.9)	580 (5.9)	22 (1.7)	591 (5.9)
New Zealand	3 (0.4)	441 (9.8)	7 (0.6)	466 (6.4)	24 (0.8)	506 (4.9)	25 (0.7)	533 (4.7)	41 (1.4)	551 (4.6)
Norway	2 (0.3)	~ ~	6 (0.4)	490 (7.7)	25 (0.9)	511 (2.9)	22 (0.7)	524 (3.4)	45 (1.2)	547 (2.4)
Portugal	10 (0.8)	456 (3.8)	26 (1.3)	464 (2.9)	32 (1.0)	479 (2.7)	15 (0.8)	493 (4.0)	17 (1.4)	508 (3.9)
Romania	24 (1.3)	467 (8.3)	22 (1.3)	476 (7.1)	19 (1.0)	483 (5.5)	11 (0.7)	503 (7.9)	24 (1.7)	518 (5.9)
Russian Federation	2 (0.3)	~ ~	11 (0.8)	508 (10.1)	36 (1.3)	527 (4.5)	24 (0.8)	550 (4.1)	26 (1.3)	561 (5.0)
Scotland	11 (1.2)	453 (5.5)	17 (1.1)	483 (4.2)	28 (1.0)	507 (4.2)	19 (1.0)	546 (4.7)	25 (2.0)	567 (7.8)
Singapore	11 (0.8)	567 (5.3)	22 (0.9)	583 (5.3)	41 (0.8)	610 (5.5)	14 (0.7)	640 (6.5)	12 (1.0)	648 (7.0)
Slovak Republic	2 (0.3)	~ ~	11 (0.6)	506 (5.3)	45 (1.1)	536 (3.5)	23 (0.9)	562 (3.9)	18 (1.0)	573 (5.1)
Slovenia	2 (0.4)	~ ~	15 (0.9)	522 (4.3)	38 (1.2)	555 (2.9)	22 (0.9)	574 (4.3)	22 (1.1)	587 (4.4)
Spain	4 (0.4)	487 (8.1)	18 (1.1)	490 (2.5)	33 (1.0)	511 (2.1)	20 (0.8)	528 (3.3)	26 (1.2)	540 (2.8)
Sweden	3 (0.3)	473 (9.9)	8 (0.7)	482 (5.6)	24 (1.0)	517 (4.3)	24 (0.8)	540 (3.6)	41 (1.5)	560 (3.5)
Switzerland	8 (1.0)	456 (8.1)	16 (0.9)	485 (6.1)	30 (1.0)	516 (3.4)	20 (0.9)	546 (3.7)	26 (1.2)	557 (4.2)
Thailand	19 (1.2)	514 (3.3)	30 (1.0)	519 (3.4)	33 (1.2)	529 (4.0)	9 (0.6)	538 (6.8)	9 (1.0)	546 (7.2)
United States	8 (0.8)	459 (6.2)	13 (0.8)	489 (5.0)	28 (0.9)	527 (4.2)	21 (0.6)	554 (4.3)	31 (1.5)	570 (5.2)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

more books students reported in the home, the higher their science achievement. Although the main purpose of the question was to gain some information about the relative importance of academic pursuits in the students' home environments rather than to determine the actual number of books in students' homes, there was a substantial amount of variation from country to country in eighth-grade students' reports about the number of books in their homes. In Colombia, Hong Kong, Iran, Kuwait, Romania, and Thailand, 40% or more of the students reported 25 or fewer books in the home. Conversely, 40% or more of the students in Australia, Hungary, Latvia (LSS), New Zealand, Norway, and Sweden reported more than 200 books in their homes.

Information about their parents' educational levels was gathered by asking students to indicate the highest level of education completed by their fathers and mothers. Table 4.3 presents the relationship between eighth-grade students' science achievement and their reports of the highest level of education of either parent. Results are presented at three educational levels: finished university, finished upper secondary school but not university, and finished primary school but not upper secondary school. These three educational levels are based on internationally-defined categories, which may not be strictly comparable across countries due to differences in national education systems. Although the majority of countries translated and defined the educational categories used in their questionnaires to be comparable to the internationally-defined levels, some countries used modified response options to conform to their national education systems. Also, for a few countries, the percentages of students responding to this question fell below 85%. When this happened, the percentages shown in the table are annotated with an "r" for a response rate of 70% to 84% or an "s" if the response rate was from 50% to 69%.

Despite the different educational approaches, structures, and organizations across the TIMSS countries, it is clear from the data in Table 4.3 that parents' education is positively related to students' science achievement. In every country, the pattern was for those eighth-grade students whose parents had more education to also be those who have higher achievement in science. Once again, the purpose of this question was not to ascertain precisely the educational levels of students' parents, but to gain further understanding about the relative importance of schooling in their home environments. As indicated by the results, there was variation among countries in the percentages of students reporting that they did not know their parents' educational levels, as well as in the percentages of students reporting that their parents had completed successively higher educational levels. For example, in Canada, Israel, Lithuania, the Russian Federation, and the United States, more than 30% of the students reported that at least one of their parents had finished university, and only relatively small percentages (fewer than 12%) reported that they did not know the educational levels of their parents. In contrast, almost all students (90% or more) in Hong Kong, Iran, Kuwait, Portugal, and Thailand also reported knowing their parents' educational levels, but for these countries fewer than 10% of students reported that either parent had finished university.

Figure 4.1 shows the definitions of the educational categories used by TIMSS and the modifications made to them by some countries. In several countries, the finished primary school but not upper secondary school category included only a single level

Table 4.3

Students' Reports on the Highest Level of Education of Either Parent[1] Science - Upper Grade (Eighth Grade*)

Country		Finished University[2]		Finished Upper Secondary School But Not University[3]		Finished Primary School But Not Upper Secondary School[4]		Do Not Know	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia		28 (1.4)	587 (4.5)	37 (0.9)	544 (4.1)	24 (0.9)	527 (4.4)	11 (0.6)	499 (5.3)
Austria		10 (0.7)	588 (7.7)	70 (1.1)	566 (4.1)	8 (0.9)	508 (8.3)	12 (0.9)	530 (6.0)
Belgium (Fl)		20 (1.6)	574 (4.5)	34 (1.3)	554 (5.0)	21 (2.4)	532 (9.1)	25 (1.4)	535 (3.7)
Belgium (Fr)		27 (1.6)	497 (4.3)	34 (1.3)	481 (4.1)	11 (1.3)	434 (5.3)	27 (1.6)	450 (5.8)
Canada		37 (1.3)	549 (3.9)	39 (1.2)	532 (3.0)	13 (0.9)	501 (4.4)	10 (0.5)	517 (4.0)
Colombia		15 (1.6)	441 (7.9)	28 (1.6)	425 (4.2)	47 (2.3)	402 (3.7)	10 (0.9)	393 (6.3)
Cyprus	r	15 (0.9)	504 (6.3)	29 (1.1)	486 (3.6)	52 (1.4)	448 (2.7)	4 (0.5)	438 (10.5)
Czech Republic		21 (1.7)	606 (7.2)	47 (1.5)	579 (4.1)	25 (1.5)	550 (3.9)	7 (0.8)	536 (7.3)
Denmark		13 (1.0)	509 (6.0)	46 (1.5)	489 (3.8)	8 (0.7)	458 (8.6)	33 (1.7)	470 (4.6)
England		- -	- -	- -	- -	- -	- -	- -	- -
France	r	13 (1.2)	524 (6.6)	36 (1.3)	505 (3.5)	19 (1.2)	493 (3.3)	31 (1.3)	488 (3.5)
Germany		11 (1.0)	573 (8.6)	32 (1.3)	550 (4.7)	38 (1.6)	529 (4.2)	19 (1.3)	502 (7.7)
Greece		18 (1.1)	536 (4.8)	39 (1.3)	506 (3.1)	40 (1.8)	479 (2.3)	3 (0.3)	463 (7.8)
Hong Kong		7 (1.0)	547 (8.6)	30 (1.2)	537 (5.1)	55 (1.8)	519 (4.7)	7 (0.7)	498 (8.5)
Hungary	r	24 (1.8)	603 (4.1)	66 (1.7)	554 (3.0)	11 (0.9)	505 (6.0)	- -	- -
Iceland		25 (2.8)	513 (8.4)	44 (2.0)	499 (3.9)	15 (1.4)	477 (8.1)	15 (1.0)	475 (8.1)
Iran, Islamic Rep.	r	3 (0.6)	505 (8.4)	21 (1.8)	488 (4.4)	68 (2.2)	469 (3.0)	7 (1.0)	453 (6.7)
Ireland		17 (1.3)	573 (6.3)	46 (1.0)	546 (4.4)	26 (1.2)	522 (5.2)	10 (0.7)	506 (6.1)
Israel		37 (2.5)	560 (7.9)	45 (2.2)	523 (5.5)	10 (1.3)	485 (7.4)	8 (0.9)	508 (8.4)
Japan		- -	- -	- -	- -	- -	- -	- -	- -
Korea		22 (1.3)	593 (3.9)	47 (1.3)	566 (2.4)	26 (1.1)	546 (3.4)	5 (0.5)	529 (7.1)
Kuwait	s	3 (1.2)	459 (11.1)	3 (0.9)	425 (13.9)	92 (2.1)	427 (4.8)	1 (0.7)	~ ~
Latvia (LSS)	r	27 (1.5)	515 (5.0)	49 (1.4)	488 (3.0)	13 (1.0)	466 (5.7)	11 (1.0)	463 (6.8)
Lithuania	s	37 (1.6)	500 (4.7)	44 (1.6)	474 (4.4)	7 (1.0)	449 (8.6)	12 (1.2)	475 (6.5)
Netherlands		12 (1.4)	586 (8.2)	55 (1.8)	567 (6.4)	10 (0.7)	547 (8.0)	23 (1.4)	542 (5.6)
New Zealand		25 (1.3)	560 (5.5)	38 (1.1)	530 (4.4)	15 (0.8)	503 (6.0)	21 (1.1)	505 (5.8)
Norway		25 (1.2)	544 (4.2)	38 (1.1)	532 (2.4)	9 (0.6)	505 (4.5)	27 (1.2)	520 (3.3)
Portugal		9 (1.2)	525 (4.6)	13 (1.0)	498 (4.1)	73 (2.0)	472 (2.1)	5 (0.4)	469 (5.6)
Romania		10 (1.3)	522 (9.7)	47 (1.5)	498 (5.0)	33 (1.9)	477 (7.7)	10 (0.9)	463 (10.0)
Russian Federation		34 (1.8)	567 (3.7)	54 (1.6)	528 (4.9)	5 (0.5)	493 (8.7)	6 (0.8)	522 (11.3)
Scotland		14 (1.4)	579 (7.1)	33 (1.4)	521 (5.4)	14 (0.8)	501 (5.1)	39 (1.3)	507 (6.2)
Singapore		8 (1.0)	661 (8.4)	69 (1.0)	612 (5.5)	23 (1.2)	578 (5.1)	- -	- -
Slovak Republic		20 (1.4)	580 (4.9)	50 (1.1)	549 (3.2)	23 (1.2)	519 (4.8)	6 (0.5)	513 (7.5)
Slovenia		19 (1.1)	600 (4.2)	59 (1.4)	558 (2.6)	18 (1.3)	533 (3.7)	4 (0.4)	545 (8.9)
Spain		15 (1.2)	547 (3.9)	21 (0.9)	531 (2.9)	54 (1.8)	509 (2.1)	10 (0.8)	504 (3.9)
Sweden		22 (1.2)	561 (4.2)	34 (1.1)	541 (3.3)	9 (0.6)	517 (5.0)	35 (1.1)	527 (3.4)
Switzerland		11 (0.8)	559 (6.4)	61 (1.3)	531 (2.7)	13 (0.9)	493 (3.9)	15 (1.0)	506 (4.5)
Thailand		9 (1.4)	557 (6.7)	14 (1.4)	540 (5.9)	73 (2.6)	519 (2.9)	3 (0.5)	522 (10.2)
United States		33 (1.4)	562 (5.9)	54 (1.3)	530 (4.1)	7 (0.8)	483 (5.7)	5 (0.4)	512 (8.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1]The response categories were defined by each country to conform to their own educational system and may not be strictly comparable across countries. See Figure 4.1 for country modifications to the definitions of educational levels. Also, no response category was provided for students whose parents had no formal education or did not finish primary school, except in France where a small percentage of students in this category are included in the missing responses.

[2]In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

[3]Finished upper secondary school with or without some tertiary education not equivalent to a university degree. In most countries, finished secondary corresponds to completion of an upper-secondary track terminating after 11 to 13 years of schooling.

[4]Finished primary school or some secondary school not equivalent to completion of upper secondary.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

Data for Singapore not obtained from students; entered at ministry level.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Figure 4.1 Country Modifications to the Definitions of Educational Levels for Parents' Highest Level of Education[1]

Finished Primary School But Not Upper Secondary School

Internationally-Defined Levels: *Finished Primary School or Finished Some Secondary School*

Countries with Modified Nationally-Defined Levels:

Austria:	*Compulsory (Pflichtschulabschluß; 9 grades)*
Denmark:	*Basic school (Folkeskolen, Realeksamen; 9 or 10 grades)*
France:	*Lower Secondary (Collége, CAP)*
Germany:	*Lower secondary (Hauptschulabschluß; 9 or 10 grades) or* *Medium secondary (Fachoberschulreife, Realschulabschluß or Polytechnische Oberschule; 10 grades)*
Hungary:	*Some or all of general school (8 grades)*
Norway:	*Compulsory (9 grades) or some upper secondary*
Scotland:	*Some secondary school*
Singapore:	*Primary school*
Sweden:	*Compulsory (9 grades) or started upper secondary*
Switzerland:	*Compulsory (9 grades)*

Finished Upper Secondary School[2] But Not University

Internationally-Defined Levels: *Finished Secondary School or Some Vocational/Technical Education After Secondary School or Some University*

Countries with Modified Nationally-Defined Levels:

Austria:	*Upper-secondary tracks: apprenticeship (Berufsschul-/Lehrabschluß), medium vocational (Handelsschule, Fachschule), higher vocational (HAK, HTL, etc.), or higher academic (Gymnasium, Realgymnasium)*
Cyprus:	*Upper-secondary tracks: academic or vocational/technical or* *Post-Secondary: Finished college*
Denmark:	*Upper-secondary tracks: academic or general/vocational (gymnasium, hf, htx, hhx) vocational training (erhvervsfaglig uddannelse)* *Post-Secondary: Medium-cycle higher education (mellemlang uddannselse)*
France:	*Upper-secondary tracks: BEP (11 grades) or baccalauréat (général, technologique or professionnel; 12 or 13 grades)* *Post-Secondary: 2 or 3 years study after baccalauréat (BTS, DUT, Licence)*
Germany:	*Upper-secondary tracks: general/academic or apprenticeship/vocational training (Lehrabschluß, Berufsfachschule)* *Post-Secondary: Higher vocational schools (Fachhochschulabschluß)*
Hungary:	*Upper-secondary tracks: apprenticeship (general + 3 years) or final exam in secondary (general + 4 years)*
Sweden:	*Upper-secondary tracks: academic or vocational (gymnasieutbildning or yrkesinriktad utbildning)* *Post-Secondary: Less than 3 years of university studies*
Switzerland:	*Upper-secondary tracks: occupational (apprentissage, école professionnelle), academic (gymnase, baccalauréat, maturité cantonale), or teacher training (école normale, formation d'enseignant)* *Post-Secondary: Applied science university (haute école professionnelle ou commerciale)*

Finished University

Internationally-Defined Level: *Finished University*

Countries with Modified Nationally-Defined Levels:

Austria:	*University (master's degree)*
Canada:	*University or college*
Cyprus:	*University degree or post-graduate studies*
France:	*4 years of study after baccalauréat*
Germany:	*University, Technical University or Pedagogical Institute*
Hungary:	*University or college diploma*
New Zealand:	*University or Teachers' College*
Norway:	*University or college*
Portugal:	*University or polytechnic*
Sweden:	*3 years university studies or more*
Switzerland:	*University or insitute of technology*
United States:	*Bachelor's degree at college or university*

[1]Educational levels were translated and defined in most countries to be comparable to the internationally-defined levels. Countries that used modified response options to conform to their national education systems are indicated to aid in the interpretation of the reporting categories presented in Table 4.3.

[2]Upper-secondary corresponds to ISCED level 3 tracks terminating after 11 to 13 years in most countries. (Education at a Glance, OECD, 1995)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

corresponding to finishing compulsory education (8 to 10 grades) and did not include finishing only primary school. In addition, in Germany, the completion of medium secondary education was considered part of this category, while in Austria, which has an educational system similar to Germany's, the medium-level vocational education was included in the second category reporting upper-secondary education.

The second reporting category (finished upper secondary school but not university) was complicated because, in many countries, particularly in Europe, there are several upper-secondary tracks leading to university or other tertiary institutions as well as vocational/apprenticeship programs. In most countries, finishing upper secondary means completion of 11 to 13 years of education. In some systems, however, the general secondary education may be completed after 9 or 10 years, followed by 2 to 4 years of full- or part-time vocational/apprenticeship training that may be either included as part of the secondary educational system or considered as post-secondary. All of the upper-secondary tracks and any upper-secondary or post-secondary vocational education programs included as response options are combined in the second reporting category.

Several countries also differed in their interpretation of what is included in the category of finished university. For example, degrees obtained from technical institutes and other non-university institutions of higher education are considered equivalent to a university degree in some countries but not in others. Therefore, completion of a degree at one of these institutions may have been included in either the finished university or the finished upper secondary school but not university categories. In countries such as Canada, New Zealand, Portugal, and the United States, the finished university category includes the completion of the equivalent of a bachelor's degree at either a university, college or polytechnic, while in Austria and France, this category corresponds to the equivalent of a master's degree received at a university.

What Are the Academic Expectations of Students, Their Families, and Their Friends?

Tables 4.4, 4.5, and 4.6 present eighth-grade students' reports about how they themselves, their mothers, and their friends feel about the importance of doing well in various academic and non-academic activities. The first three questions asked about the degree of agreement with the importance of doing well in the academic subjects of science, mathematics, and language, respectively. For most of the countries, from 80% to 95% of the students agreed or strongly agreed that it was important to do well in science. Countries with very high percentages of students agreeing that it was important to do well included Colombia (99%), England (96%), Iran (98%), Kuwait (96%), Portugal (97%), Singapore (99%), Spain (99%), and the United States (96%). Countries with fewer than 80% of the students agreeing that it was important to do well in science included Germany (72%), Lithuania (78%), and Switzerland (68%). Compared to science, somewhat more students agreed or strongly agreed that it was important to do well in mathematics and language. In part, however, the lower percentages in science may be because students in many countries, including most of the European countries, take separate science subjects in the middle school years. Therefore, the general term of "science" may not be clearly or uniformly interpreted by students across all countries.

For the most part, eighth-grade students indicated that their mothers' opinions about the importance of these academic activities corresponded very closely to their own feelings. In contrast, however, students reported that their friends were not in as much agreement about the importance of academic success, particularly in science.

Students' reports of their friends opinions about the importance of doing well in science varied substantially across countries, ranging from as low as 35% in Germany to as high as 96% in Singapore. Countries where fewer than two-thirds of eighth-graders reported that their friends agreed or strongly agreed it was important to do well in science included Australia (64%), Austria (45%), the Czech Republic (61%), France (53%), Germany (35%), Hungary (66%), Iceland (65%), Ireland (59%), Israel (56%), Latvia (LSS) (53%), Lithuania (55%), New Zealand (66%), the Slovak Republic (60%), Slovenia (56%), Sweden (61%), and Switzerland (40%).

Although students' friends reportedly were in general agreement about the importance of doing well in mathematics, the percentages were generally in the 80s, rather than the 90s as for the students themselves. According to students, their friends were in the lowest degree of agreement about doing well in mathematics in Germany and Sweden (70% for both countries).

As with the students' reports about their own feelings and those of their mothers, students indicated a close alignment in their friends' degree of agreement about the importance of academic success in mathematics and that in language. Apparently, even though the relative importance varies from group to group, students, their mothers, and their friends find it very nearly equally important to do well in mathematics and language. According to students in some countries, however, their friends do not have nearly the same positive feeling about the importance of doing well in science.

For purposes of comparison, eighth-grade students also were asked about the importance of two non-academic activities – having time to have fun and being good at sports. In most countries, very high percentages of the students (more than 95%) felt it was important to have time to have fun. The percentages in agreement were similar to those agreeing that it was important to do well in mathematics and language. Generally, there was less agreement about the importance of being good at sports, which was rather similar to the level of agreement about the importance of doing well in science. It needs to be emphasized, however, that the relative rankings given to the five activities by students varied from country to country.

In nearly all countries, 80% or more of the eighth-grade students reported that their mothers agreed that it was important to have time to have fun. The exceptions were Hong Kong (74%), Iran (79%), Korea (58%), Kuwait (63%), and Singapore (79%), where students reported from 8% to 29% lower agreement for their mothers than for themselves. According to students, their mothers give a moderate to high degree of support to the importance of being good at sports. In nearly all countries the percentages of students' reporting such agreement were in the 70s, 80s, and 90s, except in Austria (56%), Germany (48%), Kuwait (69%), the Netherlands (63%), and Switzerland (59%).

As might be anticipated, students reported that most of their friends agreed that it was important to have fun – more than 90% in all countries except Iran (87%), Korea (88%), Kuwait (77%), and Romania (86%). Internationally, eighth-graders reported that their friends generally were in moderate agreement that it was important to do well in sports. The percentages of their friends' agreement as reported by students ranged from a low of 64% in Germany to a high of 96% in Colombia.

Table 4.4

Students' Reports on Whether They Agree or Strongly Agree That It Is Important to Do Various Activities - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students				
	Do Well in Science	Do Well in Mathematics	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	89 (0.6)	96 (0.4)	95 (0.4)	98 (0.2)	85 (0.6)
Austria	82 (1.2)	94 (0.5)	93 (0.6)	98 (0.3)	82 (0.9)
Belgium (Fl)	93 (0.6)	98 (0.3)	98 (0.4)	98 (0.3)	80 (1.0)
Belgium (Fr)	94 (0.7)	98 (0.3)	98 (0.3)	98 (0.4)	87 (0.8)
Canada	94 (0.7)	98 (0.2)	97 (0.3)	99 (0.2)	86 (0.6)
Colombia	99 (0.2)	99 (0.2)	99 (0.2)	98 (0.3)	97 (0.3)
Cyprus	86 (1.0)	94 (0.5)	94 (0.6)	94 (0.5)	85 (1.0)
Czech Republic	88 (1.0)	98 (0.5)	98 (0.3)	98 (0.3)	84 (0.9)
Denmark	87 (1.0)	97 (0.4)	97 (0.4)	99 (0.3)	83 (0.8)
England	96 (0.5)	99 (0.2)	99 (0.3)	99 (0.3)	80 (1.1)
France	83 (1.2)	97 (0.4)	97 (0.5)	97 (0.4)	80 (0.8)
Germany	72 (1.0)	93 (0.6)	91 (0.6)	97 (0.4)	72 (1.1)
Greece	93 (0.5)	96 (0.4)	96 (0.4)	96 (0.4)	91 (0.6)
Hong Kong	90 (0.9)	96 (0.5)	96 (0.5)	94 (0.5)	83 (0.9)
Hungary	86 (0.8)	95 (0.5)	95 (0.5)	96 (0.5)	78 (0.9)
Iceland	90 (1.2)	97 (1.0)	97 (1.0)	98 (0.4)	90 (1.6)
Iran, Islamic Rep.	98 (0.4)	97 (0.4)	96 (0.6)	87 (1.1)	95 (0.7)
Ireland	86 (1.1)	97 (0.3)	96 (0.4)	99 (0.2)	85 (0.8)
Israel	85 (1.0)	98 (0.5)	89 (1.5)	98 (0.5)	84 (1.3)
Japan	87 (0.6)	92 (0.4)	91 (0.5)	99 (0.1)	83 (0.7)
Korea	91 (0.6)	94 (0.5)	93 (0.6)	87 (0.8)	86 (0.8)
Kuwait	96 (0.6)	96 (0.6)	96 (0.5)	85 (2.0)	81 (1.2)
Latvia (LSS)	84 (1.0)	97 (0.4)	97 (0.3)	97 (0.4)	87 (0.8)
Lithuania	78 (1.1)	93 (0.6)	96 (0.4)	94 (0.6)	93 (0.5)
Netherlands	95 (0.7)	97 (0.6)	99 (0.3)	98 (0.6)	78 (1.2)
New Zealand	92 (0.6)	97 (0.3)	96 (0.5)	99 (0.3)	86 (0.7)
Norway	92 (0.6)	96 (0.5)	96 (0.5)	99 (0.1)	79 (0.9)
Portugal	97 (0.3)	97 (0.3)	99 (0.2)	93 (0.5)	94 (0.5)
Romania	86 (0.8)	88 (0.8)	88 (0.8)	86 (1.0)	80 (1.1)
Russian Federation	95 (0.6)	97 (0.4)	97 (0.5)	98 (0.4)	88 (0.9)
Scotland	92 (0.7)	98 (0.4)	98 (0.3)	98 (0.3)	82 (0.9)
Singapore	99 (0.2)	99 (0.2)	100 (0.1)	96 (0.3)	89 (0.6)
Slovak Republic	86 (0.8)	96 (0.4)	96 (0.4)	98 (0.2)	91 (0.5)
Slovenia	86 (0.9)	96 (0.5)	96 (0.4)	95 (0.5)	87 (0.7)
Spain	99 (0.2)	99 (0.2)	99 (0.2)	99 (0.1)	95 (0.3)
Sweden	84 (0.8)	92 (0.6)	90 (0.6)	99 (0.2)	84 (0.7)
Switzerland	68 (1.1)	96 (0.4)	94 (0.4)	95 (0.6)	78 (0.9)
Thailand	94 (0.5)	93 (0.5)	96 (0.4)	95 (0.3)	91 (0.5)
United States	96 (0.5)	97 (0.3)	96 (0.3)	99 (0.2)	88 (0.6)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.5

Students' Reports on Whether Their Mothers Agree or Strongly Agree That It Is Important to Do Various Activities - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students				
	Do Well in Science	Do Well in Mathematics	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	94 (0.4)	98 (0.2)	98 (0.2)	94 (0.4)	83 (0.7)
Austria	81 (1.0)	96 (0.4)	95 (0.5)	90 (0.7)	56 (1.1)
Belgium (Fl)	93 (0.8)	97 (0.4)	98 (0.4)	94 (0.5)	73 (1.2)
Belgium (Fr)	98 (0.3)	99 (0.3)	99 (0.3)	95 (0.6)	85 (0.7)
Canada	98 (0.3)	99 (0.1)	99 (0.1)	96 (0.4)	83 (0.7)
Colombia	99 (0.3)	99 (0.4)	99 (0.2)	93 (0.6)	94 (1.0)
Cyprus	89 (0.8)	95 (0.4)	95 (0.5)	91 (0.6)	80 (0.8)
Czech Republic	93 (0.8)	99 (0.2)	98 (0.3)	90 (0.7)	74 (1.1)
Denmark	95 (0.6)	99 (0.3)	99 (0.3)	98 (0.3)	81 (1.0)
England	96 (0.5)	99 (0.3)	99 (0.3)	94 (0.6)	74 (1.2)
France	88 (0.9)	98 (0.3)	99 (0.3)	91 (0.7)	74 (1.0)
Germany	71 (1.4)	94 (0.8)	93 (0.7)	88 (0.7)	48 (1.2)
Greece	94 (0.5)	96 (0.3)	96 (0.4)	89 (0.6)	83 (0.7)
Hong Kong	86 (0.7)	93 (0.6)	93 (0.6)	74 (0.9)	71 (1.3)
Hungary	85 (0.8)	96 (0.4)	96 (0.4)	96 (0.4)	73 (1.1)
Iceland	95 (1.3)	97 (0.8)	98 (0.5)	95 (0.7)	87 (1.6)
Iran, Islamic Rep.	96 (0.5)	96 (0.5)	95 (0.5)	79 (1.8)	90 (1.5)
Ireland	89 (1.0)	98 (0.3)	98 (0.2)	94 (0.5)	83 (0.8)
Israel	89 (0.9)	99 (0.4)	93 (0.6)	95 (0.7)	79 (1.4)
Japan	- -	- -	- -	- -	- -
Korea	92 (0.5)	96 (0.4)	94 (0.5)	58 (1.1)	72 (0.9)
Kuwait	r 91 (0.9)	91 (1.0)	r 91 (0.8)	r 63 (2.2)	r 69 (2.0)
Latvia (LSS)	85 (1.1)	97 (0.4)	97 (0.5)	90 (0.8)	82 (0.9)
Lithuania	77 (1.1)	91 (0.6)	95 (0.5)	86 (0.8)	87 (0.9)
Netherlands	94 (0.7)	96 (0.5)	97 (0.4)	96 (0.4)	63 (1.4)
New Zealand	95 (0.4)	98 (0.3)	97 (0.3)	95 (0.5)	86 (0.8)
Norway	95 (0.5)	97 (0.4)	97 (0.4)	97 (0.3)	71 (1.1)
Portugal	98 (0.3)	96 (0.4)	98 (0.3)	87 (0.7)	91 (0.6)
Romania	94 (0.6)	93 (0.5)	90 (0.7)	83 (1.0)	76 (1.0)
Russian Federation	95 (0.4)	96 (0.3)	97 (0.4)	92 (0.6)	84 (0.7)
Scotland	93 (0.6)	98 (0.3)	99 (0.2)	94 (0.5)	77 (1.0)
Singapore	99 (0.2)	99 (0.2)	99 (0.1)	79 (0.8)	84 (0.8)
Slovak Republic	94 (0.5)	99 (0.2)	99 (0.2)	95 (0.4)	88 (0.6)
Slovenia	85 (0.7)	91 (0.7)	92 (0.6)	88 (0.7)	81 (0.9)
Spain	99 (0.2)	99 (0.2)	99 (0.2)	96 (0.4)	93 (0.5)
Sweden	92 (0.5)	96 (0.4)	95 (0.4)	97 (0.3)	83 (0.7)
Switzerland	69 (1.0)	96 (0.3)	95 (0.4)	83 (0.9)	59 (1.1)
Thailand	95 (0.4)	94 (0.5)	96 (0.4)	84 (0.9)	90 (0.5)
United States	97 (0.2)	98 (0.2)	98 (0.2)	93 (0.4)	81 (0.8)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Data are reported as percent of students.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (–) indicates data are not available.
An "r" indicates a 70-84% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 4.6

Students' Reports on Whether Their Friends Agree or Strongly Agree That It Is Important to Do Various Activities - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students				
	Do Well in Science	Do Well in Mathematics	Do Well in Language	Have Time to Have Fun	Be Good at Sports
Australia	64 (1.0)	78 (0.8)	76 (0.8)	98 (0.2)	83 (0.8)
Austria	45 (1.8)	77 (1.2)	74 (1.1)	97 (0.4)	79 (1.2)
Belgium (Fl)	70 (1.6)	84 (1.7)	83 (1.8)	98 (0.4)	76 (1.5)
Belgium (Fr)	78 (1.3)	86 (1.1)	87 (0.9)	97 (0.4)	84 (1.2)
Canada	68 (1.3)	80 (0.8)	78 (0.8)	99 (0.2)	87 (0.6)
Colombia	93 (0.6)	95 (0.5)	95 (0.5)	97 (0.4)	96 (0.4)
Cyprus	71 (1.1)	85 (0.8)	85 (0.9)	91 (0.6)	82 (1.0)
Czech Republic	61 (1.5)	84 (1.3)	84 (1.2)	98 (0.3)	82 (1.1)
Denmark	82 (1.0)	94 (0.6)	95 (0.6)	99 (0.2)	92 (0.7)
England	80 (1.1)	88 (0.9)	88 (0.9)	99 (0.3)	79 (1.2)
France	53 (1.5)	85 (1.3)	88 (1.1)	97 (0.4)	80 (1.0)
Germany	35 (1.4)	70 (1.3)	68 (1.3)	94 (0.5)	64 (1.3)
Greece	82 (0.8)	87 (0.7)	89 (0.6)	96 (0.3)	85 (0.8)
Hong Kong	74 (1.3)	86 (0.9)	87 (0.9)	93 (0.5)	76 (1.0)
Hungary	66 (1.2)	81 (0.9)	83 (0.8)	94 (0.5)	74 (1.1)
Iceland	65 (2.0)	85 (1.4)	85 (1.1)	98 (0.4)	89 (1.2)
Iran, Islamic Rep.	95 (0.9)	95 (0.5)	93 (0.6)	87 (1.3)	93 (0.9)
Ireland	59 (1.4)	80 (0.9)	78 (0.8)	99 (0.2)	85 (0.7)
Israel	56 (2.5)	93 (1.1)	75 (2.0)	98 (0.5)	79 (1.9)
Japan	83 (0.7)	90 (0.5)	88 (0.6)	99 (0.2)	81 (0.7)
Korea	79 (0.9)	86 (0.8)	81 (0.8)	88 (0.7)	78 (1.0)
Kuwait	90 (0.6)	90 (0.8)	86 (0.9)	77 (2.4)	78 (1.5)
Latvia (LSS)	53 (1.3)	86 (0.9)	87 (1.0)	97 (0.4)	87 (0.8)
Lithuania	55 (1.3)	83 (0.9)	88 (0.9)	95 (0.5)	90 (0.7)
Netherlands	82 (1.2)	87 (0.9)	90 (0.7)	97 (0.6)	66 (1.2)
New Zealand	66 (1.2)	77 (1.0)	76 (1.0)	98 (0.3)	87 (0.8)
Norway	72 (1.2)	84 (0.8)	83 (0.9)	99 (0.2)	83 (1.0)
Portugal	88 (0.8)	89 (0.7)	93 (0.4)	92 (0.6)	94 (0.5)
Romania	80 (1.0)	87 (0.8)	88 (0.8)	86 (1.0)	81 (1.0)
Russian Federation	81 (0.8)	88 (0.8)	88 (0.8)	97 (0.4)	84 (0.8)
Scotland	70 (1.3)	81 (1.2)	82 (1.0)	98 (0.3)	84 (0.8)
Singapore	96 (0.5)	97 (0.4)	98 (0.2)	96 (0.3)	86 (0.8)
Slovak Republic	60 (1.3)	83 (0.7)	84 (0.7)	98 (0.2)	92 (0.5)
Slovenia	56 (1.6)	77 (1.2)	78 (1.1)	95 (0.5)	81 (0.9)
Spain	89 (0.7)	91 (0.6)	91 (0.5)	99 (0.2)	94 (0.4)
Sweden	61 (1.4)	70 (1.2)	68 (1.2)	97 (0.3)	75 (0.8)
Switzerland	40 (1.4)	85 (0.8)	82 (1.0)	93 (0.8)	75 (1.1)
Thailand	94 (0.5)	93 (0.6)	95 (0.4)	95 (0.4)	91 (0.4)
United States	69 (1.2)	75 (1.0)	73 (0.9)	98 (0.2)	90 (0.7)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Data are reported as percent of students.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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How Do Students Spend Their Out-of-School Time During the School Week?

Even though education may be thought to be the dominant activity of school-aged children, young people actually spend much more of their time outside of school. Some of this out-of-school time is spent at furthering academic development – for example, in studying or doing homework in school subjects. Table 4.7 presents eighth-grade students' reports about the average number of hours per day they spend studying or doing homework in science, mathematics, and other subjects. Students in most countries reported spending between half an hour and an hour per day studying science. Eighth-graders in Australia, Denmark, and Scotland were at the lower end of the range, reporting an average of about one-half hour or less per day (.3 to .5 of an hour). Those in Colombia, Greece, Hungary, Iran, Kuwait, Romania, and Singapore reported more than one hour of science homework per day, on average, with Iran at nearly two hours (1.9). On average, students in nearly all countries reported spending somewhat more time studying mathematics, roughly an hour per day in many countries.

Participating countries showed some variation in the amount of time students spent doing homework each day across all school subjects. The most common response about the amount of homework done, reported by eighth-graders in about half the countries, was an average of two to three hours per day, but there was a range. Students in Iran and Kuwait reported spending the most time on homework, more than five hours per day. Students in the Czech Republic, Denmark, and Scotland reported spending the least amount of time per day on homework, less than two hours.

The students also were asked about a variety of other ways they could spend their time out of school. Eighth-graders were asked about watching television, playing computer games, playing or talking with friends, doing jobs at home, playing sports, and reading books for enjoyment. Their reports about the amount of time spent daily in each of these activities are shown in Table 4.8. Granted, some television programming and some computer games are targeted at developing children's academic abilities, and leisure reading also can be related to higher academic achievement. Still, much fare on television is not educationally related, and eighth-grade students in many countries reported spending nearly as much time each day watching television – an average of two to three hours per day – as they did doing homework. Eighth-graders in many countries also appear to spend several hours per day playing or talking with friends, and nearly two hours playing sports. The time spent on leisure activities is not additive, because students often do these activities simultaneously (e.g., talk with friends and watch television). Nevertheless, it does appear that in most countries at least as much time is spent in these largely non-academic activities as in studying and doing homework, and probably more time.

Table 4.9 shows the relationship between time spent doing homework in all subjects and students' average science achievement. The relationship was curvilinear in many countries, with the highest achievement being associated with a moderate amount of homework per day (one to three hours). This pattern suggests that, compared

Table 4.7

Students' Reports on How They Spend Their Daily Out-of School Study Time[1] Science - Upper Grade (Eighth Grade*)

Country	Average Hours Each Day Studying Science or Doing Science Homework After School	Average Hours Each Day Studying Mathematics or Doing Mathematics Homework After School	Average Hours Each Day Studying or Doing Homework in Other School Subjects	Total Hours Each Day on Average
Australia	0.5 (0.01)	0.7 (0.02)	0.9 (0.02)	2.0 (0.04)
Austria	0.7 (0.03)	0.8 (0.02)	0.8 (0.02)	2.4 (0.07)
Belgium (Fl)	0.8 (0.02)	1.1 (0.03)	1.5 (0.03)	3.4 (0.07)
Belgium (Fr)	0.8 (0.02)	1.0 (0.02)	1.2 (0.03)	3.0 (0.07)
Canada	0.6 (0.02)	0.7 (0.02)	0.9 (0.03)	2.2 (0.07)
Colombia	1.2 (0.06)	1.3 (0.06)	2.0 (0.07)	4.6 (0.15)
Cyprus	0.9 (0.02)	1.2 (0.02)	1.5 (0.03)	3.6 (0.06)
Czech Republic	0.6 (0.02)	0.6 (0.02)	0.6 (0.02)	1.8 (0.05)
Denmark	0.3 (0.02)	0.5 (0.02)	0.5 (0.02)	1.4 (0.05)
England	- -	- -	- -	- -
France	0.6 (0.01)	0.9 (0.02)	1.2 (0.03)	2.7 (0.05)
Germany	0.6 (0.02)	0.6 (0.02)	0.8 (0.02)	2.0 (0.05)
Greece	1.2 (0.03)	1.2 (0.03)	2.0 (0.05)	4.4 (0.08)
Hong Kong	0.6 (0.02)	0.9 (0.02)	1.1 (0.03)	2.5 (0.06)
Hungary	1.1 (0.02)	0.8 (0.02)	1.2 (0.03)	3.1 (0.06)
Iceland	0.6 (0.03)	0.9 (0.03)	0.9 (0.03)	2.4 (0.07)
Iran, Islamic Rep.	1.9 (0.05)	2.0 (0.05)	2.5 (0.05)	6.4 (0.13)
Ireland	0.6 (0.01)	0.7 (0.02)	1.4 (0.03)	2.7 (0.05)
Israel	0.6 (0.03)	1.0 (0.04)	1.2 (0.05)	2.8 (0.10)
Japan	0.6 (0.01)	0.8 (0.01)	1.0 (0.02)	2.3 (0.04)
Korea	0.6 (0.02)	0.8 (0.02)	1.1 (0.02)	2.5 (0.05)
Kuwait	1.5 (0.05)	1.6 (0.04)	2.3 (0.07)	5.3 (0.12)
Latvia (LSS)	0.6 (0.02)	0.9 (0.02)	1.2 (0.03)	2.7 (0.05)
Lithuania	0.7 (0.02)	0.8 (0.02)	1.2 (0.04)	2.7 (0.06)
Netherlands	0.6 (0.01)	0.6 (0.01)	1.0 (0.03)	2.2 (0.04)
New Zealand	0.6 (0.01)	0.7 (0.02)	0.9 (0.02)	2.1 (0.05)
Norway	0.6 (0.01)	0.7 (0.02)	1.0 (0.02)	2.3 (0.04)
Portugal	0.9 (0.02)	1.0 (0.02)	1.1 (0.02)	3.0 (0.05)
Romania	1.6 (0.06)	1.8 (0.07)	1.6 (0.06)	5.0 (0.18)
Russian Federation	1.0 (0.02)	0.9 (0.02)	1.0 (0.02)	2.9 (0.05)
Scotland	0.5 (0.01)	0.6 (0.02)	0.7 (0.02)	1.8 (0.04)
Singapore	1.3 (0.02)	1.4 (0.02)	1.9 (0.03)	4.6 (0.04)
Slovak Republic	0.8 (0.02)	0.7 (0.01)	0.9 (0.02)	2.4 (0.04)
Slovenia	1.0 (0.02)	0.9 (0.02)	0.9 (0.02)	2.9 (0.05)
Spain	1.0 (0.02)	1.2 (0.02)	1.4 (0.03)	3.6 (0.06)
Sweden	0.7 (0.01)	0.7 (0.01)	0.9 (0.02)	2.3 (0.04)
Switzerland	0.7 (0.01)	0.9 (0.02)	1.0 (0.02)	2.7 (0.04)
Thailand	1.0 (0.02)	1.2 (0.03)	1.3 (0.02)	3.5 (0.06)
United States	0.6 (0.01)	0.8 (0.02)	0.9 (0.02)	2.3 (0.04)

[1]Average hours based on: No Time = 0; Less Than 1 Hour = .5; 1-2 Hours =1.5; 3-5 Hours = 4; More Than 5 Hours = 7.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.8

Students' Reports on How They Spend Their Daily Leisure Time [1]
Science - Upper Grade (Eighth Grade*)

Country	Average Hours Each Day Watching Television or Videos	Average Hours Each Day Playing Computer Games	Average Hours Each Day Playing or Talking with Friends	Average Hours Each Day Doing Jobs at Home	Average Hours Each Day Playing Sports	Average Hours Each Day Reading a Book for Enjoyment
Australia	2.4 (0.05)	0.6 (0.02)	1.4 (0.03)	0.9 (0.02)	1.6 (0.03)	0.6 (0.02)
Austria	1.9 (0.06)	0.6 (0.03)	2.9 (0.08)	0.8 (0.03)	1.9 (0.07)	0.8 (0.03)
Belgium (Fl)	2.0 (0.05)	0.5 (0.06)	1.6 (0.05)	1.1 (0.03)	1.8 (0.07)	0.7 (0.03)
Belgium (Fr)	1.9 (0.08)	0.7 (0.03)	1.7 (0.10)	0.8 (0.03)	1.8 (0.04)	0.8 (0.03)
Canada	2.3 (0.04)	0.5 (0.02)	2.2 (0.05)	1.0 (0.02)	1.9 (0.03)	0.8 (0.02)
Colombia	2.2 (0.07)	r 0.4 (0.06)	1.9 (0.06)	2.3 (0.07)	1.9 (0.06)	0.9 (0.05)
Cyprus	2.3 (0.04)	0.8 (0.03)	1.7 (0.04)	1.0 (0.03)	1.4 (0.04)	0.8 (0.02)
Czech Republic	2.6 (0.05)	0.6 (0.03)	2.9 (0.09)	1.3 (0.04)	1.9 (0.06)	1.0 (0.03)
Denmark	2.2 (0.06)	0.7 (0.03)	2.8 (0.07)	1.1 (0.04)	1.7 (0.06)	0.7 (0.03)
England	2.7 (0.07)	0.9 (0.05)	2.5 (0.06)	0.8 (0.03)	1.5 (0.05)	0.7 (0.03)
France	1.5 (0.04)	0.5 (0.02)	1.5 (0.05)	0.9 (0.03)	1.7 (0.04)	0.8 (0.03)
Germany	1.9 (0.04)	0.8 (0.04)	3.5 (0.07)	0.9 (0.02)	1.7 (0.04)	0.7 (0.02)
Greece	2.1 (0.04)	0.7 (0.03)	1.5 (0.04)	0.9 (0.03)	1.8 (0.04)	1.0 (0.03)
Hong Kong	2.6 (0.05)	0.8 (0.03)	1.2 (0.04)	0.7 (0.02)	0.9 (0.03)	0.9 (0.02)
Hungary	3.0 (0.06)	0.7 (0.03)	2.3 (0.05)	2.0 (0.04)	1.7 (0.04)	1.2 (0.04)
Iceland	2.2 (0.05)	0.7 (0.06)	3.1 (0.06)	0.8 (0.03)	1.8 (0.06)	0.9 (0.06)
Iran, Islamic Rep.	1.8 (0.06)	r 0.2 (0.02)	1.2 (0.04)	1.8 (0.06)	1.2 (0.09)	1.1 (0.04)
Ireland	2.1 (0.03)	0.5 (0.03)	1.5 (0.06)	0.9 (0.03)	1.4 (0.05)	0.6 (0.02)
Israel	3.3 (0.10)	0.9 (0.04)	2.4 (0.08)	1.2 (0.05)	1.9 (0.09)	1.0 (0.04)
Japan	2.6 (0.04)	0.6 (0.02)	1.9 (0.04)	0.6 (0.01)	1.3 (0.03)	0.9 (0.02)
Korea	2.0 (0.04)	0.3 (0.02)	0.9 (0.03)	0.5 (0.02)	0.5 (0.02)	0.8 (0.03)
Kuwait	1.9 (0.07)	0.7 (0.05)	1.5 (0.11)	1.2 (0.08)	1.5 (0.10)	1.0 (0.04)
Latvia (LSS)	2.6 (0.05)	0.7 (0.04)	2.1 (0.06)	1.5 (0.04)	1.2 (0.04)	1.1 (0.03)
Lithuania	2.8 (0.05)	0.9 (0.04)	2.7 (0.06)	1.2 (0.03)	1.2 (0.04)	1.0 (0.03)
Netherlands	2.5 (0.09)	0.7 (0.04)	2.8 (0.08)	0.9 (0.04)	1.8 (0.06)	0.6 (0.03)
New Zealand	2.5 (0.05)	0.7 (0.03)	1.5 (0.04)	0.9 (0.02)	1.5 (0.04)	0.8 (0.02)
Norway	2.5 (0.04)	0.8 (0.03)	3.2 (0.06)	1.1 (0.03)	1.9 (0.05)	0.7 (0.02)
Portugal	2.0 (0.04)	0.7 (0.03)	1.7 (0.05)	1.0 (0.04)	1.7 (0.04)	0.7 (0.02)
Romania	1.9 (0.06)	0.6 (0.05)	1.5 (0.06)	1.9 (0.08)	1.3 (0.05)	1.3 (0.07)
Russian Federation	2.9 (0.05)	1.0 (0.04)	2.9 (0.05)	1.5 (0.03)	1.0 (0.03)	1.3 (0.04)
Scotland	2.7 (0.05)	1.0 (0.04)	2.8 (0.08)	0.7 (0.02)	1.9 (0.05)	0.7 (0.02)
Singapore	2.7 (0.05)	0.6 (0.03)	1.5 (0.04)	1.0 (0.03)	0.7 (0.03)	1.1 (0.02)
Slovak Republic	2.7 (0.05)	0.6 (0.03)	2.9 (0.07)	1.5 (0.05)	1.8 (0.04)	1.0 (0.03)
Slovenia	2.0 (0.04)	0.6 (0.02)	1.7 (0.05)	1.6 (0.05)	1.6 (0.03)	0.9 (0.02)
Spain	1.8 (0.05)	0.3 (0.02)	1.8 (0.06)	1.1 (0.03)	1.7 (0.04)	0.6 (0.02)
Sweden	2.3 (0.04)	0.6 (0.02)	2.3 (0.05)	0.9 (0.02)	1.6 (0.04)	0.7 (0.02)
Switzerland	1.3 (0.03)	0.4 (0.02)	2.4 (0.05)	1.0 (0.03)	1.8 (0.03)	0.8 (0.02)
Thailand	2.1 (0.07)	0.3 (0.02)	1.2 (0.03)	1.6 (0.03)	1.1 (0.02)	1.0 (0.02)
United States	2.6 (0.07)	0.7 (0.03)	2.5 (0.06)	1.2 (0.04)	2.2 (0.05)	0.7 (0.02)

[1]Average hours based on: No Time = 0; Less Than 1 Hour = .5; 1-2 Hours = 1.5; 3-5 Hours = 4; More Than 5 Hours = 7.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70 - 84% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 4.9

Students' Reports on Total Amount of Daily Out-of-School Study Time[1] Science - Upper Grade (Eighth Grade*)

Country	Less than 1 Hour		1 to < 2 Hours		2 to 3 Hours		More than 3 Hours	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	15 (0.9)	505 (6.9)	46 (1.0)	556 (4.1)	22 (0.6)	557 (4.9)	17 (0.7)	546 (5.0)
Austria	9 (0.8)	551 (9.9)	46 (1.3)	563 (4.8)	21 (0.9)	561 (5.0)	24 (1.2)	553 (4.8)
Belgium (Fl)	2 (0.4)	~ ~	25 (1.3)	545 (5.0)	28 (1.1)	562 (5.9)	45 (1.6)	547 (3.6)
Belgium (Fr)	7 (0.8)	428 (6.9)	32 (1.0)	481 (4.7)	21 (1.3)	481 (4.5)	40 (1.5)	467 (4.0)
Canada	14 (1.2)	524 (6.1)	47 (1.1)	541 (2.8)	18 (0.7)	531 (3.9)	21 (1.1)	517 (3.6)
Colombia	2 (0.4)	~ ~	17 (1.1)	421 (5.3)	20 (1.2)	422 (4.9)	61 (1.9)	413 (5.8)
Cyprus	9 (0.5)	430 (7.0)	19 (0.7)	468 (4.4)	26 (0.8)	475 (3.4)	46 (0.9)	466 (2.9)
Czech Republic	13 (1.1)	558 (9.0)	57 (1.1)	579 (3.9)	17 (0.9)	582 (7.2)	13 (0.8)	560 (6.4)
Denmark	39 (1.6)	494 (4.4)	39 (1.4)	479 (4.1)	13 (0.8)	459 (5.5)	9 (0.7)	457 (6.8)
England	- -	- -	- -	- -	- -	- -	- -	- -
France	8 (0.7)	481 (6.8)	33 (1.2)	497 (3.3)	28 (1.0)	506 (4.0)	31 (1.2)	499 (3.4)
Germany	14 (1.1)	505 (8.2)	51 (1.2)	541 (4.6)	18 (1.0)	544 (7.0)	17 (0.9)	525 (6.5)
Greece	6 (0.6)	473 (4.8)	14 (0.7)	497 (5.0)	21 (0.7)	500 (3.1)	59 (1.2)	502 (2.5)
Hong Kong	13 (1.0)	489 (7.3)	32 (0.9)	519 (4.7)	25 (0.9)	534 (4.8)	30 (1.1)	534 (5.2)
Hungary	4 (0.4)	519 (10.0)	33 (1.1)	553 (4.4)	22 (0.9)	557 (5.6)	41 (1.3)	557 (3.0)
Iceland	5 (1.0)	470 (8.7)	46 (1.7)	505 (5.6)	25 (1.3)	493 (4.5)	23 (1.4)	488 (7.5)
Iran, Islamic Rep.	1 (0.2)	~ ~	5 (0.5)	476 (6.0)	12 (1.0)	479 (5.2)	82 (1.3)	471 (2.7)
Ireland	5 (0.6)	475 (9.0)	29 (1.0)	529 (5.4)	40 (1.1)	550 (4.7)	26 (1.2)	550 (4.9)
Israel	5 (0.6)	532 (13.5)	36 (2.2)	555 (7.7)	26 (1.5)	523 (6.9)	33 (2.1)	505 (5.2)
Japan	13 (0.8)	551 (4.4)	39 (0.8)	573 (2.2)	20 (0.6)	572 (3.0)	28 (1.0)	577 (2.4)
Korea	15 (0.9)	544 (5.0)	32 (1.1)	564 (2.9)	25 (0.8)	562 (3.1)	29 (1.2)	581 (3.7)
Kuwait	3 (0.6)	400 (10.4)	13 (1.5)	436 (7.8)	19 (1.3)	432 (7.1)	65 (1.8)	431 (3.4)
Latvia (LSS)	4 (0.5)	468 (8.5)	35 (1.1)	492 (4.1)	32 (1.2)	490 (4.1)	29 (1.2)	481 (3.0)
Lithuania	5 (0.6)	457 (9.1)	39 (1.4)	484 (4.5)	28 (1.0)	483 (3.8)	28 (1.4)	472 (4.7)
Netherlands	3 (0.9)	519 (17.1)	54 (1.7)	559 (6.1)	27 (1.7)	578 (5.4)	16 (0.8)	545 (5.7)
New Zealand	12 (0.9)	488 (7.6)	51 (1.2)	536 (4.6)	21 (1.0)	537 (5.7)	17 (0.9)	516 (5.7)
Norway	6 (0.5)	501 (7.3)	50 (1.2)	533 (2.5)	24 (0.9)	536 (3.4)	21 (0.9)	516 (3.7)
Portugal	3 (0.3)	465 (8.8)	41 (1.1)	488 (2.9)	18 (0.7)	478 (4.1)	38 (1.2)	474 (2.8)
Romania	9 (0.7)	460 (11.7)	16 (1.0)	468 (7.0)	15 (0.7)	487 (5.7)	60 (1.6)	499 (5.2)
Russian Federation	4 (0.5)	511 (10.1)	33 (1.1)	542 (4.4)	25 (1.0)	538 (4.4)	38 (1.4)	543 (4.6)
Scotland	17 (1.4)	470 (5.3)	54 (1.2)	526 (5.1)	17 (1.0)	537 (8.5)	12 (0.8)	532 (6.5)
Singapore	2 (0.3)	~ ~	7 (0.4)	604 (8.4)	13 (0.6)	617 (7.3)	78 (0.9)	607 (5.4)
Slovak Republic	6 (0.5)	551 (7.1)	46 (0.9)	552 (3.7)	25 (0.7)	541 (3.8)	23 (1.0)	536 (4.7)
Slovenia	5 (0.5)	559 (9.2)	36 (1.0)	580 (3.5)	21 (0.8)	557 (3.2)	37 (1.1)	544 (3.3)
Spain	3 (0.4)	482 (7.9)	26 (1.0)	522 (2.8)	18 (0.9)	522 (3.5)	53 (1.3)	516 (2.2)
Sweden	7 (0.6)	520 (6.0)	55 (1.2)	544 (3.2)	17 (0.8)	539 (4.9)	21 (0.9)	523 (4.9)
Switzerland	4 (0.3)	500 (8.3)	44 (1.2)	530 (3.1)	19 (0.8)	526 (6.2)	33 (1.1)	514 (3.5)
Thailand	3 (0.3)	510 (8.8)	26 (1.0)	520 (4.0)	18 (0.7)	519 (4.3)	54 (1.5)	532 (4.1)
United States	17 (1.1)	507 (9.5)	42 (0.9)	548 (4.1)	17 (0.7)	541 (5.2)	24 (0.8)	533 (5.7)

[1]Sum of time reported spent studying or doing homework in science, mathematics, and other subjects.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

to their higher-achieving counterparts, the lower-performing students may do less homework, either because they do not do it or because their teachers do not assign it, or more homework, perhaps because they need to spend the extra time to keep up academically. In some countries, students doing one hour a day of homework or more had higher average science achievement than students doing less than one hour a day (e.g., Greece, Hungary, Japan, Kuwait, and the Russian Federation), although in these countries there was little difference in achievement as the time spent increased from at least one hour to more than three hours. A more direct positive relationship between time spent doing homework and science achievement was found in other countries, such as Hong Kong, Korea, and Romania. The only inverse relationship was noted for Denmark. Clearly, different countries have different policies and practices about assigning homework.

The relationship between science achievement and amount of time spent watching television each day was more consistent across countries than that spent doing homework (see Table 4.10). In about half the TIMSS countries, the highest science achievement was associated with watching from one to two hours of television per day. This was the most common response, reflecting from 33% to 54% of the students for all countries. That watching less than one hour of television per day generally was associated with lower average science achievement than watching one to two hours in many countries most likely has little to do with the influence of television viewing on science achievement. For these students, low television viewing may be a surrogate socio-economic indicator, suggesting something about children's access to television sets across countries. Because students with fewer socio-economic advantages generally perform less well than their counterparts academically, it may be that students' who reported less than one hour watching television each day simply do not have television sets in their homes, or come from homes with only one television set where they have less opportunity to spend a lot of time watching their choice of programming.

In general, beyond one to two hours of television viewing per day, the more television eighth-graders reported watching, the lower their science achievement, although there were several countries where students watching three to five hours of television did not have lower achievement than those watching one to two hours. In all countries, however, students watching more than five hours of television per day had the lowest average science achievement. Countries where 10% or more of the students reported watching more than five hours of television each day included Colombia, England, Hong Kong, Hungary, Israel, Latvia (LSS), Lithuania, New Zealand, the Russian Federation, Scotland, the Slovak Republic, and the United States.

Table 4.10

Students' Reports on the Hours Spent Each Day Watching Television and Videos
Science - Upper Grade (Eighth Grade*)

Country	Less than 1 Hour		1 to 2 Hours		3 to 5 Hours		More than 5 Hours	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	24 (0.9)	556 (5.3)	41 (0.8)	554 (3.7)	27 (0.8)	541 (4.5)	9 (0.6)	502 (5.7)
Austria	25 (1.4)	562 (5.7)	53 (1.1)	561 (4.8)	17 (1.0)	558 (4.7)	5 (0.6)	522 (9.7)
Belgium (Fl)	24 (1.2)	563 (4.5)	52 (1.2)	556 (4.8)	19 (1.0)	526 (6.3)	5 (0.5)	517 (8.8)
Belgium (Fr)	33 (1.3)	480 (3.6)	44 (1.8)	476 (4.3)	17 (1.3)	467 (5.2)	6 (1.0)	413 (8.7)
Canada	22 (0.7)	528 (3.5)	46 (0.8)	536 (3.2)	25 (0.7)	535 (3.2)	7 (0.6)	508 (6.1)
Colombia	31 (1.5)	411 (4.3)	39 (1.2)	419 (4.5)	20 (1.2)	417 (7.3)	11 (1.0)	412 (6.2)
Cyprus	25 (1.1)	453 (3.6)	45 (1.1)	474 (2.4)	21 (0.8)	469 (4.0)	9 (0.7)	440 (5.1)
Czech Republic	15 (0.8)	578 (6.2)	45 (1.2)	581 (4.7)	31 (1.2)	571 (4.8)	9 (0.8)	546 (8.7)
Denmark	28 (1.1)	476 (3.9)	42 (1.2)	484 (4.3)	22 (1.0)	484 (4.9)	8 (0.7)	464 (7.8)
England	20 (1.3)	545 (9.8)	37 (1.2)	565 (4.9)	31 (1.2)	558 (4.2)	11 (0.9)	530 (7.5)
France	42 (1.3)	503 (3.6)	45 (1.1)	498 (2.9)	9 (0.7)	493 (4.9)	4 (0.5)	467 (7.3)
Germany	31 (1.0)	533 (6.0)	47 (1.1)	542 (4.9)	16 (0.8)	530 (6.5)	6 (0.6)	477 (9.2)
Greece	32 (0.9)	499 (2.7)	42 (0.7)	502 (3.1)	17 (0.7)	496 (3.6)	9 (0.5)	488 (4.9)
Hong Kong	22 (0.9)	520 (5.3)	39 (0.9)	529 (5.5)	28 (1.0)	526 (4.7)	11 (0.8)	506 (7.0)
Hungary	11 (0.7)	569 (5.9)	41 (1.1)	564 (3.6)	33 (0.9)	552 (3.7)	15 (1.0)	522 (5.0)
Iceland	24 (1.3)	485 (8.9)	47 (1.3)	496 (3.5)	22 (1.2)	504 (5.0)	7 (0.8)	492 (8.4)
Iran, Islamic Rep.	32 (1.3)	463 (3.4)	46 (0.9)	473 (2.9)	17 (0.9)	485 (6.1)	5 (0.6)	474 (6.7)
Ireland	20 (0.8)	530 (5.6)	51 (1.1)	546 (4.3)	23 (0.8)	546 (5.2)	5 (0.5)	501 (9.0)
Israel	9 (1.4)	507 (19.9)	33 (2.1)	538 (6.8)	44 (1.7)	532 (5.0)	14 (1.2)	513 (9.4)
Japan	9 (0.5)	579 (4.9)	53 (0.9)	578 (2.3)	30 (0.8)	564 (2.3)	9 (0.5)	547 (4.8)
Korea	32 (1.0)	574 (3.2)	40 (1.0)	569 (2.6)	20 (0.8)	555 (4.5)	7 (0.6)	534 (6.1)
Kuwait	39 (1.7)	425 (4.3)	38 (1.3)	435 (4.5)	14 (1.2)	441 (7.2)	9 (0.8)	420 (8.1)
Latvia (LSS)	16 (1.0)	473 (5.0)	44 (1.1)	487 (3.4)	29 (1.2)	497 (3.9)	10 (0.7)	477 (5.0)
Lithuania	12 (0.7)	469 (7.2)	44 (1.3)	485 (3.8)	32 (1.2)	476 (4.1)	12 (0.9)	467 (5.8)
Netherlands	17 (1.8)	562 (11.5)	47 (1.7)	572 (4.7)	27 (1.5)	550 (6.2)	9 (0.9)	527 (6.1)
New Zealand	24 (1.0)	530 (5.8)	38 (0.9)	538 (4.8)	26 (0.9)	525 (5.1)	12 (0.8)	489 (5.5)
Norway	15 (0.7)	536 (4.7)	48 (1.0)	534 (2.2)	30 (1.0)	523 (3.5)	7 (0.4)	496 (6.1)
Portugal	27 (1.0)	474 (3.6)	48 (0.9)	481 (2.8)	20 (0.8)	488 (3.0)	5 (0.5)	471 (5.8)
Romania	38 (1.4)	479 (7.2)	39 (1.2)	493 (5.6)	16 (0.9)	503 (6.0)	8 (0.7)	475 (7.3)
Russian Federation	12 (1.0)	526 (6.7)	42 (1.4)	540 (4.4)	32 (1.0)	544 (4.2)	14 (0.9)	538 (6.2)
Scotland	15 (0.7)	509 (8.1)	43 (1.0)	525 (6.4)	31 (1.0)	525 (5.4)	11 (0.7)	491 (5.4)
Singapore	7 (0.6)	633 (8.5)	50 (1.1)	615 (6.2)	37 (1.2)	597 (5.4)	6 (0.5)	582 (6.5)
Slovak Republic	14 (0.7)	558 (6.4)	47 (1.0)	548 (3.5)	28 (0.9)	545 (4.5)	11 (0.8)	521 (5.5)
Slovenia	23 (1.1)	568 (3.9)	54 (1.1)	559 (2.9)	19 (0.9)	558 (3.5)	4 (0.4)	547 (8.7)
Spain	33 (1.2)	514 (2.8)	46 (1.0)	522 (2.2)	17 (0.8)	517 (3.6)	4 (0.5)	496 (6.0)
Sweden	16 (0.7)	540 (5.2)	51 (0.9)	543 (3.1)	27 (0.8)	531 (4.1)	6 (0.5)	490 (5.5)
Switzerland	45 (1.5)	534 (3.9)	44 (1.3)	518 (3.2)	9 (0.7)	502 (5.2)	2 (0.2)	~ ~
Thailand	28 (1.4)	518 (3.8)	46 (1.0)	527 (4.0)	19 (1.1)	534 (4.7)	8 (0.7)	524 (5.9)
United States	22 (0.8)	542 (6.0)	40 (0.9)	548 (4.3)	25 (0.6)	533 (5.4)	13 (1.0)	493 (5.9)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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How Do Students Perceive Success in the Sciences?

Table 4.11 presents eighth-grade students' perceptions about doing well in the sciences. The results for each country are reported for either integrated science or separately for the science subject areas of biological science, earth science and physical science, depending on the form of the student questionnaire used. In all but three countries (Hong Kong, Japan, and Korea), the majority of students agreed or strongly agreed that they did well in either integrated science or in all of the science subject areas. Interestingly, two of these three countries where fewer than half of students thought they did well in science, Japan (45%) and Korea (35%), were among the highest performing countries on the TIMSS science test.

In several countries, more than 85% of students reported doing well in integrated science, including Colombia (91%), England (88%), Iran (95%), Kuwait (89%), and the United States (86%). Corresponding student reports for the separate sciences included Lithuania (85% in biological science), Slovak Republic (89% in biological science and 91% in earth science), and Slovenia (86% in biological science). For most separate-subject countries, more students reported doing well in biological science than in physical science.

Figure 4.2 indicates that for most countries, both boys and girls tended to agree that they did well in the sciences – a perception that did not always coincide with their achievement on the TIMSS science test. Among the countries that administered the integrated science form of the questionnaire, eighth-grade girls in England, Hong Kong, Japan, New Zealand, Norway, Scotland, Singapore, and Switzerland reported significantly lower self-perceptions than boys about doing well in science.

Among countries that asked about the separate science subject areas, fewer differences between girls' and boys' self-perceptions about doing well in the sciences were reported, but the differences that did exist indicated higher self-perceptions for boys. More than half of the countries had no or very small gender differences in self-perception about doing well in any of the subject areas, while in seven countries, boys had higher self-perceptions than girls in at least one of the subject areas (Austria, Flemish-speaking Belgium, Denmark, France, Germany, the Netherlands, and Sweden). Only in the Netherlands did boys have higher self-perceptions about doing well in all three subject areas.

The gender differences in self-perceptions differed across subject areas, with the physical sciences having the largest number of countries where boys reported higher self-perceptions than girls. In the biological sciences, there was very little difference across all countries between boys and girls in their self-perceptions about doing well. These differences in the self-perceptions of boys and girls across science subject areas correspond to the higher performance of boys on the physics and chemistry content areas of the TIMSS science test (Table 2.4).

Students were asked about the necessity of various attributes or activities to do well in science (see Table 4.12). There was enormous variation from country to country in the percentage of eighth-grade students agreeing that natural talent or ability were

Table 4.11

Students' Reports on Their Self-Perceptions About Usually Doing Well in the Sciences[1] - Upper Grade (Eighth Grade*)

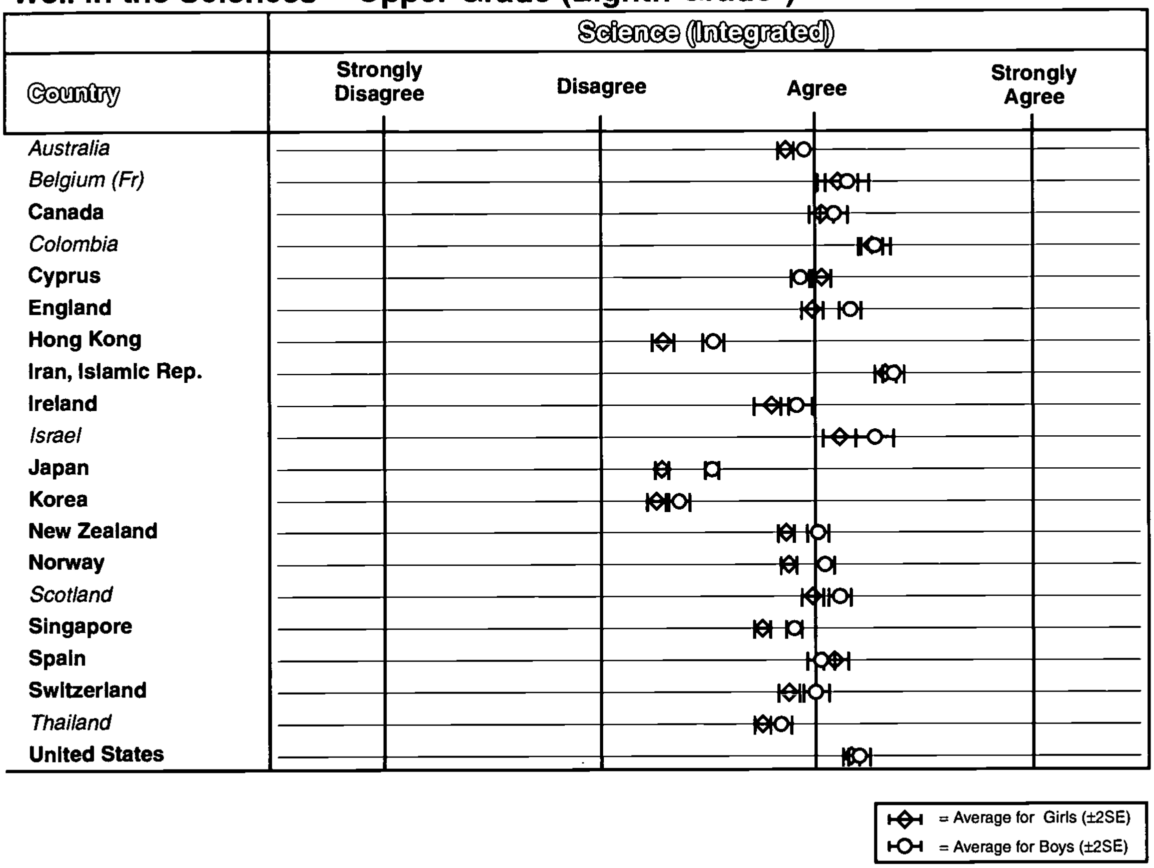
Country	Percent of Students Responding Agree or Strongly Agree			
	Science (Integrated)	Science Subject Areas		
		Biological Science	Earth Science	Physical Science
Australia	77 (1.0)	. .	. .	. .
Austria	. .	84 (1.2)	76 (1.4)	70 (1.5)
Belgium (Fl)	. .	71 (2.4)	65 (2.7)	s 56 (3.8)
Belgium (Fr)	s 85 (1.9)	. .	. .	. .
Canada	82 (1.2)	. .	. .	. .
Colombia	91 (0.8)	. .	. .	. .
Cyprus	76 (1.2)	. .	. .	. .
Czech Republic	. .	82 (2.0)	84 (1.1)	69 (2.0)
Denmark	. .	79 (1.0)	78 (1.3)	72 (1.3)
England	88 (1.0)	. .	. .	. .
[2] **France**	. .	71 (1.5)	. .	74 (1.7)
Germany	. .	79 (1.1)	70 (1.3)	63 (1.6)
Greece	. .	. .	. .	81 (0.9)
Hong Kong	43 (1.6)	. .	. .	. .
Hungary	. .	82 (1.2)	76 (1.3)	63 (1.5)
Iceland	. .	81 (1.6)	s 60 (1.8)	72 (1.5)
Iran, Islamic Rep.	95 (0.5)	. .	. .	. .
Ireland	74 (1.6)	. .	. .	. .
Israel	84 (1.3)	. .	. .	. .
Japan	45 (0.9)	. .	. .	. .
Korea	35 (1.1)	. .	. .	. .
Kuwait	89 (1.0)	. .	. .	. .
Latvia (LSS)	. .	74 (1.2)	. .	72 (1.4)
Lithuania	. .	85 (1.0)	61 (1.7)	60 (1.8)
Netherlands	. .	r 83 (1.4)	81 (1.7)	83 (1.6)
New Zealand	80 (0.9)	. .	. .	. .
Norway	80 (1.1)	. .	. .	. .
[3] **Portugal**	. .	72 (1.3)	. .	68 (1.5)
Romania	. .	77 (1.1)	77 (1.3)	69 (1.3)
Russian Federation	. .	84 (1.4)	74 (1.6)	70 (1.3)
Scotland	84 (0.9)	. .	. .	. .
Singapore	73 (1.2)	. .	. .	. .
Slovak Republic	. .	89 (0.8)	91 (0.7)	78 (1.2)
Slovenia	. .	86 (1.2)	. .	82 (1.1)
Spain	80 (1.2)	. .	. .	. .
Sweden	. .	82 (0.9)	83 (0.8)	77 (1.1)
Switzerland	76 (1.2)	. .	. .	. .
Thailand	67 (1.4)	. .	. .	. .
United States	86 (0.7)	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Biological science data for France are for students taking biology/geology classes.
[3]Biological science data for Portugal are for students taking natural science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.2

Gender Differences in Students' Self-Perceptions About Usually Doing Well in the Sciences[1] - Upper Grade (Eighth Grade*)



[1]Countries administered either an integrated science or separate subject area form of the questionnaire. Percentages for separate science subject areas are based only on those students taking each subject.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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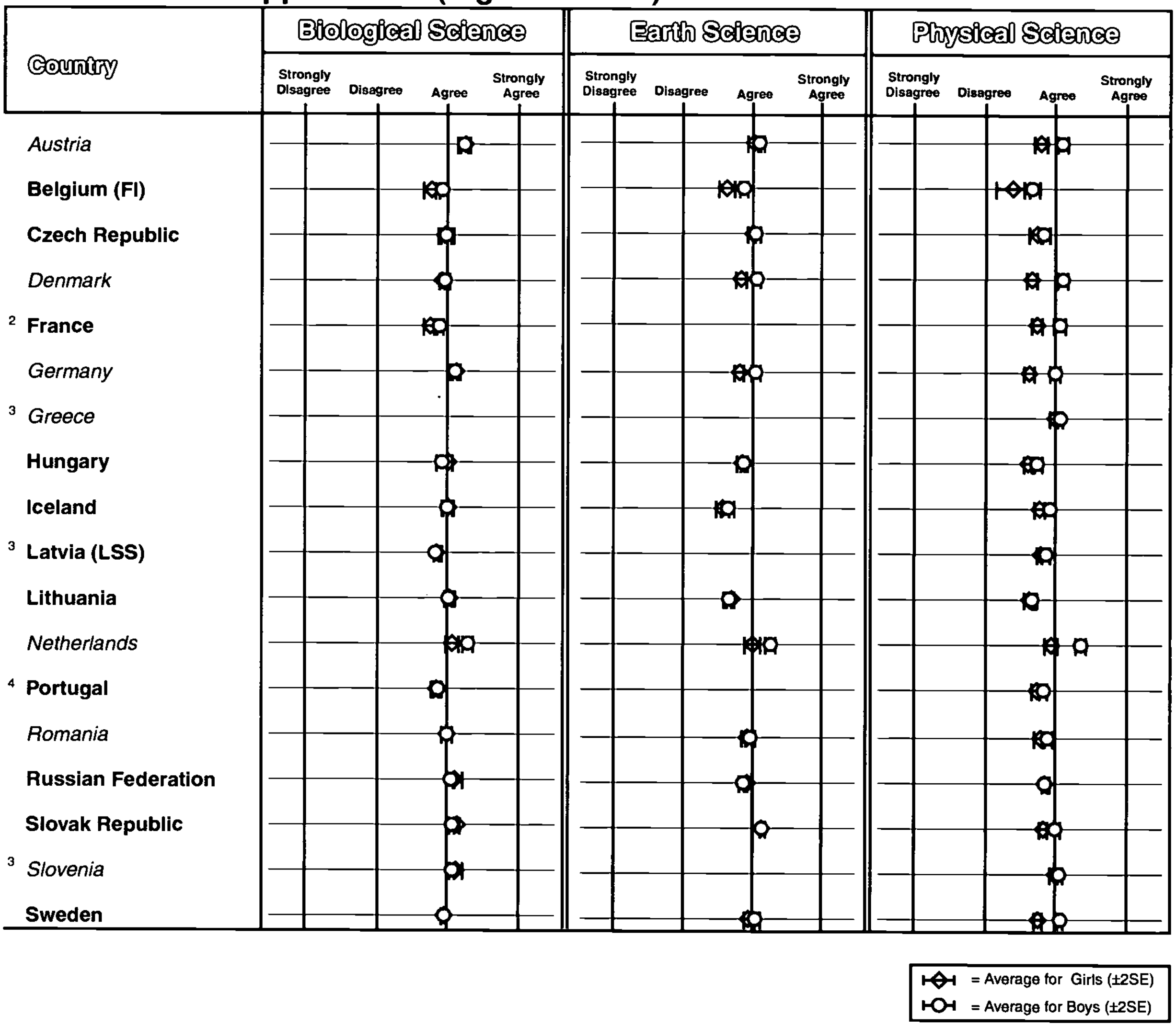
Figure 4.2 (Continued)
Gender Differences in Students' Self-Perceptions About Usually Doing Well in the Sciences[1] - Upper Grade (Eighth Grade*)



[1]Countries administered either an integrated science or separate subject area form of the questionnaire. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Biological science data for France are for students taking biology/geology classes.
[3]Greece, Latvia, and Slovenia did not ask about all three science subjects.
[4]Biological science data for Portugal are for students taking natural science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

important to do well in science. Fewer than 50% of the students agreed in the Czech Republic, England, France, Iceland, the Netherlands, and Sweden compared to 90% or more in Colombia, Iran, and Kuwait. Internationally, relatively few students agreed that good luck was important to do well. The countries where more than 50% of the eighth-graders agreed that good luck was needed to do well in science included Colombia, the Czech Republic, Hungary, Iran, Japan, Korea, Kuwait, Latvia (LSS), Lithuania, Romania, the Russian Federation, and the Slovak Republic.

Internationally, there was a high degree of agreement among students that lots of hard work studying at home was necessary in order to do well in science. Percentages of agreement were in the 80s and 90s for most countries and in the 70s for Austria, Hungary, Lithuania, and Switzerland. The variation was substantial from country to country regarding students' agreement with the necessity of memorizing the textbook or notes. In Belgium (French), France, Iceland, Iran, Japan, Korea, Kuwait, and Thailand, 90% or more of the eighth-grade students agreed or strongly agreed that memorization was important to doing well in science. In contrast, fewer than 50% agreed in Latvia (LSS), Lithuania, and Sweden.

Students also were asked about why they need to do well in the sciences. Depending on which questionnaire each country used, the results are reported for either integrated science or the separate science subject areas of biology, chemistry, earth science, and physics. Students could agree with any or all of three areas of possible motivation presented in Table 4.13 (to get their desired job), in Table 4.14 (to get into their preferred university or secondary school) and in Table 4.15 (to please their parents). There were substantial differences from country to country in students' responses for the three motivational factors.

As indicated in Table 4.13, the majority of eighth-grade students in many countries asked about integrated science either agreed or strongly agreed that getting their desired job was a motivating factor, although there were several countries where only slightly more than half of the students agreed. Eighty-five percent or more of students agreed in Iran (90%), Kuwait (85%), and Thailand (94%), compared to fewer than half of the students in Austria (38%), Japan (40%), Korea (44%), Norway (47%), and Switzerland (33%).

Compared to the integrated-science students, in general, fewer students in the countries asking about separate science subject areas agreed with the need to do well to get their desired job. Fewer than 60% of students in nearly all of these countries (primarily in Europe) agreed for any of the science subject areas that this was a reason to do well. In particular, fewer than 30% of students in Belgium (Flemish) and Hungary agreed for any subject, and only in Greece, Latvia (LSS), Lithuania, and Romania, did 50% or more of students agree for all subject areas. At the eighth grade, it appears that many students in these countries do not make a connection between getting a job they want and their performance in specific science subject areas. While this may be due to fewer students in these countries desiring jobs that use a particular science, it is also very likely that many students in this age group do not yet have a clear conception of either the type of job they want to pursue or the specific science education requirements for different jobs.

In the majority of countries, pleasing their parents and getting into their preferred university or secondary school were both stronger motivators than getting their desired job for eighth-grade students in either integrated science or separate science subject areas. However, 40% or fewer students in Denmark, Iceland, Japan, Lithuania (biology and chemistry), and Slovenia agreed that doing well was important in order to please their parents.

Table 4.12

Students' Reports on Things Necessary to Do Well in the Sciences Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Agree or Strongly Agree			
	Natural Talent/Ability	Good Luck	Lots of Hard Work Studying at Home	Memorize the Textbook or Notes
Australia	66 (0.8)	33 (0.8)	91 (0.5)	71 (0.9)
Austria	61 (1.5)	31 (1.3)	78 (1.4)	65 (1.2)
Belgium (Fl)	53 (1.5)	24 (1.8)	85 (0.9)	63 (1.9)
Belgium (Fr)	67 (1.2)	25 (1.1)	94 (0.7)	94 (0.6)
Canada	61 (1.0)	30 (1.0)	89 (0.7)	52 (1.0)
Colombia	91 (0.7)	64 (1.5)	97 (0.4)	79 (1.2)
Cyprus	51 (1.0)	34 (0.9)	93 (0.6)	76 (0.9)
Czech Republic	45 (1.0)	55 (1.2)	82 (1.2)	59 (1.4)
Denmark	89 (0.6)	35 (1.3)	82 (1.2)	65 (1.4)
England	47 (1.4)	25 (1.0)	93 (0.6)	56 (1.0)
France	38 (1.3)	23 (1.1)	88 (0.8)	95 (0.8)
Germany	57 (1.5)	28 (1.2)	82 (1.1)	70 (1.0)
Greece	58 (1.0)	27 (0.9)	96 (0.4)	87 (0.6)
Hong Kong	74 (0.9)	38 (1.0)	96 (0.5)	84 (0.7)
Hungary	88 (0.7)	56 (1.1)	79 (0.9)	57 (1.3)
Iceland	36 (1.4)	26 (1.6)	90 (0.9)	95 (0.8)
Iran, Islamic Rep.	95 (0.7)	51 (2.3)	97 (0.4)	91 (0.7)
Ireland	70 (1.0)	32 (1.1)	95 (0.6)	78 (0.9)
Israel	53 (1.9)	19 (1.8)	95 (0.9)	54 (2.1)
Japan	82 (0.6)	60 (1.0)	97 (0.3)	97 (0.3)
Korea	85 (0.7)	62 (1.0)	98 (0.2)	94 (0.4)
Kuwait	90 (1.4)	78 (1.7)	83 (1.3)	92 (0.7)
Latvia (LSS)	50 (1.2)	61 (1.2)	87 (0.8)	42 (1.3)
Lithuania	76 (1.0)	68 (1.1)	76 (1.1)	31 (1.2)
Netherlands	46 (1.4)	25 (1.6)	93 (0.8)	67 (1.2)
New Zealand	63 (1.1)	29 (1.2)	92 (0.5)	75 (1.0)
Norway	84 (0.7)	22 (0.9)	92 (0.6)	81 (0.9)
Portugal	72 (1.1)	39 (1.3)	98 (0.2)	66 (1.3)
Romania	64 (1.1)	59 (1.3)	86 (0.9)	78 (1.1)
Russian Federation	77 (0.7)	53 (1.7)	87 (0.9)	66 (1.8)
Scotland	- -	- -	- -	- -
Singapore	86 (0.7)	40 (0.9)	98 (0.3)	87 (0.8)
Slovak Republic	61 (1.1)	52 (1.1)	92 (0.6)	55 (1.2)
Slovenia	75 (1.0)	41 (1.4)	90 (0.6)	- -
Spain	66 (1.1)	35 (1.0)	96 (0.4)	79 (1.0)
Sweden	45 (1.0)	26 (1.1)	87 (0.6)	42 (1.0)
Switzerland	56 (1.2)	25 (0.7)	75 (1.1)	58 (1.5)
Thailand	69 (1.1)	35 (1.3)	80 (0.8)	97 (0.3)
United States	51 (0.8)	34 (1.3)	90 (0.6)	66 (1.0)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
A dash (-) indicates data are not available.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.13

Students' Perceptions About the Need to Do Well in the Sciences to Get Their Desired Job[1] - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Agree or Strongly Agree				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	52 (1.0)	. .	. .	. .	. .
Austria	38 (1.4)	. .	. .	. .	. .
Belgium (Fl)	. .	28 (1.4)	. .	18 (0.8)	x x
[2] *Belgium (Fr)*	s 53 (2.3)	x x	. .	. .	x x
Canada	63 (1.2)	. .	. .	. .	. .
Colombia	74 (1.3)	. .	. .	. .	. .
Cyprus	57 (1.3)	. .	. .	. .	. .
Czech Republic	. .	36 (1.0)	40 (1.3)	42 (1.2)	48 (1.5)
[3] *Denmark*	. .	31 (1.3)	. .	r 32 (1.4)	37 (1.1)
England	62 (1.5)	. .	. .	. .	. .
[4] **France**	. .	36 (1.1)	. .	. .	39 (1.3)
Germany	. .	33 (1.1)	s 32 (1.8)	. .	34 (1.2)
Greece	. .	. .	60 (0.8)	54 (0.9)	70 (0.8)
Hong Kong	55 (1.0)	. .	. .	. .	. .
Hungary	. .	26 (1.1)	20 (0.9)	19 (0.9)	25 (0.9)
Iceland	. .	44 (1.6)	x x	x x	s 46 (1.7)
Iran, Islamic Rep.	90 (1.0)	. .	. .	. .	. .
Ireland	50 (1.2)	. .	. .	. .	. .
Israel	51 (1.9)	. .	. .	. .	. .
Japan	40 (0.7)	. .	. .	. .	. .
Korea	44 (1.0)	. .	. .	. .	. .
Kuwait	85 (1.3)	. .	. .	. .	. .
Latvia (LSS)	. .	50 (1.3)	54 (1.2)	. .	61 (1.3)
Lithuania	. .	52 (1.5)	53 (1.3)	55 (1.3)	59 (1.2)
[5] *Netherlands*	. .	r 39 (1.9)	. .	22 (1.4)	36 (1.7)
New Zealand	55 (1.1)	. .	. .	. .	. .
Norway	47 (1.1)	. .	. .	. .	. .
[6] **Portugal**	. .	55 (1.2)	. .	. .	49 (1.1)
Romania	. .	59 (1.3)	55 (1.4)	57 (1.4)	57 (1.2)
Russian Federation	. .	45 (1.1)	46 (0.9)	44 (1.2)	55 (0.9)
Scotland	65 (1.1)	. .	. .	. .	. .
Singapore	71 (1.4)	. .	. .	. .	. .
Slovak Republic	. .	36 (1.2)	31 (1.0)	34 (1.0)	42 (1.2)
Slovenia	. .	37 (1.4)	38 (1.4)	. .	45 (1.4)
Spain	65 (1.0)	. .	. .	. .	. .
Sweden	. .	36 (1.2)	s 38 (1.5)	r 47 (1.1)	r 45 (1.1)
Switzerland	33 (0.9)	. .	. .	. .	. .
Thailand	94 (0.5)	. .	. .	. .	. .
United States	65 (0.9)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6]Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.14

Students' Perceptions About the Need to Do Well in the Sciences to Get Into Their Preferred University or Secondary School[1] - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Agree or Strongly Agree				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	59 (1.0)	. .	. .	. .	. .
Austria	48 (1.5)	. .	. .	. .	. .
Belgium (Fl)	. .	38 (1.5)	. .	28 (1.2)	x x
[2] *Belgium (Fr)*	s 59 (2.6)	x x	. .	. .	x x
Canada	81 (0.9)	. .	. .	. .	. .
Colombia	87 (0.8)	. .	. .	. .	. .
Cyprus	68 (1.1)	. .	. .	. .	. .
Czech Republic	. .	57 (1.1)	57 (1.3)	55 (1.2)	61 (1.5)
[3] *Denmark*	. .	49 (1.4)	. .	r 55 (1.5)	59 (1.5)
England	75 (1.2)	. .	. .	. .	. .
[4] **France**	. .	57 (1.1)	. .	. .	59 (1.1)
Germany	. .	36 (1.4)	s 35 (1.8)	. .	35 (1.3)
Greece	. .	. .	77 (1.1)	67 (0.9)	77 (0.6)
Hong Kong	74 (0.9)	. .	. .	. .	. .
Hungary	. .	63 (1.2)	61 (1.3)	61 (1.2)	63 (1.4)
Iceland	. .	76 (1.6)	x x	x x	s 70 (1.7)
Iran, Islamic Rep.	93 (0.5)	. .	. .	. .	. .
Ireland	66 (1.3)	. .	. .	. .	. .
Israel	83 (1.2)	. .	. .	. .	. .
Japan	86 (0.8)	. .	. .	. .	. .
Korea	80 (0.8)	. .	. .	. .	. .
Kuwait	86 (1.1)	. .	. .	. .	. .
Latvia (LSS)	. .	69 (1.2)	70 (1.2)	. .	71 (1.1)
Lithuania	. .	57 (1.2)	57 (1.3)	59 (1.0)	61 (1.3)
[5] *Netherlands*	. .	r 47 (1.5)	. .	29 (1.4)	42 (1.9)
New Zealand	60 (1.0)	. .	. .	. .	. .
Norway	64 (1.0)	. .	. .	. .	. .
[6] **Portugal**	. .	71 (1.0)	. .	. .	65 (1.2)
Romania	. .	64 (1.2)	61 (1.2)	61 (1.3)	60 (1.2)
Russian Federation	. .	62 (1.1)	64 (1.0)	59 (1.1)	67 (0.9)
Scotland	71 (1.2)	. .	. .	. .	. .
Singapore	93 (0.5)	. .	. .	. .	. .
Slovak Republic	. .	49 (1.2)	44 (1.2)	43 (1.1)	52 (1.0)
Slovenia	. .	55 (1.3)	54 (1.5)	. .	58 (1.3)
Spain	78 (0.8)	. .	. .	. .	. .
Sweden	. .	54 (1.1)	s 53 (1.1)	r 58 (0.9)	r 56 (0.9)
Switzerland	43 (0.9)	. .	. .	. .	. .
Thailand	97 (0.4)	. .	. .	. .	. .
United States	89 (0.6)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6]Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.15

Students' Perceptions About the Need to Do Well in the Sciences to Please Their Parents[1] - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Agree or Strongly Agree				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	66 (0.8)	. .	. .	. .	. .
Austria	48 (1.3)	. .	. .	. .	. .
Belgium (Fl)	. .	66 (1.0)	. .	67 (1.1)	x x
[2] *Belgium (Fr)*	s 73 (2.1)	x x	. .	. .	x x
Canada	63 (1.3)	. .	. .	. .	. .
Colombia	75 (1.4)	. .	. .	. .	. .
Cyprus	65 (1.1)	. .	. .	. .	. .
Czech Republic	. .	80 (1.1)	81 (1.1)	82 (1.1)	83 (1.0)
[3] *Denmark*	. .	27 (1.4)	. .	30 (1.5)	30 (1.4)
England	63 (1.4)	. .	. .	. .	. .
[4] **France**	. .	48 (1.3)	. .	. .	52 (1.3)
Germany	. .	41 (1.3)	s 48 (1.5)	. .	46 (1.2)
Greece	. .	. .	73 (0.9)	74 (0.9)	76 (0.8)
Hong Kong	56 (1.0)	. .	. .	. .	. .
Hungary	. .	41 (1.1)	41 (1.1)	43 (1.2)	46 (1.2)
Iceland	. .	37 (1.7)	x x	x x	s 38 (1.9)
Iran, Islamic Rep.	95 (0.6)	. .	. .	. .	. .
Ireland	56 (1.0)	. .	. .	. .	. .
Israel	47 (2.1)	. .	. .	. .	. .
Japan	33 (0.8)	. .	. .	. .	. .
Korea	53 (1.2)	. .	. .	. .	. .
Kuwait	93 (0.9)	. .	. .	. .	. .
Latvia (LSS)	. .	71 (1.3)	77 (1.1)	. .	77 (1.2)
Lithuania	. .	36 (1.4)	39 (1.3)	41 (1.2)	45 (1.4)
[5] *Netherlands*	. .	r 49 (2.0)	. .	50 (1.7)	52 (1.8)
New Zealand	61 (0.9)	. .	. .	. .	. .
Norway	48 (1.1)	. .	. .	. .	. .
[6] **Portugal**	. .	64 (1.2)	. .	. .	63 (1.2)
Romania	. .	61 (1.4)	62 (1.4)	62 (1.3)	63 (1.2)
Russian Federation	. .	62 (1.1)	63 (1.3)	64 (1.3)	67 (1.4)
Scotland	60 (1.2)	. .	. .	. .	. .
Singapore	68 (1.0)	. .	. .	. .	. .
Slovak Republic	. .	64 (1.2)	64 (1.1)	68 (1.2)	68 (1.2)
Slovenia	. .	33 (1.3)	33 (1.4)	. .	37 (1.3)
Spain	83 (0.9)	. .	. .	. .	. .
Sweden	. .	40 (1.2)	s 42 (1.4)	r 46 (1.3)	r 44 (1.2)
Switzerland	42 (1.1)	. .	. .	. .	. .
Thailand	98 (0.2)	. .	. .	. .	. .
United States	79 (0.7)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6]Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Are Students' Attitudes Towards the Sciences?

To collect information on eighth-grade students' perceptions of the sciences, TIMSS asked them a series of questions about the utility, importance, and enjoyability of science and science subject areas. Students' perceptions about the value of learning the sciences may be considered as both an input and outcome variable, because their attitudes towards science subjects can be related to educational achievement in ways that reinforce higher or lower performance. That is, students who do well in the sciences generally have more positive attitudes towards the science subjects, and those who have more positive attitudes tend to perform better.

Table 4.16 summarizes students' responses to the questions about how much they like or dislike science or the separate science subject areas of biological science, earth science, and physical science. Even though the majority of eighth-graders in nearly every country indicated they liked science or liked science a lot, clearly not all students feel equally positive about these subject areas. For example, 60% or fewer of students reported that they liked integrated science in Australia (60%), Israel (59%), Japan (56%), and Korea (59%). For biology, this was the case only in Denmark (52%). Fewer than 60% of the students reported liking earth science in 7 out of 13 countries. For physics, the figures fell below 60% in 10 out of 18 countries. More than 80% of students reported liking science (integrated) in several countries, including Colombia, Iran, Kuwait, Singapore, and Thailand. Similarly, more than 80% of the students in Latvia (LSS), Portugal, and the Russian Federation reported liking biology. More eighth-grade students internationally reported liking biological science than either earth science or physical science. For example, the percent of students agreeing or strongly agreeing that they liked biological science ranged from 52% in Denmark to 90% in Portugal, whereas the range in physical science was from 44% in the Czech Republic to 81% in Portugal. In Denmark, fewer than 60% of students reported liking any of the three science subject areas.

The data in Figure 4.3 reveal that, on average, in the majority of countries eighth-graders of both genders were relatively neutral about liking the sciences. There was, however, more variation in the average response across countries asking about integrated science than across those asking about the separate science subject areas. Boys reported liking science (integrated) more than did girls in England, Hong Kong, Japan, New Zealand, Norway, and Singapore.

Across the separate science subject areas, the greatest number of statistically significant gender differences were found in physical science, with boys liking physical science more than girls did. In contrast, in all countries, girls reported liking biological science at least as much as did boys. In fact, the only statistically significant gender differences in liking biological science favored girls in Austria, Hungary, and Slovenia. These differences in students' reports of liking science subjects correspond with the relative performance of boys and girls on the life science and physical science content areas on the TIMSS test, with the majority of statistically significant gender differences in performance favoring boys on the physics and chemistry items (Table 2.4).

Table 4.16

Students' Reports About Liking the Sciences[1] Upper Grade (Eighth Grade*)

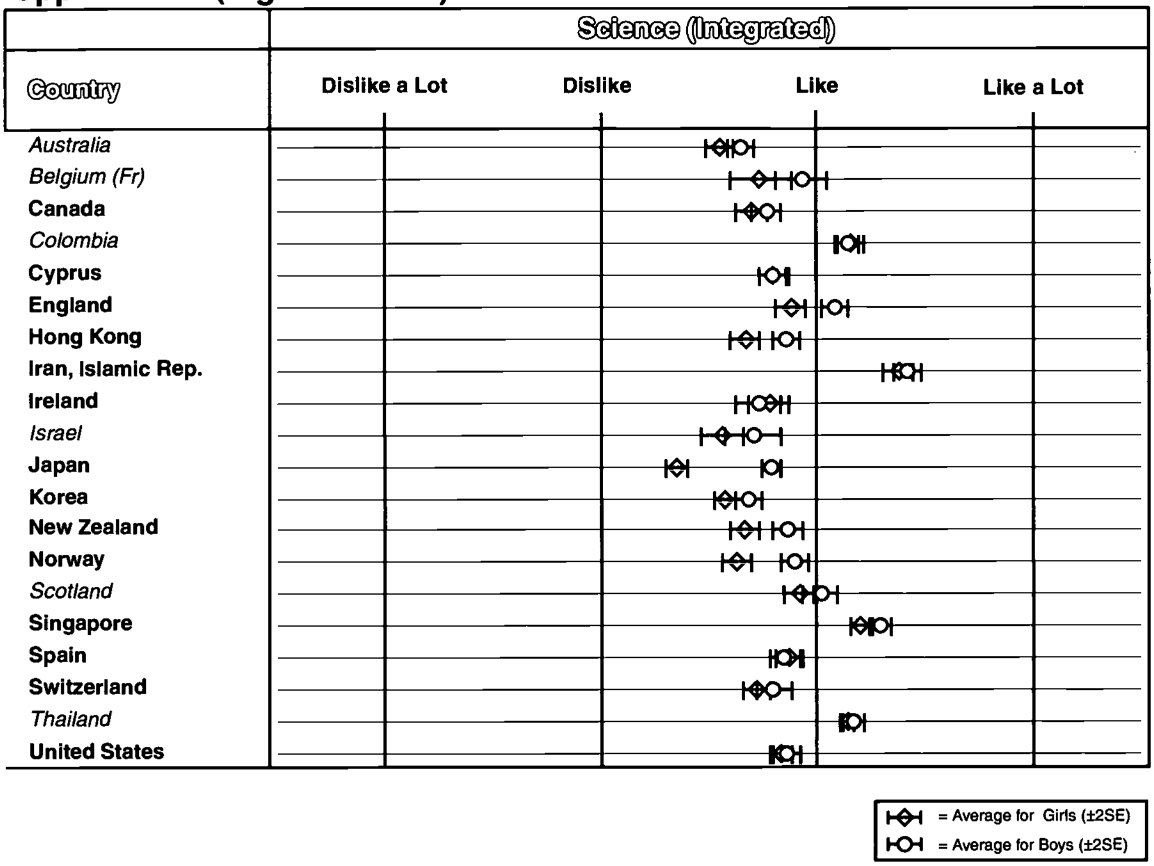
Country	Percent of Students Responding Like or Like a Lot			
	Science (Integrated)	Science Subject Areas		
		Biological Science	Earth Science	Physical Science
Australia	60 (1.2)	. .	. .	. .
Austria	. .	70 (1.7)	55 (2.0)	49 (2.0)
Belgium (Fl)	. .	68 (2.0)	53 (2.2)	s 54 (2.3)
Belgium (Fr)	s 71 (2.2)	. .	. .	. .
Canada	68 (1.3)	. .	. .	. .
Colombia	87 (0.9)	. .	. .	. .
Cyprus	70 (1.3)	. .	. .	. .
Czech Republic	. .	65 (2.4)	65 (2.3)	44 (1.6)
Denmark	. .	52 (2.1)	51 (1.9)	56 (1.7)
England	78 (1.1)	. .	. .	. .
[2] **France**	. .	67 (1.7)	. .	65 (2.1)
Germany	. .	65 (1.5)	55 (1.5)	49 (1.5)
Greece	. .	. .	. .	76 (1.0)
Hong Kong	69 (1.5)	. .	. .	. .
Hungary	. .	73 (1.4)	63 (1.5)	49 (1.3)
Iceland	. .	72 (2.8)	r 53 (2.2)	59 (2.3)
Iran, Islamic Rep.	93 (0.8)	. .	. .	. .
Ireland	67 (1.6)	. .	. .	. .
Israel	59 (2.0)	. .	. .	. .
Japan	56 (1.1)	. .	. .	. .
Korea	59 (1.5)	. .	. .	. .
Kuwait	89 (1.2)	. .	. .	. .
Latvia (LSS)	. .	81 (1.3)	. .	74 (1.3)
Lithuania	. .	77 (1.2)	56 (1.4)	55 (1.6)
Netherlands	. .	r 72 (1.9)	55 (2.6)	57 (2.2)
New Zealand	68 (1.2)	. .	. .	. .
Norway	67 (1.6)	. .	. .	. .
[3] **Portugal**	. .	90 (0.8)	. .	81 (1.3)
Romania	. .	76 (1.2)	75 (1.1)	65 (1.4)
Russian Federation	. .	85 (1.0)	70 (1.3)	71 (1.4)
Scotland	78 (1.3)	. .	. .	. .
Singapore	92 (0.6)	. .	. .	. .
Slovak Republic	. .	69 (1.4)	72 (1.4)	51 (1.7)
Slovenia	. .	74 (1.7)	. .	66 (1.4)
Spain	73 (1.3)	. .	. .	. .
Sweden	. .	61 (1.4)	66 (1.3)	63 (1.3)
Switzerland	67 (1.5)	. .	. .	. .
Thailand	90 (0.7)	. .	. .	. .
United States	71 (1.1)	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Biological science data for France are for students taking biology/geology classes.
[3]Biological science data for Portugal are for students taking natural science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.3

Gender Differences in Liking the Sciences[1]
Upper Grade (Eighth Grade*)

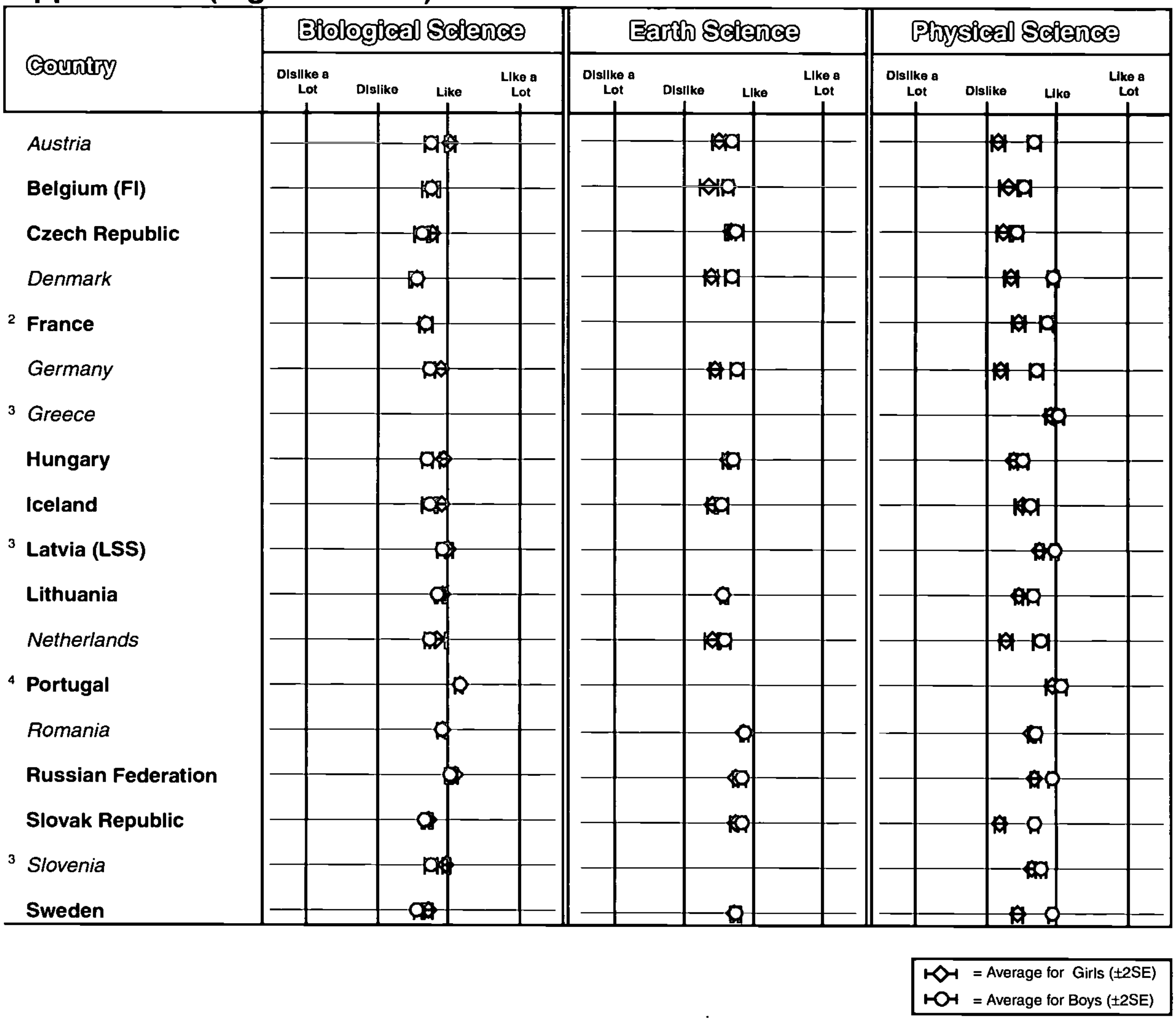


[1]Countries administered either an integrated science or separate subject area form of the questionnaire. Percentages for separate science subject areas are based only on those students taking each subject.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 4.3 (Continued)

Gender Differences in Liking the Sciences[1]
Upper Grade (Eighth Grade*)



[1]Countries administered either an integrated science or separate subject area form of the questionnaire. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Biological science data for France are for students taking biology/geology classes.
[3]Greece, Latvia, and Slovenia did not ask about all three science subjects.
[4]Biological science data for Portugal are for students taking natural science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Chapter 5

TEACHERS AND INSTRUCTION

Teachers and the instructional approaches they use are fundamental in building students' understanding of science. Primary among their many duties and responsibilities, teachers structure and guide the pace of individual, small-group, and whole-class work to present new material, engage students in scientific tasks, and help deepen students' grasp of the science being studied. Teachers may help students use technology and laboratory equipment to investigate scientific ideas, develop their understanding of scientific approaches to problem solving, and promote positive attitudes towards science. They also may assign homework and conduct informal as well as formal assessments to monitor progress in student learning, make ongoing instructional decisions, and evaluate achievement outcomes.

Effective science teaching is a complex endeavor requiring knowledge of the subject matter of science, understanding of student learning, and appreciation of the pedagogy of science. It can be fostered through institutional support and adequate resources. Teachers also can support each other in planning instructional strategies, devising real-world applications of scientific concepts, and developing sequences that move students from concrete tasks to the ability to think for themselves and explore scientific theories.

TIMSS administered a background questionnaire to teachers to gather information about their backgrounds, training, and how they think about science. The questionnaire also asked about how they spend their time related to their teaching tasks and the instructional approaches they use in their classrooms. Information was collected about the materials used in instruction, the activities students do in class, the use of calculators and computers in science lessons, the role of homework, and the reliance on different types of assessment approaches.

This chapter presents the results of teacher's responses to some of these questions. Because the sampling for the teacher questionnaires was based on participating students, the responses to the science teacher questionnaire do not necessarily represent all of the eighth-grade science teachers in each of the TIMSS countries. Rather, they represent teachers of the representative samples of students assessed. It is important to note that in this report, the student is always the unit of analysis, even when information from the teachers' questionnaires is being reported. Using the student as the unit of analysis makes it possible to describe the instruction received by representative samples of students. Although this approach may provide a different perspective from that obtained by simply collecting information from teachers, it is consistent with the TIMSS goals of providing information about the educational contexts and performance of students.

The tables in this chapter contain special notation regarding response rates. For a country where teacher responses were available for 70% to 84% of the students, an "r" is included next to the data for that country. When teacher responses were available for 50% to 69% of the students, an "s" is included next to the data for that country. When teacher responses were available for less than 50% of the students, an "x" replaces the data.[1]

Who Delivers Science Instruction?

This section provides information about the science teaching force in each of the participating countries, in terms of certification, degrees, age, gender, and years of teaching experience.

Table 5.1 summarizes information gathered from each country about the requirements for certification held by the majority of the seventh- and eighth-grade teachers. In many countries, the type of education required for qualification includes a university degree. In other countries, study at a teacher training institution is required, or even both a university degree and study at a teacher training institution. The number of years of post-secondary education required for a teaching qualification ranged from two years in Iran to as much as six years in Canada, although many countries reported four years. All of the countries except Colombia, Cyprus, Greece, and Lithuania reported that teaching practice was required. A large number of countries reported that an evaluation or examination was required for certification. Those countries not having such a requirement included Canada, Colombia, Cyprus, Greece, Iran, Israel, Korea, Portugal, Sweden, and the United States.

Table 5.2 contains teachers' reports on their age and gender. If a constant supply of teachers were entering the teaching force, devoting their careers to the classroom, and then retiring, one might expect approximately equivalent percentages of students taught by teachers in their 20s, 30s, 40s, and 50s, and this does appear to hold for some countries. In most countries, however, the majority of the eighth-grade students were taught science by teachers in their 30s or 40s. Very few countries seemed to have a comparatively younger teaching force, with only Iran having 40% or more of the students with science teachers in their 20s or younger, and just five countries (Hong Kong, Iran, Korea, Kuwait, and Portugal) having 70% or more students with teachers in their 30s or younger. Countries with a comparatively older teaching force included Cyprus, the Czech Republic, and Germany, where 70% or more of the eighth-grade students had science teachers in their 40s or older.

In a number of countries, approximately equivalent percentages of eighth-grade students were taught science by male teachers and female teachers. However, at least 70% of the eighth-grade students had female science teachers in the Czech Republic, Hungary, Israel, Latvia (LSS), Lithuania, Portugal, Romania, the Russian Federation, and Slovenia. In contrast, at least 70% of the students had male teachers in Denmark, Japan, the Netherlands, and Switzerland.

As might be expected from the differences in teachers' ages from country to country, the TIMSS data indicate differences in teacher experience across countries (see Table 5.3). Those countries with younger teaching forces tended to have more students

[1] Similar to Chapter 4, background data are not available for Bulgaria and South Africa.

taught by less experienced teachers. At least half the eighth-grade students had science teachers with 10 years or less of experience in Hong Kong, Iceland, Iran, Israel, Korea, Kuwait, Portugal, and Thailand. Fewer countries had relatively experienced teaching forces. Only in the Czech Republic, France, and Romania did more than half the students have science teachers with more than 20 years of experience.

The relationship between years of teaching experience and science achievement is not clear in many countries. In about one-fourth of the countries, the eighth-grade students with the most experienced teachers (more than 20 years) had higher science achievement than did those with less experienced teachers (5 years or fewer). This may reflect the practice of giving teachers with more seniority the more advanced classes. However, there were also several countries where the students with less experienced teachers had higher achievement than did those with the most experienced teachers.

Table 5.1

Requirements for Certification Held by the Majority of Lower- and Upper-Grade (Seventh and Eighth Grade*) Teachers[1]

Country	Type of Education Required for Qualification	Number of Years of Post-Secondary Education Required	Teaching or Practice Experience Required	Evaluation or Examination Required
Australia	University or Teacher Training Institution	4	yes	yes
Austria	Teacher Training Institution: Teachers in the general secondary schools (70%) are required to have an education from a teacher training institution. Teachers in the academic secondary schools (30%) are required to have a university education.	3–5	yes	yes
Belgium (Fl)	Teacher Training Institution	3	yes	yes
Belgium (Fr)	Teacher Training Institution	3	yes	yes
Bulgaria	University	5	yes	yes
Canada	University	5–6	yes	no
Colombia	University	4	no	no
Cyprus	University	4	no	no
Czech Republic	University	4–5	yes	yes
Denmark	Teacher Training Institution	4	yes	yes
England	University or Higher Education Institution: Teachers of lower- and upper-grade students normally study their specialist subject area for their degree for 3 or 4 years. This is followed by a one-year post graduate course. However, some teachers study education and specialty concurrently. All teachers who qualified since 1975 are graduates. Some teachers who qualified before this date hold teacher certificates but are not graduates.	3–5	yes	yes
France	University and Teacher Training: As of 1991, teachers of lower- and upper-grade students are required to have a 3-year university diploma, followed by a competitive examination and professional training. The majority of teachers (more than 50%) meet the requirements (more in the public schools than in the private sector). Yet, there are still many teachers recruited before 1991 who do not have the same level of qualification.	4 or 5	yes	yes
Germany	University and Post-University Teacher Training Institution	3–5 +2 years	yes	yes
Greece	University	4	no	no
Hong Kong	University and one year Post-Graduate training	4	yes	yes
Hungary	Teacher Training Institution	4	yes	yes
Iceland	University	3	yes	yes
Iran	Teacher Training Institution	2	yes	no
Ireland	University with Post Graduate University Training	4–5	yes	yes
Israel	University	4	yes	no
Japan	University	4	yes	yes

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
[1]Certification pertains to the majority (more than 50%) of teachers of lower- and upper-grade students in each country.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

Table 5.1 (Continued)

Requirements for Certification Held by the Majority of Lower- and Upper-Grade (Seventh and Eighth Grade*) Teachers [1]

Country	Type of Education Required for Qualification	Number of Years of Post-Secondary Education Required	Teaching or Practice Experience Required	Evaluation or Examination Required
Korea	University	4	yes	no
Kuwait	University	4	yes	yes
Latvia	Pedagogical Institution	4	yes	yes
Lithuania	University or Teacher Training Institution	5	no	yes
Netherlands	Teacher Training Institution	4	yes	yes
New Zealand	Teacher Training Institution or University with Teacher Training Institution: Teachers of students in the lower grade are required to attend a teacher training institution. Teachers in the upper grade are required to have a university and teacher training institution education.	3 (lower gr.) 4 (upper gr.)	yes	yes
Norway	Teacher Training Institution or University: Most teachers of students in the lower grade have a certificate from a teacher training institution. For teachers of students in the upper grade there is about an equal distribution between those who attended a teacher training institution and those who attended university.	3–4[2]	yes	yes
Philippines	Teacher Training Institution or University	4	yes	yes
Portugal	University	3–5	yes	no
Romania	University	4–5	yes	yes
Russian Federation	University or Teacher Training Institution or Post-Graduate University Training	4–5	yes	yes
Scotland	University or Teacher Training Institution	4	yes	yes
Singapore	Post-Graduate University Training	4–5	yes	yes
Slovak Republic	Teacher Training Institution or University	4–5[3]	yes	yes
Slovenia	University	4–5	yes	yes
South Africa	Teacher Training Institution	3	yes	yes
Spain	Teacher Training Institution or University	3	yes	yes
Sweden	Teacher Training Institution (lower grade) University (upper grade)	3-3.5 (lower gr.)[4] 4-4.5 (upper gr.)[4]	yes	yes
Switzerland	University or Teacher Training Institution	2–4	yes	yes
Thailand	Teacher Training Institution or University	4	yes	yes
United States	University	4	yes	no

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
[1]Certification pertains to the majority (more than 50%) of teachers of lower- and upper-grade students in each country.
[2]Norway: Until 1965 2 years of post-secondary education were required. Between 1965 and 1995 3 years were required. As of 1996, new certified teachers are required to have completed 4 years of post-secondary education.
[3]Slovak Republic: In the past, 4 years of study at a teacher training institution were required. Currently, the requirement is 5 years at a teacher training institution or university.
[4]Sweden: Until 1988 3 years of post-secondary education were required for lower-grade teachers and 4 years for upper-grade teachers. Since 1988 3.5 years of post-secondary education are required for lower-grade teachers and 4-4.5 years are required for upper-grade teachers.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95. Information provided by TIMSS National Research Coordinators.

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Table 5.2

Teachers' Reports on Their Age and Gender
Science - Upper Grade (Eighth Grade*)

Country		Percent of Students Taught by Teachers					Percent of Students Taught by Teachers	
		29 Years or Under	30 - 39 Years	40 - 49 Years	50 Years or Older		Female	Male
Australia	r	17 (2.2)	31 (3.2)	37 (3.3)	16 (2.2)	r	39 (3.5)	61 (3.5)
Austria	r	6 (1.8)	41 (4.0)	43 (3.6)	10 (2.0)	r	52 (3.4)	48 (3.4)
Belgium (Fl)		13 (2.5)	30 (3.9)	32 (4.3)	25 (3.4)		55 (4.2)	45 (4.2)
Belgium (Fr)	s	15 (3.5)	33 (5.8)	31 (4.7)	21 (3.8)	s	56 (5.8)	44 (5.8)
Canada		21 (3.5)	27 (2.9)	33 (4.0)	19 (3.1)		37 (3.6)	63 (3.6)
Colombia		18 (4.6)	31 (4.2)	36 (4.5)	14 (3.6)		39 (5.0)	61 (5.0)
Cyprus	r	0 (0.0)	28 (3.1)	53 (3.7)	19 (3.3)	r	52 (4.0)	48 (4.0)
Czech Republic		8 (2.1)	18 (2.9)	32 (2.8)	42 (3.0)		76 (2.5)	24 (2.5)
Denmark	s	8 (3.5)	23 (5.7)	39 (6.1)	30 (5.8)	s	23 (4.4)	77 (4.4)
England	s	15 (2.0)	25 (2.5)	41 (2.9)	19 (2.6)	s	39 (3.2)	61 (3.2)
France		13 (1.9)	19 (2.7)	41 (3.5)	27 (3.3)		51 (3.9)	49 (3.9)
Germany	s	0 (0.0)	15 (3.7)	37 (4.0)	47 (3.9)	s	39 (4.8)	61 (4.8)
Greece		2 (0.4)	43 (3.4)	43 (3.4)	12 (2.1)		43 (3.9)	57 (3.9)
Hong Kong		34 (5.8)	38 (6.1)	20 (4.3)	8 (3.1)		32 (5.4)	68 (5.4)
Hungary		14 (1.7)	27 (2.3)	39 (2.2)	20 (2.1)		74 (2.2)	26 (2.2)
Iceland	r	22 (4.2)	46 (4.9)	24 (3.4)	8 (2.9)	r	44 (7.4)	56 (7.4)
Iran, Islamic Rep.		45 (5.5)	39 (5.7)	15 (3.9)	1 (0.9)		40 (4.7)	60 (4.7)
Ireland	r	18 (2.6)	40 (3.7)	29 (4.0)	13 (2.7)	r	54 (4.6)	46 (4.6)
Israel	s	26 (7.8)	49 (8.8)	11 (5.4)	14 (6.8)	s	91 (5.4)	9 (5.4)
Japan		19 (3.6)	48 (4.4)	20 (3.8)	13 (3.2)		20 (3.6)	80 (3.6)
Korea		24 (3.2)	46 (4.1)	21 (3.4)	10 (2.2)		48 (4.0)	52 (4.0)
Kuwait	r	33 (8.1)	48 (8.1)	19 (4.9)	1 (0.6)	r	50 (8.0)	50 (8.0)
Latvia (LSS)	r	13 (1.5)	34 (2.8)	25 (2.2)	28 (2.4)	r	75 (2.1)	25 (2.1)
Lithuania		17 (2.0)	32 (2.3)	26 (2.2)	24 (2.2)		78 (1.8)	22 (1.8)
Netherlands		11 (2.3)	27 (3.4)	35 (3.7)	27 (3.4)		20 (3.1)	80 (3.1)
New Zealand		11 (2.6)	28 (3.8)	39 (4.2)	22 (3.3)		40 (4.3)	60 (4.3)
Norway		12 (2.9)	19 (3.6)	41 (3.9)	28 (3.8)		31 (3.9)	69 (3.9)
Portugal		37 (3.0)	44 (3.2)	13 (2.4)	6 (1.5)		78 (3.0)	22 (3.0)
Romania		11 (1.6)	21 (2.0)	38 (2.2)	30 (2.3)		74 (1.9)	26 (1.9)
Russian Federation		18 (3.7)	26 (3.0)	31 (2.5)	25 (2.4)		86 (2.0)	14 (2.0)
Scotland	s	9 (1.7)	26 (4.3)	43 (4.8)	22 (3.9)	s	37 (3.8)	63 (3.8)
Singapore		30 (4.3)	23 (4.0)	28 (4.9)	19 (3.6)		69 (4.6)	31 (4.6)
Slovak Republic		13 (2.7)	25 (3.9)	40 (4.4)	21 (3.5)		63 (4.2)	37 (4.2)
Slovenia	r	13 (2.4)	45 (3.2)	24 (2.8)	18 (2.9)	r	77 (2.6)	23 (2.6)
Spain		3 (1.5)	31 (3.8)	50 (4.1)	16 (3.1)		44 (4.2)	56 (4.2)
Sweden		11 (1.9)	23 (2.6)	28 (2.7)	39 (3.0)		37 (2.9)	63 (2.9)
Switzerland	r	15 (4.1)	26 (4.1)	39 (4.6)	19 (3.3)	r	14 (2.5)	86 (2.5)
Thailand	r	22 (5.0)	43 (5.7)	33 (6.2)	2 (2.2)	r	64 (5.7)	36 (5.7)
United States	r	17 (2.9)	27 (2.5)	34 (3.5)	23 (3.4)	r	54 (4.1)	46 (4.1)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.3

Teachers' Reports on Their Years of Teaching Experience Science - Upper Grade (Eighth Grade*)

Country		0 - 5 Years		6-10 Years		11-20 Years		More than 20 Years	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r	19 (2.3)	537 (8.4)	20 (2.9)	539 (10.4)	38 (3.5)	555 (7.9)	23 (2.7)	548 (7.9)
Austria	r	5 (1.1)	553 (11.5)	17 (2.3)	567 (5.0)	49 (3.5)	560 (4.9)	30 (3.3)	562 (4.7)
Belgium (Fl)		11 (2.3)	548 (8.0)	11 (2.8)	574 (6.2)	38 (5.3)	549 (8.8)	40 (4.8)	549 (7.7)
Belgium (Fr)	s	13 (3.6)	482 (8.7)	8 (2.7)	492 (8.1)	44 (5.7)	485 (4.8)	35 (5.0)	478 (5.8)
Canada		25 (3.3)	535 (7.2)	18 (2.5)	542 (6.7)	23 (3.0)	521 (4.4)	33 (3.6)	529 (5.6)
Colombia	r	18 (3.4)	404 (9.5)	10 (2.8)	410 (9.7)	36 (3.7)	415 (5.5)	36 (4.6)	421 (4.5)
Cyprus	s	34 (5.1)	457 (5.0)	10 (2.9)	461 (11.7)	24 (3.1)	454 (4.8)	32 (4.1)	463 (3.4)
Czech Republic		11 (1.8)	566 (8.1)	12 (1.9)	589 (14.2)	13 (2.0)	573 (5.9)	64 (2.5)	572 (4.1)
Denmark	s	14 (4.2)	482 (8.0)	15 (4.6)	461 (7.2)	32 (5.9)	478 (4.6)	40 (6.3)	484 (6.2)
England	s	21 (2.2)	559 (11.5)	14 (2.2)	559 (10.7)	33 (3.2)	566 (8.3)	32 (3.0)	569 (8.3)
France		16 (2.2)	498 (4.3)	9 (2.2)	489 (7.1)	19 (2.5)	492 (4.3)	55 (4.0)	501 (3.8)
Germany	s	5 (2.0)	557 (30.0)	13 (3.2)	529 (14.0)	39 (4.3)	546 (7.4)	43 (4.4)	526 (10.2)
Greece		19 (3.0)	485 (4.4)	26 (4.2)	481 (3.3)	42 (4.0)	508 (3.6)	14 (2.3)	512 (4.5)
Hong Kong		38 (6.3)	532 (7.6)	23 (4.8)	516 (11.3)	25 (5.4)	504 (10.4)	14 (4.1)	536 (13.5)
Hungary		15 (1.9)	545 (5.6)	12 (1.8)	552 (4.9)	32 (2.7)	556 (4.6)	41 (2.7)	552 (3.9)
Iceland	r	34 (4.6)	489 (8.9)	21 (5.6)	492 (6.1)	31 (6.5)	485 (5.1)	14 (3.5)	483 (5.3)
Iran, Islamic Rep.		37 (4.7)	456 (4.2)	20 (5.7)	473 (5.6)	34 (4.7)	478 (4.8)	9 (3.2)	487 (6.2)
Ireland	r	18 (3.1)	563 (11.3)	17 (2.9)	533 (12.0)	38 (4.1)	547 (7.0)	27 (3.9)	527 (10.2)
Israel	r	28 (7.8)	501 (15.7)	27 (7.6)	512 (12.8)	31 (7.4)	553 (13.4)	14 (6.2)	552 (23.0)
Japan		19 (3.4)	563 (4.1)	21 (3.4)	573 (3.4)	36 (4.2)	574 (3.9)	23 (3.5)	573 (3.2)
Korea		23 (3.5)	562 (4.9)	31 (3.3)	568 (4.0)	32 (3.7)	562 (3.8)	13 (2.7)	567 (5.9)
Kuwait	s	37 (7.0)	433 (5.0)	25 (7.3)	445 (8.4)	33 (8.5)	413 (10.8)	5 (4.2)	421 (41.2)
Latvia (LSS)	r	13 (1.8)	485 (3.6)	20 (2.3)	482 (3.9)	28 (2.7)	486 (4.2)	39 (2.6)	485 (3.6)
Lithuania	r	19 (2.2)	483 (4.7)	14 (1.7)	479 (5.4)	28 (2.0)	474 (5.1)	39 (2.8)	474 (5.0)
Netherlands		20 (2.9)	556 (9.2)	11 (2.4)	558 (7.0)	32 (2.8)	562 (7.5)	37 (3.6)	567 (11.6)
New Zealand		16 (3.1)	525 (9.1)	21 (3.6)	531 (10.7)	38 (3.7)	528 (7.0)	25 (3.3)	523 (9.5)
Norway		16 (3.4)	533 (5.1)	8 (2.4)	528 (5.6)	36 (4.2)	527 (3.1)	40 (4.5)	528 (3.9)
Portugal		46 (3.4)	473 (3.0)	25 (2.7)	482 (3.2)	21 (2.6)	484 (4.3)	7 (1.7)	502 (6.3)
Romania		12 (1.6)	465 (9.4)	11 (1.4)	484 (8.7)	22 (2.0)	488 (6.5)	55 (2.5)	492 (6.1)
Russian Federation		17 (3.9)	541 (8.7)	13 (1.8)	531 (7.2)	28 (3.4)	536 (6.1)	43 (3.4)	538 (5.6)
Scotland	s	19 (3.0)	499 (7.3)	15 (3.1)	510 (11.6)	36 (4.7)	533 (10.1)	31 (4.5)	523 (7.6)
Singapore		30 (4.4)	615 (11.4)	13 (3.0)	591 (18.0)	21 (4.0)	599 (9.8)	36 (4.4)	610 (9.7)
Slovak Republic		15 (2.8)	546 (7.4)	18 (3.5)	548 (6.7)	18 (3.2)	540 (8.7)	49 (4.7)	545 (4.4)
Slovenia	r	11 (2.3)	569 (5.6)	17 (2.2)	560 (4.9)	38 (3.5)	553 (3.5)	33 (3.3)	560 (3.6)
Spain		9 (2.1)	527 (9.4)	13 (2.9)	516 (5.1)	40 (4.2)	516 (3.7)	39 (4.3)	514 (3.2)
Sweden		19 (2.3)	538 (4.1)	12 (2.0)	539 (6.9)	27 (2.3)	534 (5.0)	42 (3.0)	538 (3.4)
Switzerland	r	17 (3.7)	516 (9.4)	10 (2.5)	540 (11.6)	37 (4.4)	520 (6.9)	35 (4.1)	521 (6.7)
Thailand	r	41 (7.0)	522 (6.1)	20 (5.1)	537 (10.2)	36 (6.8)	535 (7.7)	3 (1.8)	529 (47.6)
United States	r	30 (3.8)	538 (8.0)	15 (3.0)	549 (10.5)	26 (3.7)	534 (7.0)	29 (3.8)	542 (7.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Are Teachers' Perceptions About Science?

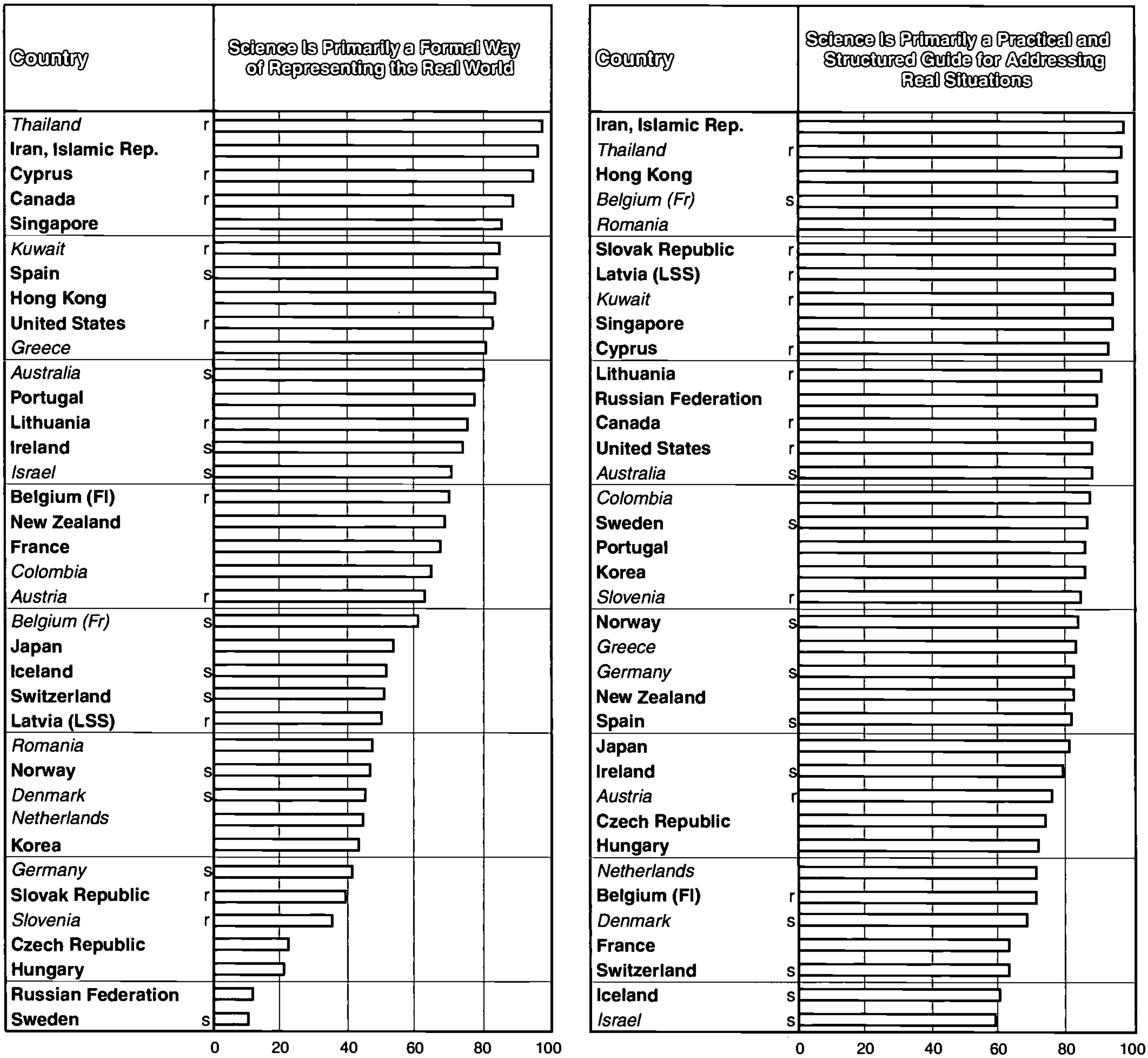
Figure 5.1 depicts the percentages of eighth-grade students whose science teachers reported certain beliefs about science and the way science should be taught. Teacher views about the nature of science varied considerably across countries. In many countries, most notably Thailand, Iran, Cyprus, Canada, and Singapore, teachers agreed that science is primarily a formal way of representing the real world, while in the Slovak Republic, Slovenia, the Czech Republic, Hungary, the Russian Federation, and Sweden, less than 40% of students had teachers holding this view. However, teachers in most countries indicated a fairly practical view of science, agreeing that it is primarily a practical and structured guide for addressing real situations. In most countries also, the majority of eighth-grade students had teachers who agreed that some students have a natural talent for science.

Regarding perceptions about how to teach science, there seemed to be widespread agreement that it is important to give students prescriptive and sequential directions for doing science experiments. Only in the Slovak Republic, New Zealand, Iceland, Denmark, and Korea did fewer than 60% of the eighth-grade students have teachers who agreed with this approach.

TIMSS also queried teachers about the cognitive demands of science, asking them to rate the importance of various skills for success in the discipline. Figure 5.2 shows the percentages of students whose teachers rated each of four different skills as very important. Internationally, most science teachers felt it was very important for students to be able to think in a sequential and procedural manner, to be able to think creatively, to understand how science is used in the real world, and to be able to provide reasons to support their conclusions. However, there was some variation across countries. In every country except Slovenia and Israel, the majority of students were taught by teachers who considered it very important that students be able to think in a sequential and procedural manner. Fewer than half of the eighth-grade students in Austria, Singapore, the Netherlands, Switzerland, Israel, Belgium (Flemish), Ireland, and France had teachers who felt it was very important to think creatively, and fewer than half in Switzerland, France, Austria and Belgium (Flemish) had teachers who felt it was very important to understand how science is used in the real world. With the current calls from business and industry on helping students improve their ability to apply scientific and solve practical problems in job-related situations, it might be rather surprising that teachers in these countries do not place more importance on these two aspects of science. In all countries except Korea, Switzerland, the Slovak Republic, Kuwait, and Austria, the majority of students had teachers who felt it was very important to be able to provide reasons to support their conclusions.

Figure 5.1

Percent of Students Whose Science Teachers Agree or Strongly Agree with Statements About the Nature of Science and Science Teaching Upper Grade (Eighth Grade*)

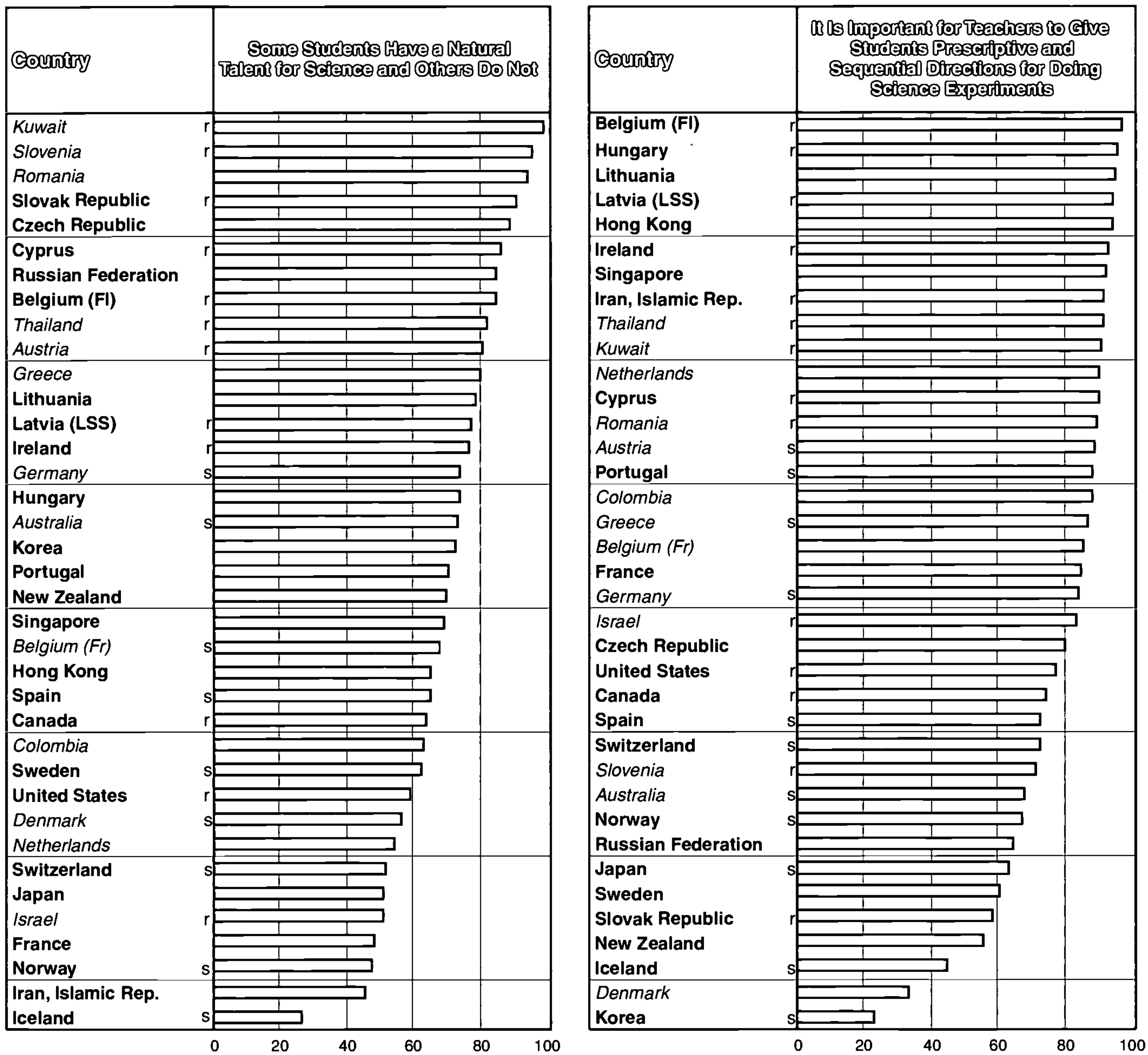


*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (England).
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.1 (Continued)

Percent of Students Whose Science Teachers Agree or Strongly Agree with Statements About the Nature of Science and Science Teaching Upper Grade (Eighth Grade*)



*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (England).
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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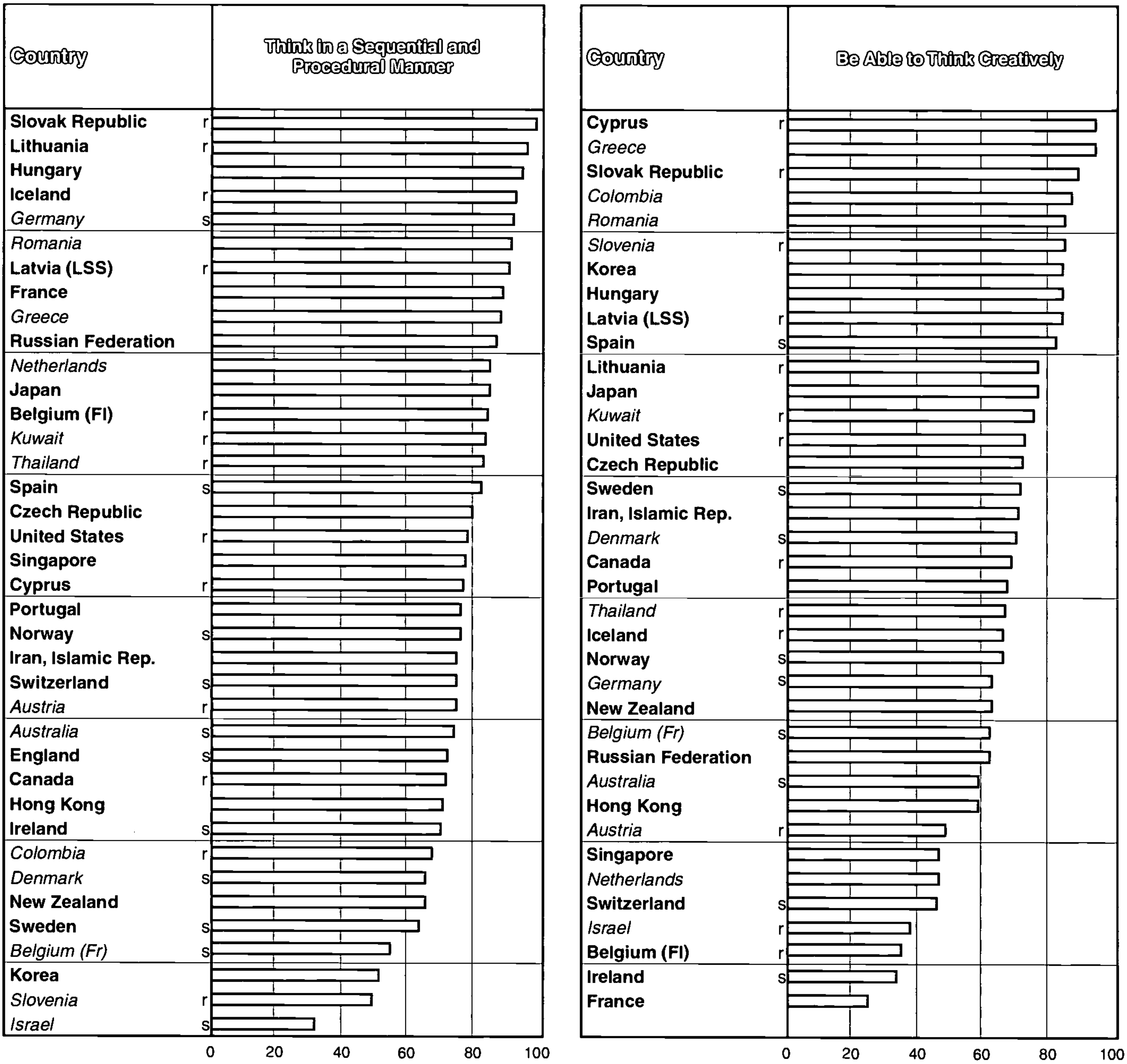
Figure 5.2

Percent of Students Whose Science Teachers Think Particular Abilities Are Very Important for Students' Success in the Sciences in School - Upper Grade (Eighth Grade*)

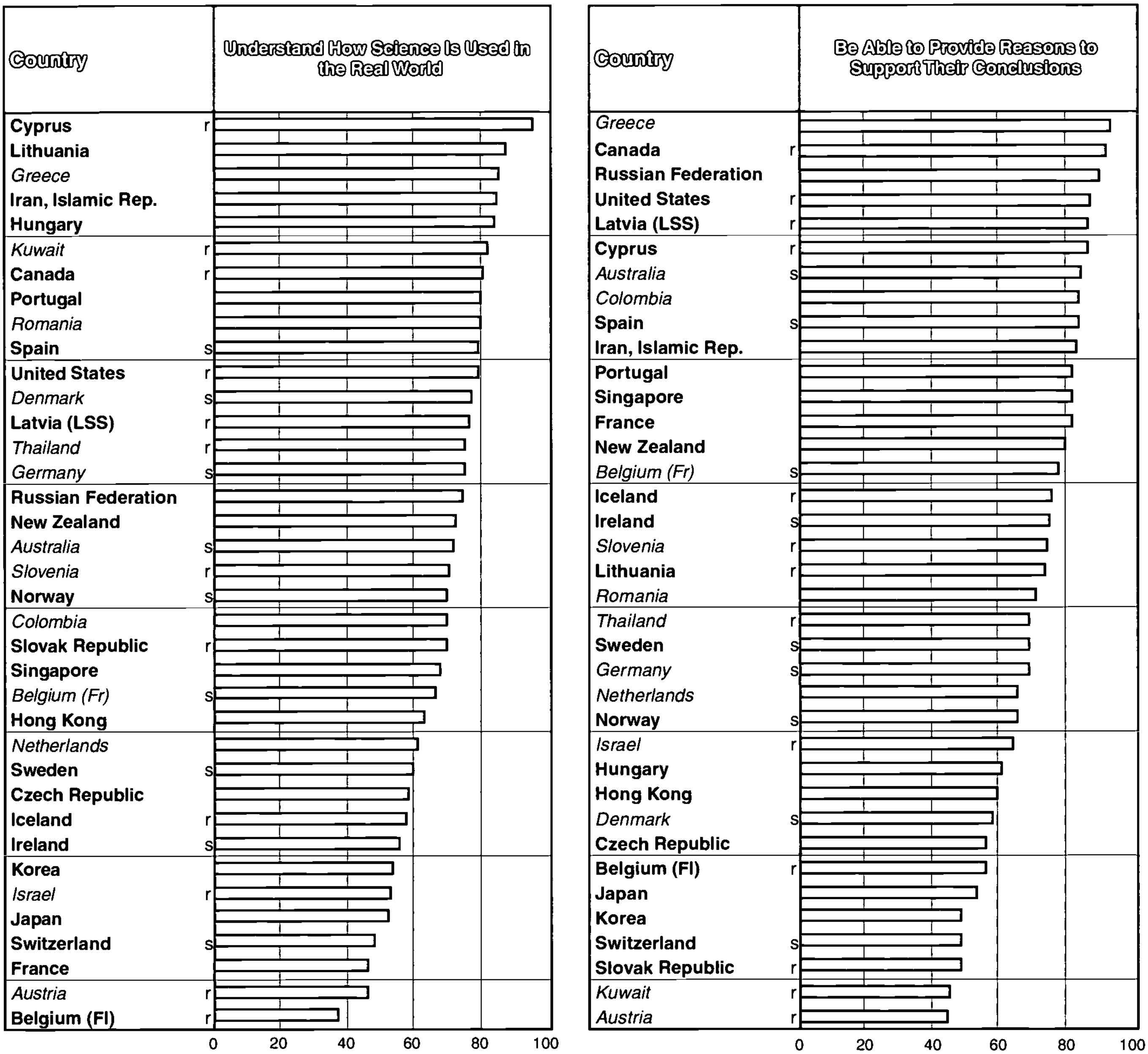


*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (England).
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.2 (Continued)

Percent of Students Whose Science Teachers Think Particular Abilities Are Very Important for Students' Success in the Sciences in School - Upper Grade (Eighth Grade*)



*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (England in the second, third, and fourth panels).
Scotland did not ask these questions.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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How Do Science Teachers Spend Their School-Related Time?

The data in Table 5.4 reveal that in a number of countries, eighth-grade science teachers are specialists. In Belgium (Flemish), Cyprus, France, Kuwait, Latvia (LSS), Lithuania, the Netherlands, New Zealand, Portugal, the Russian Federation, and Scotland, the majority of eighth-grade students had teachers who spent at least 75% of their formally scheduled school time teaching science. For most participating countries, there was little difference in students' achievement according to whether they were taught by specialists.

As shown in Table 5.5, teachers in most countries where science is taught as an integrated subject reported that science classes typically meet for less than 3.5 hours per week, although 3.5 to nearly 5 hours was reported for more than three-quarters of the eighth-grade students in Singapore and almost half of those in New Zealand. The data reveal no clear pattern between the number of in-class instructional hours and achievement either across or between countries. Common sense and research both support the idea that increased time on task can yield commensurate increases in achievement, yet this time also can be spent outside of school on homework or in special tutoring. The ability to use straightforward analyses such as these to disentangle complicated relationships also is made difficult by the practice of providing additional in-school instruction for lower-performing students.

In addition to their formally scheduled duties, teachers were asked about the number of hours per week spent on selected school-related activities outside the regular school day. Table 5.6 presents the results. For example, on average, eighth-grade students in Australia had science teachers who spent 2.1 hours per week preparing or grading tests, and another 2.3 hours per week reading and grading student work. Their teachers spent 2.8 hours per week on lesson planning and 1.6 hours combined on meeting students and parents. They spent 1.2 hours on professional reading and development, and 3.2 hours on record-keeping and administrative tasks combined. Across countries, teachers reported that grading tests, grading student work, and lesson planning were the most time-consuming activities, averaging as much as 10 hours per week in Singapore. In general, teachers also reported several hours per week spent on keeping students' records and other administrative tasks.

Opportunities to meet with colleagues to plan curriculum or teaching approaches enable teachers to expand their views of science, their resources for teaching, and their repertoire of teaching and learning skills. Table 5.7 contains teachers' reports on how often they meet with other teachers in their subject area to discuss and plan curriculum or teaching approaches. Teachers of the majority of the students reported weekly or even daily planning meetings in Cyprus, the Czech Republic, England, Hungary, Korea, Kuwait, Norway, Scotland, the Slovak Republic, and Sweden. In the remaining countries, however, most students had science teachers who reported only limited opportunities to plan curriculum or teaching approaches with other teachers (monthly or even yearly meetings).

Table 5.4

Teachers' Reports on the Proportion of Their Formally Scheduled School Time Spent Teaching the Sciences[1] - Upper Grade (Eighth Grade*)

Country		Less Than 50 Percent		50-74 Percent		75-100 Percent	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	r	34 (2.7)	539 (6.3)	25 (3.1)	551 (7.0)	42 (3.2)	554 (8.4)
Austria	r	67 (2.8)	550 (4.1)	16 (2.5)	566 (6.1)	17 (1.9)	602 (4.3)
Belgium (Fl)		20 (3.2)	548 (6.7)	18 (3.1)	569 (4.5)	61 (4.0)	548 (6.2)
Belgium (Fr)	s	24 (4.5)	477 (6.1)	33 (4.6)	487 (5.4)	43 (5.2)	484 (4.3)
Canada		55 (3.5)	523 (3.0)	24 (3.5)	549 (6.2)	22 (2.7)	534 (5.8)
Colombia		27 (4.2)	399 (11.1)	39 (4.8)	415 (4.5)	34 (4.0)	419 (4.8)
Cyprus	r	12 (2.0)	448 (4.9)	22 (3.8)	455 (4.6)	66 (4.0)	463 (2.6)
Czech Republic		69 (2.9)	569 (3.7)	18 (2.7)	574 (6.7)	13 (2.5)	597 (8.2)
Denmark	s	66 (5.2)	481 (4.0)	20 (3.8)	481 (8.3)	15 (4.1)	463 (8.6)
England		x x	x x	x x	x x	x x	x x
France		15 (2.1)	489 (4.3)	8 (1.7)	495 (10.1)	77 (2.5)	501 (2.6)
Germany	s	47 (3.8)	524 (10.0)	22 (3.4)	534 (8.8)	31 (3.7)	556 (7.0)
Greece		- -	- -	- -	- -	- -	- -
Hong Kong		32 (6.1)	506 (11.0)	26 (5.2)	530 (8.7)	42 (5.3)	530 (7.5)
Hungary		- -	- -	- -	- -	- -	- -
Iceland	r	64 (6.5)	488 (5.0)	14 (6.1)	490 (5.5)	21 (7.1)	486 (8.3)
Iran, Islamic Rep.		- -	- -	- -	- -	- -	- -
Ireland	r	25 (3.7)	541 (10.2)	36 (4.6)	546 (7.5)	39 (4.2)	538 (8.7)
Israel	s	32 (9.3)	549 (17.0)	22 (6.4)	548 (10.6)	46 (9.5)	507 (10.1)
Japan		28 (3.8)	571 (3.5)	38 (3.9)	574 (3.6)	34 (4.4)	568 (3.2)
Korea		51 (3.4)	565 (3.0)	41 (3.4)	563 (3.2)	8 (1.9)	576 (6.7)
Kuwait	r	23 (6.1)	422 (10.2)	26 (4.6)	432 (4.2)	51 (7.4)	425 (6.0)
Latvia (LSS)	r	25 (2.5)	484 (5.0)	18 (2.0)	484 (3.6)	57 (3.0)	484 (3.0)
Lithuania		20 (2.0)	481 (6.9)	15 (1.8)	472 (5.9)	65 (2.3)	476 (4.0)
Netherlands		16 (2.5)	539 (12.3)	15 (2.5)	556 (12.3)	68 (3.7)	569 (5.8)
New Zealand		19 (3.0)	514 (9.9)	24 (2.9)	527 (7.4)	57 (4.0)	532 (5.9)
Norway		81 (3.5)	532 (2.2)	7 (2.2)	513 (6.2)	12 (3.0)	512 (5.7)
Portugal		15 (2.3)	477 (3.5)	22 (2.5)	478 (3.6)	63 (2.9)	481 (3.0)
Romania		81 (2.3)	489 (5.0)	14 (2.1)	472 (9.3)	4 (1.0)	489 (13.1)
Russian Federation		5 (1.2)	537 (12.6)	5 (1.3)	529 (10.8)	90 (2.0)	538 (4.1)
Scotland	s	0 (0.0)	~ ~	3 (1.5)	499 (16.9)	97 (1.5)	521 (5.6)
Singapore		10 (2.3)	577 (12.6)	56 (5.3)	608 (7.8)	34 (4.9)	613 (10.4)
Slovak Republic		83 (2.9)	543 (3.7)	14 (2.6)	549 (6.7)	3 (1.6)	572 (17.2)
Slovenia	r	29 (2.5)	558 (3.8)	30 (3.6)	554 (4.5)	41 (3.4)	561 (3.2)
Spain		85 (3.3)	515 (1.9)	14 (3.2)	524 (7.0)	1 (0.9)	~ ~
Sweden		62 (2.6)	538 (3.1)	28 (2.5)	533 (5.0)	9 (1.7)	540 (5.8)
Switzerland	r	70 (3.4)	520 (4.1)	14 (3.1)	507 (9.6)	16 (2.2)	544 (7.3)
Thailand	r	27 (5.6)	526 (9.5)	28 (5.3)	528 (7.7)	45 (6.2)	532 (6.2)
United States	r	40 (3.5)	546 (4.5)	36 (3.9)	541 (7.1)	25 (3.5)	526 (9.8)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1]Formally scheduled school time included time scheduled for teaching all subjects, as well as student supervision, student counseling/appraisal, administrative duties, individual curriculum planning, cooperative curriculum planning, and other non-student contact time.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.5

Teachers' Reports[1] on Average Number of Hours Integrated Science Is Taught Weekly to Their Science Classes - Upper Grade (Eighth Grade*)

Country	Less Than 2 Hours		2 Hours to < 3.5		3.5 hours to < 5		5 Hours or More	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	x x	x x	x x	x x	x x	x x	x x	x x
Canada	r 11 (2.1)	512 (8.9)	69 (3.9)	540 (3.8)	11 (2.5)	528 (5.5)	8 (2.1)	517 (10.3)
Colombia	r 6 (2.3)	416 (4.5)	75 (4.2)	415 (5.6)	13 (3.2)	404 (5.5)	6 (2.4)	403 (18.6)
Cyprus	x x	x x	x x	x x	x x	x x	x x	x x
England	- -	- -	- -	- -	- -	- -	- -	- -
Hong Kong	7 (2.3)	492 (29.9)	82 (3.9)	526 (5.3)	9 (3.3)	518 (8.6)	2 (1.6)	~ ~
Iran, Islamic Rep.	- -	- -	- -	- -	- -	- -	- -	- -
Ireland	s 4 (1.9)	578 (16.5)	94 (2.1)	540 (6.2)	2 (0.8)	~ ~	0 (0.0)	~ ~
Israel	s 19 (7.9)	547 (19.6)	77 (7.2)	520 (9.1)	4 (3.5)	529 (0.0)	0 (0.0)	~ ~
Japan	5 (1.6)	618 (15.2)	94 (1.7)	569 (1.5)	0 (0.0)	~ ~	1 (0.6)	~ ~
Korea	43 (2.9)	569 (3.3)	51 (3.2)	561 (3.1)	1 (0.8)	~ ~	5 (2.3)	568 (12.7)
Kuwait	r 3 (2.6)	409 (1.9)	97 (2.6)	426 (4.4)	1 (0.5)	~ ~	0 (0.0)	~ ~
New Zealand	1 (0.9)	~ ~	52 (4.1)	527 (6.3)	47 (4.2)	525 (6.6)	0 (0.0)	~ ~
Norway	s 27 (4.9)	526 (3.0)	73 (4.9)	524 (2.6)	1 (0.6)	~ ~	0 (0.0)	~ ~
Scotland	s 14 (3.1)	538 (23.4)	83 (3.6)	519 (4.8)	3 (1.7)	488 (22.5)	0 (0.0)	~ ~
Singapore	0 (0.0)	~ ~	24 (4.4)	618 (14.6)	76 (4.4)	603 (6.0)	0 (0.0)	~ ~
Spain	r 5 (2.6)	532 (2.5)	84 (3.9)	518 (2.1)	11 (3.0)	502 (9.4)	1 (0.7)	~ ~
Switzerland	s 41 (4.7)	532 (6.6)	37 (4.4)	524 (8.4)	9 (3.1)	486 (13.7)	13 (3.5)	519 (15.6)
Thailand	x x	x x	x x	x x	x x	x x	x x	x x
United States	x x	x x	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1]Reported for countries using integrated science form of student questionnaire.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.6

Average Number of Hours[1] Students' Teachers Spend on Various School-Related Activities Outside the Formal School Day During the School Week
Science - Upper Grade (Eighth Grade*)

Country	Preparing or Grading Tests	Reading and Grading Student Work	Planning Lessons by Self	Meeting with Students Outside Classroom Time	Meeting with Parents	Professional Reading and Development	Keeping Students' Records	Administrative Tasks
Australia	r 2.1 (0.1)	s 2.3 (0.1)	r 2.8 (0.1)	s 1.1 (0.1)	s 0.5 (0.0)	r 1.2 (0.1)	s 1.1 (0.1)	r 2.1 (0.1)
Austria	r 1.7 (0.1)	r 2.6 (0.1)	r 3.6 (0.1)	r 0.5 (0.0)	r 0.6 (0.0)	r 1.9 (0.1)	r 0.9 (0.1)	r 1.1 (0.1)
Belgium (Fl)	3.5 (0.1)	1.5 (0.1)	3.6 (0.1)	0.7 (0.1)	r 0.6 (0.1)	1.2 (0.1)	r 0.5 (0.1)	1.4 (0.1)
Belgium (Fr)	s 3.2 (0.2)	s 1.7 (0.1)	s 3.5 (0.2)	s 0.7 (0.1)	s 0.5 (0.1)	s 1.4 (0.1)	s 0.8 (0.1)	s 1.1 (0.1)
Canada	2.2 (0.1)	2.5 (0.1)	2.6 (0.1)	1.4 (0.1)	0.5 (0.0)	r 0.8 (0.1)	1.1 (0.0)	1.7 (0.1)
Colombia	2.9 (0.1)	r 2.5 (0.2)	3.1 (0.1)	r 1.5 (0.2)	r 0.9 (0.1)	r 2.4 (0.2)	r 0.8 (0.1)	r 1.4 (0.2)
Cyprus	r 3.4 (0.1)	r 1.6 (0.1)	r 3.5 (0.1)	s 0.3 (0.0)	r 1.0 (0.1)	r 1.0 (0.1)	s 0.5 (0.1)	r 1.3 (0.1)
Czech Republic	2.5 (0.1)	1.2 (0.1)	4.0 (0.1)	1.1 (0.1)	0.5 (0.0)	1.0 (0.1)	0.9 (0.0)	1.3 (0.1)
Denmark	- -	- -	- -	- -	- -	- -	- -	- -
England	x x	x x	x x	x x	x x	x x	x x	x x
France	3.8 (0.1)	r 1.0 (0.1)	3.6 (0.1)	0.6 (0.0)	0.5 (0.0)	1.4 (0.1)	0.9 (0.0)	1.3 (0.1)
Germany	s 2.7 (0.1)	s 2.3 (0.1)	s 4.1 (0.1)	s 0.7 (0.1)	s 0.7 (0.1)	s 1.9 (0.1)	s 1.0 (0.1)	s 1.7 (0.1)
Greece	2.8 (0.1)	1.2 (0.1)	2.4 (0.1)	0.6 (0.1)	0.9 (0.1)	2.6 (0.1)	0.4 (0.0)	1.3 (0.2)
Hong Kong	2.3 (0.2)	3.1 (0.2)	2.8 (0.2)	1.9 (0.1)	0.4 (0.1)	1.0 (0.1)	0.8 (0.1)	1.8 (0.2)
Hungary	2.7 (0.1)	2.2 (0.1)	3.7 (0.1)	1.8 (0.1)	0.8 (0.0)	2.1 (0.1)	0.7 (0.0)	2.3 (0.1)
Iceland	s 1.8 (0.2)	s 2.8 (0.2)	s 4.0 (0.2)	r 0.6 (0.1)	s 0.5 (0.0)	r 1.3 (0.2)	s 1.3 (0.1)	r 2.0 (0.2)
Iran, Islamic Rep.	2.5 (0.2)	1.8 (0.2)	2.0 (0.1)	0.9 (0.1)	0.7 (0.0)	0.51(0.1)	0.9 (0.1)	0.8 (0.1)
Ireland	r 2.1 (0.1)	s 1.7 (0.1)	r 2.3 (0.1)	r 0.8 (0.1)	r 0.3 (0.1)	r 0.8 (0.1)	r 0.8 (0.1)	r 1.1 (0.1)
Israel	r 3.4 (0.3)	s 2.1 (0.2)	r 3.5 (0.3)	s 1.1 (0.2)	s 0.7 (0.1)	s 3.3 (0.3)	s 1.2 (0.2)	r 1.6 (0.2)
Japan	1.8 (0.1)	1.7 (0.1)	3.0 (0.1)	2.0 (0.1)	0.5 (0.0)	1.7 (0.1)	1.3 (0.1)	2.4 (0.1)
Korea	1.9 (0.1)	1.7 (0.1)	2.4 (0.1)	1.9 (0.1)	0.4 (0.0)	1.7 (0.1)	1.1 (0.1)	1.9 (0.1)
Kuwait	r 2.8 (0.2)	r 2.1 (0.2)	r 2.1 (0.2)	s 0.4 (0.1)	r 0.5 (0.1)	s 0.9 (0.1)	r 1.3 (0.2)	r 0.8 (0.1)
Latvia (LSS)	r 2.3 (0.1)	r 1.6 (0.1)	r 3.1 (0.1)	r 1.5 (0.1)	r 0.6 (0.0)	r 1.2 (0.1)	r 0.4 (0.0)	r 1.4 (0.1)
Lithuania	r 1.5 (0.1)	r 2.0 (0.1)	r 2.6 (0.1)	r 1.6 (0.1)	r 0.8 (0.0)	r 2.3 (0.1)	r 0.8 (0.0)	r 0.7 (0.1)
Netherlands	3.8 (0.1)	r 1.1 (0.1)	3.0 (0.1)	r 1.3 (0.1)	0.6 (0.0)	1.2 (0.1)	r 0.5 (0.0)	1.4 (0.1)
New Zealand	2.3 (0.1)	2.1 (0.1)	3.0 (0.1)	1.2 (0.1)	0.4 (0.1)	1.3 (0.1)	1.0 (0.1)	2.6 (0.1)
Norway	2.1 (0.1)	1.6 (0.1)	3.4 (0.1)	0.7 (0.1)	0.6 (0.0)	0.5 (0.1)	0.8 (0.1)	1.7 (0.1)
Portugal	3.0 (0.1)	2.2 (0.1)	3.7 (0.1)	0.7 (0.1)	0.6 (0.0)	1.5 (0.1)	0.9 (0.1)	1.5 (0.1)
Romania	2.1 (0.1)	1.7 (0.1)	3.3 (0.1)	1.4 (0.1)	1.1 (0.0)	1.4 (0.1)	1.5 (0.1)	2.2 (0.1)
Russian Federation	2.1 (0.1)	2.0 (0.1)	3.1 (0.1)	1.9 (0.1)	1.0 (0.0)	2.8 (0.1)	0.9 (0.0)	1.9 (0.1)
Scotland	s 1.5 (0.1)	s 1.7 (0.1)	s 2.0 (0.1)	s 0.9 (0.1)	s 0.6 (0.1)	s 1.1 (0.1)	s 1.1 (0.1)	s 1.6 (0.1)
Singapore	3.3 (0.2)	4.0 (0.1)	3.1 (0.1)	1.4 (0.1)	0.4 (0.0)	1.3 (0.1)	1.2 (0.1)	2.3 (0.1)
Slovak Republic	2.3 (0.1)	1.6 (0.1)	3.5 (0.1)	1.2 (0.1)	0.6 (0.0)	0.9 (0.1)	1.1 (0.1)	1.1 (0.1)
Slovenia	r 2.2 (0.1)	r 1.2 (0.1)	r 3.4 (0.1)	r 1.2 (0.1)	r 1.1 (0.1)	r 2.2 (0.1)	r 0.6 (0.0)	r 1.6 (0.1)
Spain	2.2 (0.1)	1.5 (0.1)	1.8 (0.1)	0.9 (0.1)	1.1 (0.1)	1.6 (0.1)	0.8 (0.1)	1.7 (0.1)
Sweden	2.3 (0.1)	1.5 (0.1)	4.0 (0.1)	0.6 (0.0)	0.8 (0.0)	1.5 (0.1)	0.9 (0.0)	2.4 (0.1)
Switzerland	r 3.0 (0.1)	r 2.1 (0.1)	r 3.8 (0.1)	r 0.9 (0.1)	r 0.7 (0.1)	r 1.9 (0.1)	r 0.7 (0.0)	r 2.3 (0.1)
Thailand	s 2.7 (0.2)	s 2.4 (0.2)	s 2.3 (0.2)	s 1.3 (0.1)	s 0.6 (0.1)	s 1.6 (0.2)	s 1.4 (0.1)	s 1.8 (0.2)
United States	r 2.1 (0.1)	r 2.4 (0.1)	r 2.2 (0.1)	r 1.2 (0.1)	r 0.7 (0.1)	r 1.0 (0.1)	r 1.5 (0.1)	r 2.0 (0.1)

[1]Average hours based on: No time=0, Less Than 1 Hour=.5, 1-2 Hours=1.5; 3-4 Hours=3.5; More Than 4 Hours=5.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.7

Teachers' Reports on How Often They Meet with Other Teachers in Their Subject Area To Discuss and Plan Curriculum or Teaching Approaches Science - Upper Grade (Eighth Grade*)

Country		Percent of Students Taught by Teachers			
		Meeting Never or Once/Twice a Year	Meeting Monthly or Every Other Month	Meeting Once, Twice, or Three Times a Week	Meeting Almost Every Day
Australia	r	10 (2.0)	50 (3.6)	30 (3.2)	9 (2.3)
Austria	r	20 (2.5)	37 (3.0)	36 (3.1)	6 (1.9)
Belgium (Fl)		48 (5.6)	28 (4.2)	21 (3.5)	3 (1.2)
Belgium (Fr)	s	22 (4.2)	34 (5.6)	38 (5.2)	7 (2.4)
Canada		38 (2.9)	25 (3.5)	31 (3.8)	6 (1.7)
Colombia		24 (3.3)	30 (4.4)	42 (4.8)	4 (1.8)
Cyprus	r	4 (1.7)	6 (0.7)	67 (3.2)	22 (2.2)
Czech Republic		22 (3.2)	23 (2.5)	34 (3.4)	20 (2.3)
Denmark		- -	- -	- -	- -
England	s	8 (1.6)	41 (3.1)	51 (3.2)	0 (0.1)
France		45 (4.2)	22 (2.8)	29 (4.2)	4 (1.4)
Germany	s	32 (4.5)	31 (4.8)	22 (3.6)	15 (3.4)
Greece		43 (4.2)	26 (3.4)	26 (3.9)	6 (1.7)
Hong Kong		33 (5.3)	48 (5.9)	19 (4.3)	0 (0.0)
Hungary		9 (1.6)	16 (2.1)	39 (2.7)	35 (3.1)
Iceland	r	42 (6.1)	29 (7.0)	29 (8.0)	0 (0.0)
Iran, Islamic Rep.		18 (3.3)	37 (4.4)	34 (4.6)	11 (3.1)
Ireland	r	59 (4.3)	25 (4.1)	14 (3.1)	2 (0.9)
Israel	r	25 (6.9)	34 (9.5)	37 (8.6)	4 (2.6)
Japan		24 (3.4)	29 (3.9)	46 (3.7)	1 (1.0)
Korea		22 (3.0)	26 (3.6)	37 (4.1)	15 (3.1)
Kuwait	r	10 (4.5)	2 (1.1)	66 (8.3)	22 (7.3)
Latvia (LSS)	r	28 (2.5)	46 (3.0)	16 (2.3)	10 (1.9)
Lithuania		25 (2.5)	36 (2.7)	24 (2.4)	14 (1.7)
Netherlands		13 (2.5)	65 (3.9)	21 (3.1)	2 (0.9)
New Zealand		6 (1.8)	45 (4.1)	43 (4.0)	6 (2.1)
Norway		7 (2.3)	20 (3.5)	65 (4.0)	8 (2.0)
Portugal		8 (1.6)	69 (3.0)	18 (2.8)	5 (1.2)
Romania		12 (1.8)	58 (2.6)	14 (1.7)	16 (1.9)
Russian Federation		12 (1.9)	57 (2.7)	20 (2.6)	11 (2.1)
Scotland	s	7 (1.7)	12 (2.6)	74 (4.0)	8 (2.3)
Singapore		15 (3.8)	61 (4.6)	21 (4.1)	3 (1.4)
Slovak Republic		4 (1.5)	23 (3.6)	35 (4.0)	39 (4.6)
Slovenia	r	5 (1.8)	53 (3.6)	18 (2.8)	24 (2.9)
Spain		17 (2.9)	48 (4.4)	32 (4.0)	2 (1.2)
Sweden		9 (1.8)	19 (2.5)	46 (3.5)	26 (2.6)
Switzerland	r	36 (4.0)	32 (4.0)	30 (3.9)	2 (1.3)
Thailand	s	53 (6.1)	17 (4.3)	23 (5.2)	6 (3.1)
United States	r	37 (3.3)	31 (3.5)	26 (4.0)	6 (1.3)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Are Science Classes Organized?

Table 5.8 presents teachers' reports about the size of eighth-grade science classes for the TIMSS countries. The data reveal rather large variation from country to country. Scotland appeared to have the smallest eighth-grade science classes, with 99% of the students in classes of 20 or fewer students. According to teachers, science classes were relatively small in a number of countries. For example, 90% or more of the students were in science classes of 30 or fewer students in Austria, Belgium (Flemish), Belgium (French), Denmark, France, Germany, Hungary, Iceland, Ireland, Lithuania, the Netherlands, Norway, Portugal, the Russian Federation, Scotland, Slovenia, and Switzerland. At the other end of the spectrum, 89% of the students in Korea were in science classes with more than 40 students. In Colombia, Hong Kong, Japan, Korea, and Singapore, 90% of the students were in classes with more than 30 students. Extensive research about class size in relation to achievement indicates that the existence of such a relationship is dependent on the situation. Dramatic reductions in class size can be related to gains in achievement, but the chief effects of smaller classes often are in relation to teacher attitudes and instructional behaviors. The TIMSS data illustrate the complexity of this issue. Across countries, three of the four highest-performing countries at the eighth grade–Singapore, Korea, and Japan–are among those with the largest science classes. Within countries, several show little or no relationship between achievement and class size, often because students mostly are in classes of similar size. Within others, there appears to be a curvilinear relationship, or those students with higher achievement appear to be in larger classes. In some countries, larger classes may represent the more usual situation for teaching science, with smaller classes used primarily for students needing remediation or for those students in the less advanced tracks.

Teachers can adopt a variety of organizational and interactive approaches in science class. Whole-class instruction can be very efficient, because it requires less time on management functions and provides more time for developing science concepts. Teachers can make presentations, conduct discussions, or demonstrate procedures and applications to all students simultaneously. Both whole-class and independent work have been standard features of science classrooms. Students also can benefit from the type of cooperative learning that occurs with effective use of small-group work. Because they can help each other, students in groups can often handle challenging situations beyond their individual capabilities. Further, the positive affective impact of working together mirrors the use of science in the workplace.

Figure 5.3 provides a pictorial view of the emphasis on individual, group, and whole class work as reported by the science teachers in the TIMSS countries. Because learning may be enhanced with teacher guidance and monitoring of individual and small-group activities, the frequency of lessons using each of these organizational approaches is shown both with and without assistance from the teacher. Internationally, teachers reported that working together as a class with the teacher teaching the whole class is a frequently used instructional approach. In most countries, 50% or more of the eighth-grade students were taught this way during most or every lesson. Students working individually with assistance from the teacher is also a popular

Table 5.8

Teachers' Reports on Average Size of Science Class Upper Grade (Eighth Grade*)

Country		1 - 20 Students: Percent of Students	1 - 20 Students: Mean Achievement	21 - 30 Students: Percent of Students	21 - 30 Students: Mean Achievement	31 - 40 Students: Percent of Students	31 - 40 Students: Mean Achievement	41 or More Students: Percent of Students	41 or More Students: Mean Achievement
Australia		x x	x x	x x	x x	x x	x x	x x	x x
Austria	r	17 (3.9)	568 (8.9)	81 (3.9)	561 (3.6)	1 (0.7)	~ ~	0 (0.0)	~ ~
Belgium (Fl)	r	45 (4.6)	550 (8.4)	53 (4.5)	560 (8.1)	2 (1.2)	~ ~	0 (0.0)	~ ~
Belgium (Fr)	s	42 (6.2)	489 (6.1)	57 (6.1)	484 (3.9)	1 (1.3)	~ ~	0 (0.0)	~ ~
Canada	s	10 (2.6)	520 (11.0)	62 (4.2)	540 (3.9)	25 (3.4)	535 (6.6)	3 (1.3)	533 (12.0)
Colombia	r	4 (1.7)	422 (9.8)	6 (2.4)	420 (21.6)	37 (4.3)	422 (5.2)	53 (4.5)	411 (4.2)
Cyprus	s	2 (0.1)	~ ~	45 (3.5)	460 (4.0)	53 (3.5)	458 (3.5)	0 (0.0)	~ ~
Czech Republic	r	11 (2.7)	552 (6.4)	78 (5.1)	576 (5.4)	11 (4.6)	590 (11.7)	0 (0.0)	~ ~
Denmark	s	62 (6.7)	481 (3.7)	38 (6.7)	485 (6.7)	0 (0.0)	~ ~	0 (0.0)	~ ~
England		x x	x x	x x	x x	x x	x x	x x	x x
France		16 (3.6)	490 (6.6)	83 (3.6)	501 (2.7)	1 (0.6)	~ ~	0 (0.0)	~ ~
Germany	s	20 (4.5)	520 (18.4)	73 (5.1)	536 (5.5)	6 (2.8)	587 (15.7)	0 (0.0)	~ ~
Greece		6 (1.8)	474 (7.0)	71 (3.9)	498 (2.6)	22 (3.3)	500 (4.9)	1 (0.9)	~ ~
Hong Kong		0 (0.0)	~ ~	1 (1.2)	~ ~	57 (6.5)	520 (7.5)	42 (6.5)	530 (7.9)
Hungary		40 (3.7)	548 (4.1)	56 (3.9)	555 (4.1)	4 (1.8)	569 (8.9)	0 (0.0)	~ ~
Iceland	s	38 (6.5)	480 (5.2)	59 (6.8)	486 (3.7)	0 (0.0)	~ ~	3 (2.4)	519 (0.0)
Iran, Islamic Rep.	r	3 (1.3)	467 (18.0)	23 (4.3)	475 (6.0)	52 (5.2)	472 (3.9)	22 (4.0)	462 (6.8)
Ireland	s	12 (3.0)	490 (19.4)	80 (4.4)	548 (5.4)	9 (3.2)	575 (13.0)	0 (0.0)	~ ~
Israel	s	11 (5.9)	532 (8.3)	30 (7.0)	533 (16.0)	47 (9.8)	544 (9.3)	12 (7.4)	466 (24.8)
Japan		0 (0.2)	~ ~	4 (1.4)	570 (6.6)	88 (2.0)	567 (1.6)	8 (1.5)	615 (10.2)
Korea		6 (1.8)	573 (9.0)	1 (0.7)	~ ~	5 (1.5)	536 (8.1)	89 (2.5)	566 (2.3)
Kuwait	r	0 (0.0)	~ ~	48 (6.8)	427 (5.4)	50 (6.5)	425 (7.3)	2 (2.1)	~ ~
Latvia (LSS)	s	37 (4.0)	485 (5.2)	47 (3.8)	488 (3.4)	10 (2.6)	483 (7.9)	6 (1.6)	477 (3.5)
Lithuania	r	38 (3.1)	467 (5.4)	59 (2.9)	484 (5.2)	1 (0.5)	~ ~	2 (1.0)	~ ~
Netherlands	r	15 (5.0)	498 (21.4)	75 (5.7)	567 (5.0)	10 (3.5)	615 (13.6)	0 (0.0)	~ ~
New Zealand		7 (1.8)	501 (12.4)	75 (3.5)	522 (5.7)	18 (3.0)	556 (8.0)	1 (0.0)	~ ~
Norway	s	27 (4.4)	519 (4.6)	72 (4.7)	526 (2.8)	2 (1.4)	~ ~	0 (0.0)	~ ~
Portugal		15 (2.9)	469 (4.0)	77 (3.8)	481 (2.8)	8 (2.5)	487 (9.7)	0 (0.4)	~ ~
Romania		20 (2.5)	476 (9.5)	52 (4.5)	474 (6.1)	25 (4.2)	510 (9.9)	2 (1.3)	~ ~
Russian Federation		15 (2.7)	523 (11.7)	76 (3.6)	539 (3.9)	9 (2.3)	546 (14.4)	0 (0.0)	~ ~
Scotland	s	99 (0.9)	520 (5.9)	1 (0.6)	~ ~	0 (0.0)	~ ~	1 (0.7)	~ ~
Singapore		0 (0.0)	~ ~	9 (2.4)	609 (15.7)	72 (4.2)	604 (7.3)	19 (4.0)	616 (7.7)
Slovak Republic	r	12 (3.1)	533 (13.9)	69 (4.8)	543 (4.2)	19 (4.3)	554 (10.1)	0 (0.0)	~ ~
Slovenia	r	14 (2.8)	554 (7.5)	81 (3.2)	558 (3.1)	5 (1.5)	575 (13.6)	0 (0.4)	~ ~
Spain	r	9 (2.5)	505 (8.3)	49 (4.0)	515 (3.4)	35 (4.2)	525 (3.8)	7 (2.4)	509 (6.3)
Sweden		x x	x x	x x	x x	x x	x x	x x	x x
Switzerland	s	50 (5.0)	513 (7.0)	47 (4.8)	530 (6.2)	3 (1.9)	551 (7.5)	0 (0.0)	~ ~
Thailand		x x	x x	x x	x x	x x	x x	x x	x x
United States		x x	x x	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A tilde (~) indicates insufficient data to report achievement.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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approach, as is working in pairs or small groups with teacher assistance. Working without teacher assistance is less common in most countries, although it does seem to be a feature of life in science classrooms in Canada, the Netherlands, and New Zealand.

Figure 5.3

Teachers' Reports About Classroom Organization During Science Lessons Upper Grade (Eighth Grade*)

Country	Percent of Students Whose Teachers Report Using Each Organizational Approach "Most or Every Lesson"					
	Work Together as a Class with Students Responding to One Another	Work Together as a Class with Teacher Teaching the Whole Class	Work Individually with Assistance from Teacher	Work Individually without Assistance from Teacher	Work in Pairs or Small Groups with Assistance from Teacher	Work in Pairs or Small Groups without Assistance from Teacher
Austria	r 3	r 65	r 13	r 3	r 18	r 12
Belgium (Fl)	r 11	r 62	r 19	r 6	r 13	r 7
Belgium (Fr)	s 11	s 53	s 24	s 8	s 8	s 4
Canada	s 17	r 28	r 26	r 23	r 33	s 24
Colombia	r 33	r 48	r 55	r 10	r 43	r 13
Cyprus	s 3	s 74	s 35	s 3	s 17	s 6
Czech Republic	11	70	r 46	15	14	4
Denmark	s 2	s 22	s 25	s 3	s 46	s 13
France	16	57	34	16	27	12
Germany	s 30	s 69	s 28	s 7	s 19	s 5
Greece	3	67	45	10	13	1
Hong Kong	12	45	35	2	44	13
Hungary	7	80	54	13	11	2
Iceland	s 1	r 35	r 30	r 9	r 16	r 6
Iran, Islamic Rep.	25	57	36	2	25	11
Ireland	s 7	s 62	s 25	s 6	s 20	s 6
Israel	s 17	r 41	r 30	r 15	r 32	r 18
Japan	19	79	12	8	12	6

Percent for "Most or Every Lesson" →

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (Australia, England, Sweden, and the United States).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Figure 5.3 (Continued)

Teachers' Reports About Classroom Organization During Science Lessons
Upper Grade (Eighth Grade*)

Country	Work Together as a Class with Students Responding to One Another	Work Together as a Class with Teacher Teaching the Whole Class	Work Individually with Assistance from Teacher	Work Individually without Assistance from Teacher	Work in Pairs or Small Groups with Assistance from Teacher	Work in Pairs or Small Groups without Assistance from Teacher
	Percent of Students Whose Teachers Report Using Each Organizational Approach "Most or Every Lesson"					
Korea	34	83	28	8	15	3
Kuwait	r 9	r 46	r 45	r 0	r 36	r 2
Latvia (LSS)	s 25	s 84	s 59	s 32	s 24	s 8
Lithuania	r 16	r 60	r 57	r 22	r 26	r 8
Netherlands	r 5	r 63	r 36	r 23	r 25	r 18
New Zealand	15	41	33	26	44	20
Norway	s 24	s 62	s 23	s 1	s 23	s 4
Portugal	14	66	54	3	54	5
Romania	15	86	47	8	27	r 2
Russian Federation	9	68	43	21	13	7
Scotland	s 7	s 22	s 27	s 11	s 56	s 19
Singapore	12	59	41	17	40	19
Slovak Republic	r 48	r 64	r 45	r 15	r 3	r 1
Slovenia	r 7	r 65	r 57	r 19	r 34	r 13
Spain	r 14	r 65	r 46	r 14	r 18	r 7
Switzerland	s 3	s 56	s 21	s 6	s 30	8
Thailand	r 16	r 38	r 33	r 10	r 32	s 11

Percent for "Most or Every Lesson" →

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (Australia, England, Sweden, and the United States).

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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What Activities Do Students Do in Their Science Lessons?

As shown in Table 5.9, science teachers in the participating countries generally reported heavier reliance on curriculum guides than textbooks in deciding which topics to teach. Only Japan, Korea, the Netherlands, and Thailand use textbooks more for this purpose. In contrast, in almost all countries the textbook was the major written source science teachers used in deciding how to present a topic to their classes. Internationally, the textbook appears to play a role in science classrooms in many countries. For nearly all students in all countries, teachers reported using a textbook in their science classes (see Figure 5.4).

The types of activities teachers asked eighth-grade students to do, however, varied from country to country. Teachers were asked how often they asked students to do reasoning tasks in science. The data in Table 5.10 reveal that such activities are very common in science classes, with the majority of students in all countries being asked to do some type of science reasoning task in most or every lesson. The activities TIMSS inquired about included explaining the reasoning behind an idea, using tables, charts or graphs to represent and analyze relationships, working on problems for which there is no immediately obvious solution, writing explanations about what was observed and why it happened, and putting events in order and giving a reason for the organization. In Cyprus, the Czech Republic, Hungary, Portugal, Romania, the Russian Federation, and the Slovak Republic, 90% or more of the students were asked to do at least one of these types of reasoning tasks in most or every lesson.

Students were asked about the frequency with which their teachers demonstrate an experiment or with which they themselves do an experiment or practical investigation in class. Since in almost half of the TIMSS countries science is taught not as an integrated subject but as individual science subjects (biology, chemistry, etc.), the student reports are presented to reflect this. According to students (Table 5.11), teacher demonstrations are common in almost all countries where science is taught as an integrated subject, and they are also common in chemistry and physics classes. Such demonstrations are reported much less frequently in biology and earth science classes. Countries with integrated science where students report high frequencies of teacher demonstrations usually also have high reported frequencies of student experiments or practical investigations, although there are some countries, notably Cyprus, Iran, Kuwait, and Thailand, where teacher demonstrations are reported as much more frequent than student practical work (see Table 5.12). In countries where science is taught as individual subjects, students reported more frequent teacher demonstrations than student practical work in most countries, particularly for chemistry and physics.

Students were also asked about the frequency with which they use things from everyday life in solving problems in science class (Table 5.13). Among countries with integrated science, more than half of the eighth-grade students in Canada, Colombia, Cyprus, England, Hong Kong, Iran, Scotland, Singapore, and the United States reported being asked to solve such problems on a frequent basis (pretty often or almost always). Using everyday things for science problems was reportedly less common in countries with individual science subjects, although more than half of the students in Latvia (LSS) reported that they do so frequently in all science subject classes (biology, chemistry, and physics).

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Table 5.9

Teachers' Reports on Their Main Sources of Written Information When Deciding Which Topics to Teach and How to Present a Topic Science - Upper Grade (Eighth Grade*)[1]

Country	Percent of Students Taught by Teachers					
	Deciding Which Topics to Teach			Deciding How to Present a Topic		
	Curriculum Guide	Textbook	Examination Specifications	Curriculum Guide	Textbook	Examination Specifications
Australia	x x	x x	- -	x x	x x	- -
Austria	r 72 (2.8)	28 (2.8)	0 (0.2)	r 29 (3.3)	70 (3.2)	1 (0.6)
Belgium (Fl)	r 90 (3.7)	10 (3.7)	- -	r 13 (2.6)	87 (2.6)	- -
Belgium (Fr)	s 90 (4.5)	10 (4.5)	- -	s 8 (2.8)	92 (2.8)	- -
Canada	- -	- -	- -	- -	- -	- -
Colombia	r 68 (5.0)	30 (5.0)	2 (1.1)	r 34 (4.8)	64 (5.0)	2 (1.1)
Cyprus	s 89 (2.2)	9 (2.1)	2 (0.1)	s 36 (3.9)	62 (3.9)	2 (0.1)
Czech Republic	r 76 (2.8)	24 (2.8)	- -	r 8 (1.3)	92 (1.3)	- -
Denmark	- -	- -	- -	- -	- -	- -
England	- -	- -	- -	- -	- -	- -
France	94 (1.5)	5 (1.4)	2 (0.9)	32 (2.9)	68 (2.9)	0 (0.4)
Germany	s 88 (3.0)	12 (3.0)	- -	s 26 (5.0)	74 (5.0)	- -
Greece	71 (3.5)	29 (3.5)	- -	12 (3.1)	88 (3.1)	- -
Hong Kong	55 (4.9)	40 (4.9)	5 (2.5)	25 (4.3)	74 (4.5)	1 (1.3)
Hungary	78 (2.5)	19 (2.3)	4 (1.0)	25 (2.3)	73 (2.3)	2 (0.8)
Iceland	s 57 (8.1)	27 (7.0)	16 (3.7)	s 22 (6.9)	78 (6.9)	0 (0.0)
Iran, Islamic Rep.	r 49 (5.8)	48 (6.1)	3 (1.3)	r 36 (5.8)	51 (6.4)	14 (6.1)
Ireland	s 68 (4.9)	32 (4.9)	- -	s 16 (3.1)	84 (3.1)	- -
Israel	s 94 (4.4)	5 (3.5)	1 (1.4)	s 23 (8.1)	77 (8.1)	0 (0.0)
Japan	35 (4.3)	62 (4.4)	3 (1.4)	15 (3.2)	83 (3.2)	1 (0.9)
Korea	16 (2.9)	77 (3.7)	7 (2.2)	16 (2.8)	81 (2.9)	3 (1.6)
Kuwait	- -	- -	- -	- -	- -	- -
Latvia (LSS)	s 81 (2.2)	17 (2.1)	2 (0.7)	s 33 (2.7)	65 (2.8)	2 (0.8)
Lithuania	x x	x x	x x	x x	x x	x x
Netherlands	r 3 (1.1)	72 (3.5)	24 (3.4)	r 7 (1.8)	88 (2.3)	4 (1.4)
New Zealand	91 (2.5)	6 (2.0)	4 (1.7)	53 (4.6)	47 (4.6)	0 (0.0)
Norway	s 66 (4.6)	34 (4.6)	- -	s 11 (3.5)	89 (3.5)	- -
Portugal	94 (1.5)	6 (1.5)	- -	63 (3.6)	37 (3.6)	- -
Romania	93 (1.1)	4 (0.9)	3 (0.8)	35 (2.4)	61 (2.6)	4 (1.2)
Russian Federation	83 (2.9)	9 (1.7)	8 (1.9)	9 (1.9)	88 (2.0)	3 (1.2)
Scotland	s 68 (4.2)	24 (3.9)	8 (2.0)	s 49 (5.1)	47 (5.1)	4 (1.6)
Singapore	76 (4.0)	24 (4.0)	0 (0.0)	11 (2.7)	89 (2.7)	1 (0.4)
Slovak Republic	r 80 (4.4)	20 (4.4)	0 (0.0)	r 22 (3.8)	78 (3.8)	1 (0.8)
Slovenia	r 88 (2.2)	9 (2.0)	3 (1.1)	r 29 (2.8)	69 (2.9)	2 (0.9)
Spain	- -	- -	- -	- -	- -	- -
Sweden	x x	x x	- -	x x	x x	- -
Switzerland	x x	x x	x x	x x	x x	x x
Thailand	r 41 (6.7)	57 (6.4)	3 (1.6)	r 22 (5.6)	78 (5.6)	0 (0.0)
United States	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

[1]Curriculum Guides include national, regional, and school curriculum guides; Textbooks include teacher and student editions, as well as other resource books; and Examination Specifications include national and regional levels.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 5.4

Teachers' Reports About Using a Textbook in Teaching Science Upper Grade (Eighth Grade*)

Countries are classified by percentage of students whose teachers reported that they use a textbook in teaching their science class.

100%

- [r]*Austria*
- [s]**Cyprus**
- **Czech Republic**
- **Hong Kong**
- [r]*Israel*
- **Japan**
- [r]**Lithuania**
- **Portugal**
- *Romania*
- **Russian Federation**
- **Singapore**
- [r]*Slovenia*

95-99%

- [s]*Germany*
- *Greece*
- [r]**Hungary**
- [s]**Iceland**
- [s]**Ireland**
- **Korea**
- [r]*Kuwait*
- [s]**Latvia (LSS)**
- *Netherlands*
- [s]**Norway**
- [r]**Spain**
- [r]*Thailand*

85-94%

- [r]**Belgium(Flemish)**
- [r]**Canada**
- [r]*Colombia*
- **France**
- **Iran, Islamic Rep.**

Note: Twenty-four percent of the students in [s]Belgium(French), 70% in [s]Denmark, 71% in New Zealand, 84% in [s]Scotland, and 63% in [s]Switzerland had teachers who reported using a textbook in their science class.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
Countries where data were not available or where teacher response data were available for <50% of students are omitted from the figure (Australia, England, Sweden, and the United States).
The Slovak Republic did not ask this question.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.10

Teachers' Reports on How Often They Ask Students To Do Reasoning Tasks[1] Science - Upper Grade (Eighth Grade*)

Country		Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
		Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia		x x	x x	x x	x x	x x	x x	x x	x x
Austria	r	1 (0.4)	~ ~	32 (3.9)	560 (4.5)	51 (3.6)	562 (4.6)	16 (2.6)	569 (7.4)
Belgium (Fl)	r	5 (3.1)	497 (66.9)	26 (3.0)	554 (5.3)	53 (4.7)	556 (6.9)	15 (3.5)	573 (6.0)
Belgium (Fr)	s	0 (0.0)	~ ~	22 (5.5)	481 (6.3)	55 (5.9)	484 (4.6)	23 (4.4)	485 (6.2)
Canada	r	0 (0.0)	~ ~	13 (2.1)	533 (8.3)	63 (3.7)	533 (4.4)	24 (3.5)	542 (6.8)
Colombia	r	0 (0.0)	~ ~	18 (4.7)	412 (22.1)	53 (5.1)	417 (4.3)	29 (4.0)	407 (6.0)
Cyprus	s	1 (1.3)	~ ~	4 (1.5)	445 (15.0)	54 (4.3)	460 (3.4)	41 (4.0)	458 (4.9)
Czech Republic		0 (0.0)	~ ~	4 (1.1)	549 (10.5)	60 (3.1)	576 (4.3)	36 (3.2)	576 (6.4)
Denmark	s	2 (1.6)	~ ~	49 (6.5)	479 (5.2)	46 (6.3)	480 (4.6)	3 (2.0)	458 (22.2)
England	s	0 (0.0)	~ ~	11 (1.9)	539 (13.4)	63 (3.1)	561 (5.9)	26 (2.9)	582 (10.3)
France		0 (0.0)	~ ~	23 (2.7)	503 (4.0)	56 (3.9)	496 (3.2)	21 (3.4)	505 (4.8)
Germany	s	0 (0.0)	~ ~	24 (3.9)	543 (12.4)	63 (4.2)	534 (6.3)	13 (3.0)	531 (16.2)
Greece		1 (0.7)	~ ~	19 (2.9)	498 (4.7)	55 (4.1)	497 (3.4)	25 (2.8)	497 (3.6)
Hong Kong		1 (1.2)	~ ~	21 (4.7)	510 (14.2)	50 (5.8)	525 (6.2)	27 (5.1)	522 (11.5)
Hungary		0 (0.3)	~ ~	4 (1.1)	540 (11.0)	63 (2.4)	553 (3.1)	33 (2.2)	555 (4.0)
Iceland	s	1 (0.7)	~ ~	35 (6.0)	486 (9.3)	58 (5.3)	489 (3.4)	6 (2.4)	480 (8.3)
Iran, Islamic Rep.		3 (2.6)	493 (3.7)	24 (4.5)	472 (5.4)	56 (5.1)	468 (4.0)	17 (4.1)	469 (5.3)
Ireland	s	0 (0.0)	~ ~	12 (2.6)	539 (12.6)	59 (4.6)	549 (6.7)	28 (4.5)	528 (11.6)
Israel	r	0 (0.0)	~ ~	11 (5.3)	541 (52.2)	45 (9.3)	538 (10.2)	44 (8.9)	515 (11.8)
Japan		0 (0.0)	~ ~	17 (3.3)	572 (3.7)	55 (4.5)	568 (3.0)	28 (3.5)	578 (3.6)
Korea		0 (0.3)	~ ~	12 (2.3)	560 (4.7)	62 (3.7)	567 (2.9)	25 (3.0)	562 (4.3)
Kuwait	r	0 (0.0)	~ ~	16 (5.5)	438 (3.0)	58 (6.5)	420 (4.4)	26 (5.1)	434 (12.9)
Latvia (LSS)	s	0 (0.0)	~ ~	11 (2.0)	482 (7.4)	71 (2.2)	486 (2.6)	18 (2.2)	486 (3.9)
Lithuania	r	0 (0.2)	~ ~	19 (1.9)	470 (6.2)	56 (2.4)	482 (4.5)	25 (1.9)	472 (4.9)
Netherlands	r	1 (0.2)	~ ~	31 (3.5)	541 (11.2)	52 (3.6)	569 (6.7)	16 (2.5)	581 (7.7)
New Zealand		0 (0.0)	~ ~	18 (3.1)	532 (11.7)	66 (3.9)	523 (5.4)	16 (3.0)	533 (12.3)
Norway	s	0 (0.0)	~ ~	52 (5.6)	520 (3.2)	45 (5.5)	531 (3.0)	2 (1.6)	~ ~
Portugal		0 (0.0)	~ ~	7 (1.6)	478 (4.8)	60 (3.2)	479 (3.1)	33 (3.2)	481 (3.2)
Romania		0 (0.0)	~ ~	4 (0.8)	466 (10.0)	29 (2.1)	482 (6.2)	67 (2.0)	489 (5.3)
Russian Federation		0 (0.0)	~ ~	16 (2.5)	536 (8.1)	56 (3.6)	537 (5.2)	28 (3.6)	540 (5.5)
Scotland		- -	- -	- -	- -	- -	- -	- -	- -
Singapore		0 (0.0)	~ ~	26 (3.9)	592 (8.2)	57 (4.6)	612 (8.5)	16 (3.6)	611 (12.0)
Slovak Republic	r	0 (0.0)	~ ~	0 (0.3)	~ ~	46 (5.1)	543 (5.8)	54 (5.1)	546 (5.1)
Slovenia	r	0 (0.0)	~ ~	17 (2.8)	560 (5.2)	71 (3.3)	558 (3.1)	12 (2.5)	548 (5.6)
Spain	r	0 (0.0)	~ ~	21 (4.0)	517 (4.6)	55 (3.9)	518 (2.7)	24 (4.5)	516 (4.9)
Sweden		x x	x x	x x	x x	x x	x x	x x	x x
Switzerland	s	0 (0.0)	~ ~	18 (4.0)	507 (14.2)	73 (4.1)	528 (4.9)	8 (2.9)	518 (13.8)
Thailand	r	0 (0.0)	~ ~	14 (4.6)	514 (14.7)	56 (6.0)	534 (6.1)	30 (5.0)	528 (6.2)
United States		x x	x x	x x	x x	x x	x x	x x	x x

[1]Based on most frequent response for: explain reasoning behind an idea; represent and analyze relationships using tables, charts or graphs; work on problems for which there is no immediately obvious method of solution; write explanations about what was observed and why it happened; and put events in order and give a reason for the organization.

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.

An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.11

Students' Reports on the Frequency with Which Their Teacher Gives a Demonstration of an Experiment[1] - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Pretty Often or Almost Always				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	75 (1.1)	. .	. .	. .	. .
Austria	68 (2.0)	. .	. .	. .	. .
Belgium (Fl)	. .	79 (1.7)	. .	18 (1.6)	x x
[2] **Belgium (Fr)**	s 62 (3.6)	x x	. .	. .	x x
Canada	73 (1.5)	. .	. .	. .	. .
Colombia	59 (1.9)	. .	. .	. .	. .
Cyprus	89 (0.7)	. .	. .	. .	. .
Czech Republic	. .	20 (2.0)	70 (2.5)	3 (0.4)	60 (2.4)
[3] *Denmark*	. .	32 (1.8)	. .	r 20 (1.4)	81 (1.5)
England	90 (0.9)	. .	. .	. .	. .
[4] **France**	. .	56 (1.9)	. .	. .	90 (1.1)
Germany	. .	30 (1.7)	s 76 (1.8)	. .	70 (1.6)
Greece	. .	. .	75 (1.4)	43 (1.5)	77 (1.5)
Hong Kong	91 (1.1)	. .	. .	. .	. .
Hungary	. .	18 (1.5)	80 (1.7)	9 (0.8)	68 (1.5)
Iceland	. .	33 (3.6)	x x	x x	s 72 (2.3)
Iran, Islamic Rep.	63 (2.3)	. .	. .	. .	. .
Ireland	84 (1.7)	. .	. .	. .	. .
Israel	73 (2.7)	. .	. .	. .	. .
Japan	66 (1.6)	. .	. .	. .	. .
Korea	42 (1.7)	. .	. .	. .	. .
Kuwait	81 (1.4)	. .	. .	. .	. .
Latvia (LSS)	. .	49 (1.9)	77 (1.6)	. .	73 (1.7)
Lithuania	. .	25 (1.6)	57 (2.1)	10 (0.9)	59 (1.9)
[5] *Netherlands*	. .	r 28 (2.2)	. .	6 (0.6)	53 (2.4)
New Zealand	79 (1.2)	. .	. .	. .	. .
Norway	71 (1.6)	. .	. .	. .	. .
Portugal	- -	- -	- -	- -	- -
Romania	. .	49 (1.3)	63 (1.7)	34 (1.4)	60 (1.6)
Russian Federation	. .	30 (1.5)	71 (1.9)	16 (1.4)	70 (1.6)
Scotland	89 (1.1)	. .	. .	. .	. .
Singapore	86 (1.0)	. .	. .	. .	. .
Slovak Republic	. .	29 (1.5)	64 (1.8)	12 (0.8)	58 (2.0)
Slovenia	. .	37 (2.0)	72 (1.7)	. .	61 (1.8)
Spain	28 (1.8)	. .	. .	. .	. .
Sweden	. .	61 (1.9)	s 90 (0.9)	r 21 (1.2)	r 83 (1.0)
Switzerland	51 (2.1)	. .	. .	. .	. .
Thailand	84 (1.3)	. .	. .	. .	. .
United States	68 (1.4)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.12

Students' Reports on Frequency of Doing an Experiment or Practical Investigation in Science Class[1] - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Pretty Often or Almost Always				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	77 (1.4)	. .	. .	. .	. .
Austria	33 (2.2)	. .	. .	. .	. .
[2] **Belgium (Fl)**	. .	43 (1.8)	. .	11 (1.1)	x x
Belgium (Fr)	s 36 (3.2)	x x	. .	. .	x x
Canada	70 (1.8)	. .	. .	. .	. .
Colombia	47 (1.9)	. .	. .	. .	. .
Cyprus	36 (1.0)	. .	. .	. .	. .
Czech Republic	. .	20 (1.6)	35 (2.2)	3 (0.4)	29 (2.0)
[3] *Denmark*	. .	32 (2.2)	. .	r 22 (1.4)	79 (1.3)
England	91 (0.6)	. .	. .	. .	. .
[4] **France**	. .	36 (2.0)	. .	. .	74 (2.0)
Germany	. .	21 (1.6)	s 48 (3.1)	. .	41 (2.1)
Greece	. .	. .	35 (1.7)	29 (1.6)	40 (1.7)
Hong Kong	83 (2.0)	. .	. .	. .	. .
Hungary	. .	7 (0.6)	20 (1.6)	6 (0.6)	20 (1.0)
Iceland	. .	32 (3.8)	x x	x x	s 74 (3.0)
Iran, Islamic Rep.	32 (1.4)	. .	. .	. .	. .
Ireland	61 (2.7)	. .	. .	. .	. .
Israel	53 (2.8)	. .	. .	. .	. .
Japan	77 (1.5)	. .	. .	. .	. .
Korea	33 (1.7)	. .	. .	. .	. .
Kuwait	47 (2.0)	. .	. .	. .	. .
Latvia (LSS)	. .	36 (1.7)	50 (2.3)	. .	46 (1.9)
Lithuania	. .	17 (1.8)	24 (1.6)	8 (0.6)	29 (1.6)
[5] *Netherlands*	. .	r 20 (2.6)	. .	5 (0.8)	49 (2.8)
New Zealand	81 (1.3)	. .	. .	. .	. .
Norway	66 (2.2)	. .	. .	. .	. .
[6] **Portugal**	. .	26 (1.5)	. .	. .	36 (1.7)
Romania	. .	34 (1.1)	49 (1.8)	32 (1.3)	49 (1.7)
Russian Federation	. .	17 (1.0)	45 (2.4)	12 (1.0)	44 (1.6)
Scotland	87 (0.9)	. .	. .	. .	. .
Singapore	85 (1.0)	. .	. .	. .	. .
Slovak Republic	. .	19 (1.1)	25 (1.5)	12 (0.7)	30 (1.5)
Slovenia	. .	15 (1.3)	25 (1.9)	. .	31 (1.6)
Spain	23 (1.6)	. .	. .	. .	. .
Sweden	. .	65 (1.8)	s 92 (0.8)	r 23 (1.1)	r 82 (1.3)
Switzerland	35 (1.7)	. .	. .	. .	. .
Thailand	55 (1.2)	. .	. .	. .	. .
United States	62 (1.7)	. .	. .	. .	. .

[1] Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2] Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3] Physics data for Denmark are for students taking physics/chemistry classes.
[4] Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5] Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6] Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.13

Students' Reports on Frequency of Using Things from Everyday Life in Solving Science Problems[1] - Upper Grade (Eighth Grade*)

Country	Percent of Students Responding Pretty Often or Almost Always				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	43 (0.8)	. .	. .	. .	. .
Austria	31 (1.0)	. .	. .	. .	. .
Belgium (Fl)	. .	44 (1.2)	. .	40 (1.2)	x x
[2] **Belgium (Fr)**	x x	x x	. .	. .	x x
Canada	52 (1.1)	. .	. .	. .	. .
Colombia	52 (1.4)	. .	. .	. .	. .
Cyprus	65 (1.1)	. .	. .	. .	. .
Czech Republic	. .	33 (1.3)	31 (1.5)	35 (1.5)	39 (1.3)
[3] *Denmark*	. .	23 (1.2)	. .	r 19 (1.1)	27 (1.2)
England	51 (1.2)	. .	. .	. .	. .
[4] **France**	. .	41 (1.1)	. .	. .	51 (1.5)
Germany	. .	34 (1.5)	s 34 (1.7)	. .	37 (1.3)
Greece	. .	. .	48 (1.2)	52 (1.5)	65 (1.2)
Hong Kong	57 (1.5)	. .	. .	. .	. .
Hungary	. .	35 (1.4)	29 (1.2)	32 (1.3)	33 (1.1)
Iceland	. .	31 (2.2)	x x	x x	s 38 (1.9)
Iran, Islamic Rep.	53 (1.4)	. .	. .	. .	. .
Ireland	41 (1.2)	. .	. .	. .	. .
Israel	40 (2.0)	. .	. .	. .	. .
Japan	23 (0.9)	. .	. .	. .	. .
Korea	17 (0.8)	. .	. .	. .	. .
Kuwait	47 (2.0)	. .	. .	. .	. .
Latvia (LSS)	. .	65 (1.4)	73 (1.3)	. .	77 (1.1)
Lithuania	. .	24 (1.2)	30 (1.2)	22 (1.1)	44 (1.4)
[5] *Netherlands*	. .	r 36 (1.5)	. .	31 (1.4)	31 (1.4)
New Zealand	48 (1.1)	. .	. .	. .	. .
Norway	31 (1.0)	. .	. .	. .	. .
[6] **Portugal**	. .	35 (1.2)	. .	. .	43 (1.4)
Romania	. .	52 (1.2)	41 (1.3)	45 (1.4)	46 (1.1)
Russian Federation	. .	36 (2.7)	32 (2.0)	34 (1.8)	40 (1.8)
Scotland	57 (1.4)	. .	. .	. .	. .
Singapore	59 (1.1)	. .	. .	. .	. .
Slovak Republic	. .	35 (1.6)	30 (1.2)	40 (1.4)	31 (1.2)
Slovenia	. .	41 (1.7)	32 (1.2)	. .	24 (1.9)
Spain	44 (1.3)	. .	. .	. .	. .
Sweden	. .	37 (1.1)	s 43 (1.7)	r 33 (1.3)	r 48 (1.3)
Switzerland	40 (1.1)	. .	. .	. .	. .
Thailand	48 (1.3)	. .	. .	. .	. .
United States	51 (0.9)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6]Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Are Calculators and Computers Used?

As shown in Table 5.14, nearly all eighth-grade students reported having a calculator in the home, except in Iran (61%), Romania (62%), and Thailand (68%). Internationally, fewer students reported a computer in the home, even though more than three-fourths did so in Denmark, England, Iceland, Ireland, Israel, the Netherlands, and Scotland. Between 50% and 75% so reported in Australia, Austria, Belgium (Flemish), Belgium (French), Canada, France, Germany, Kuwait, New Zealand, Norway, Sweden, Switzerland, and the United States. Fewer than 20% of the students reported home computers in Colombia, Iran, Latvia (LSS), Romania, and Thailand.

Table 5.15 provides teachers' reports about how often calculators are used in eighth-grade science classes. Even though calculators appear to be widely available in most countries, teachers reported relatively low levels of calculator use in science classrooms. Only in Hungary, Kuwait, Latvia (LSS), Lithuania, the Russian Federation, and the Slovak Republic were the majority of students reported to use calculators as often as once or twice a week. The lowest levels of usage were reported in Japan and Korea, with more than 70% of students taught by teachers who reported that calculators are never or hardly ever used in their science classes. Although using calculators can take the drudgery out of mathematical computations in science class and free the learner to concentrate on higher-order problem-solving skills, another point of view is that permitting unrestricted use of calculators may damage students' mastery of basic computational skills.

As revealed in Table 5.16, teachers reported that students use calculators in science classes for a variety of purposes. Across countries, no single use appears to predominate, although routine computation, checking answers, and solving complex problems are frequent purposes in many countries.

Table 5.17 contains teachers' reports about how often computers are used in science class to solve exercises or problems. Such usage is reportedly quite rare, and only in Canada, Denmark, England, Iceland, Israel, Kuwait, Slovenia, and Switzerland did more than 20% of the students have teachers who reported at least some usage. Table 5.18 contains students' responses to a similar question, although expressed as the percentage of students using computers to solve problems in science class at least once in a while. Internationally, teachers and students agree that the computer is rarely used in most students' science lessons. Students reported moderate use of computers (more than 20% of the students in some lessons) in Austria, Canada, Cyprus, Denmark, England, Greece, Israel, New Zealand, Romania, the Russian Federation, Scotland, Slovenia, Sweden, and the United States.

Table 5.14

Students' Reports on Having a Calculator and Computer in the Home Science - Upper Grade (Eighth Grade*)

Country	Calculator				Computer			
	Yes		No		Yes		No	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	97 (0.3)	548 (3.8)	3 (0.3)	467 (13.8)	73 (1.2)	554 (4.3)	27 (1.2)	525 (4.2)
Austria	100 (0.1)	558 (3.8)	0 (0.1)	~ ~	59 (1.5)	565 (4.0)	41 (1.5)	548 (4.7)
Belgium (Fl)	97 (0.8)	553 (4.0)	3 (0.8)	467 (11.4)	67 (1.3)	558 (4.2)	33 (1.3)	536 (5.3)
Belgium (Fr)	98 (0.3)	472 (2.9)	2 (0.3)	~ ~	60 (1.4)	481 (3.0)	40 (1.4)	457 (3.6)
Canada	98 (0.2)	533 (2.6)	2 (0.2)	~ ~	61 (1.3)	543 (2.5)	39 (1.3)	513 (3.1)
Colombia	88 (1.5)	415 (3.6)	12 (1.5)	389 (9.1)	11 (1.2)	431 (9.7)	89 (1.2)	409 (3.9)
Cyprus	96 (0.4)	466 (2.0)	4 (0.4)	403 (6.3)	39 (0.9)	472 (2.9)	61 (0.9)	459 (2.5)
Czech Republic	99 (0.2)	574 (4.3)	1 (0.2)	~ ~	36 (1.2)	593 (6.0)	64 (1.2)	563 (3.6)
Denmark	99 (0.3)	479 (3.1)	1 (0.3)	~ ~	76 (1.2)	484 (3.1)	24 (1.2)	464 (4.7)
England	99 (0.2)	554 (3.5)	1 (0.2)	~ ~	89 (0.8)	553 (3.7)	11 (0.8)	558 (6.5)
France	99 (0.2)	499 (2.6)	1 (0.2)	~ ~	50 (1.3)	504 (3.0)	50 (1.3)	492 (3.0)
Germany	99 (0.2)	532 (4.7)	1 (0.2)	~ ~	71 (1.0)	538 (4.6)	29 (1.0)	517 (6.4)
Greece	87 (0.6)	504 (2.2)	13 (0.6)	455 (3.7)	29 (1.0)	512 (4.3)	71 (1.0)	492 (2.1)
Hong Kong	99 (0.1)	524 (4.7)	1 (0.1)	~ ~	39 (1.9)	539 (5.0)	61 (1.9)	514 (4.9)
Hungary	97 (0.4)	556 (2.8)	3 (0.4)	496 (14.3)	37 (1.2)	581 (3.2)	63 (1.2)	539 (3.1)
Iceland	100 (0.1)	494 (4.1)	0 (0.1)	~ ~	77 (1.4)	494 (4.6)	23 (1.4)	491 (3.6)
Iran, Islamic Rep.	61 (1.8)	482 (2.8)	39 (1.8)	457 (3.6)	4 (0.4)	474 (11.3)	96 (0.4)	472 (2.4)
Ireland	97 (0.3)	540 (4.4)	3 (0.3)	506 (9.0)	78 (1.1)	542 (4.7)	22 (1.1)	530 (6.0)
Israel	99 (0.3)	529 (5.3)	1 (0.3)	~ ~	76 (2.1)	540 (5.8)	24 (2.1)	492 (4.6)
Japan	- -	- -	- -	- -	- -	- -	- -	- -
Korea	91 (0.5)	567 (2.0)	9 (0.5)	540 (5.5)	39 (1.2)	584 (2.7)	61 (1.2)	553 (2.2)
Kuwait	84 (1.4)	434 (3.6)	16 (1.4)	412 (6.0)	53 (2.1)	431 (5.4)	47 (2.1)	430 (3.3)
Latvia (LSS)	94 (0.5)	486 (2.7)	6 (0.5)	475 (5.9)	13 (0.9)	487 (5.3)	87 (0.9)	485 (2.6)
Lithuania	90 (1.0)	481 (3.5)	10 (1.0)	441 (6.4)	42 (1.4)	476 (3.9)	58 (1.4)	477 (4.1)
Netherlands	100 (0.1)	561 (5.2)	0 (0.1)	~ ~	85 (1.2)	563 (6.3)	15 (1.2)	547 (6.6)
New Zealand	99 (0.2)	528 (4.3)	1 (0.2)	~ ~	60 (1.3)	538 (4.8)	40 (1.3)	509 (4.8)
Norway	99 (0.2)	528 (1.9)	1 (0.2)	~ ~	64 (1.1)	534 (2.4)	36 (1.1)	516 (3.0)
Portugal	99 (0.2)	480 (2.3)	1 (0.2)	~ ~	39 (1.8)	493 (3.2)	61 (1.8)	471 (2.2)
Romania	62 (1.5)	495 (5.1)	38 (1.5)	473 (6.8)	19 (1.2)	504 (7.1)	81 (1.2)	482 (4.9)
Russian Federation	92 (0.8)	541 (3.8)	8 (0.8)	508 (8.8)	35 (1.5)	542 (4.7)	65 (1.5)	536 (4.7)
Scotland	98 (0.4)	520 (5.3)	2 (0.4)	~ ~	90 (0.6)	518 (5.3)	10 (0.6)	522 (8.6)
Singapore	100 (0.1)	608 (5.6)	0 (0.1)	~ ~	49 (1.5)	626 (6.2)	51 (1.5)	590 (5.4)
Slovak Republic	99 (0.2)	545 (3.2)	1 (0.2)	~ ~	31 (1.2)	561 (3.9)	69 (1.2)	537 (3.5)
Slovenia	98 (0.3)	561 (2.5)	2 (0.3)	~ ~	47 (1.3)	579 (3.2)	53 (1.3)	543 (2.9)
Spain	99 (0.2)	517 (1.7)	1 (0.2)	~ ~	42 (1.2)	528 (2.7)	58 (1.2)	509 (2.1)
Sweden	99 (0.1)	536 (2.9)	1 (0.1)	~ ~	60 (1.3)	547 (2.9)	40 (1.3)	518 (3.6)
Switzerland	99 (0.2)	523 (2.6)	1 (0.2)	~ ~	66 (1.2)	530 (2.9)	34 (1.2)	507 (3.2)
Thailand	68 (2.2)	528 (4.5)	32 (2.2)	520 (3.1)	4 (0.9)	542 (10.7)	96 (0.9)	525 (3.6)
United States	98 (0.3)	536 (4.6)	2 (0.3)	~ ~	59 (1.7)	555 (4.1)	41 (1.7)	506 (5.4)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.15

Teachers' Reports on Frequency of Students' Use of Calculators in Science Class[1] Upper Grade (Eighth Grade*)

Country	Never or Hardly Ever		Once or Twice a Month		Once or Twice a Week		Almost Every Day	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	x x	x x	x x	x x	x x	x x	x x	x x
Austria	r 61 (3.0)	563 (3.4)	32 (3.2)	561 (5.2)	4 (1.3)	566 (9.0)	3 (0.8)	557 (16.4)
Belgium (Fl)	r 61 (4.5)	550 (8.5)	14 (2.5)	572 (5.5)	9 (2.5)	557 (4.9)	16 (2.9)	560 (4.8)
Belgium (Fr)	s 31 (5.9)	479 (6.5)	37 (5.3)	481 (5.1)	9 (3.0)	506 (7.9)	23 (3.9)	486 (6.1)
Canada	r 16 (2.7)	532 (7.7)	38 (4.1)	536 (6.7)	21 (2.7)	538 (4.2)	25 (4.0)	539 (5.5)
Colombia	r 50 (5.2)	420 (4.8)	21 (3.8)	407 (6.6)	17 (5.0)	396 (18.1)	12 (3.1)	416 (13.1)
Cyprus	s 51 (3.9)	454 (3.5)	13 (2.5)	467 (8.9)	12 (3.1)	465 (8.4)	25 (3.7)	462 (5.2)
Czech Republic	r 22 (1.9)	572 (5.5)	30 (3.5)	582 (7.9)	31 (2.8)	572 (7.7)	17 (2.4)	575 (3.9)
Denmark	s 56 (5.8)	476 (4.9)	26 (5.3)	478 (6.1)	10 (3.8)	500 (10.8)	9 (3.6)	479 (6.0)
England	x x	x x	x x	x x	x x	x x	x x	x x
France	r 17 (2.4)	505 (5.0)	39 (3.6)	499 (3.5)	22 (2.4)	499 (4.4)	22 (2.8)	496 (3.8)
Germany	s 40 (4.5)	536 (7.3)	16 (3.2)	518 (14.2)	20 (3.5)	560 (9.2)	24 (3.6)	530 (12.5)
Greece	64 (4.0)	496 (2.7)	8 (1.9)	499 (6.0)	15 (2.7)	495 (5.8)	13 (2.5)	504 (5.3)
Hong Kong	59 (5.8)	525 (7.5)	24 (5.1)	516 (11.5)	5 (2.7)	488 (26.1)	12 (3.5)	542 (10.5)
Hungary	r 31 (2.9)	551 (4.2)	8 (1.5)	566 (6.9)	20 (2.0)	549 (4.1)	40 (3.3)	554 (5.4)
Iceland	s 31 (8.3)	489 (11.3)	35 (8.4)	484 (3.6)	17 (4.0)	488 (7.8)	17 (4.3)	486 (6.3)
Iran, Islamic Rep.	68 (5.3)	469 (3.3)	22 (4.7)	467 (4.3)	6 (1.7)	489 (7.0)	4 (1.9)	465 (7.3)
Ireland	s 54 (4.8)	536 (7.7)	28 (3.9)	547 (9.4)	12 (3.5)	567 (13.2)	6 (2.2)	539 (19.1)
Israel	s 53 (8.8)	535 (11.7)	35 (8.7)	510 (16.1)	4 (3.1)	514 (46.3)	8 (4.8)	535 (4.1)
Japan	91 (2.4)	570 (2.1)	9 (2.4)	580 (8.1)	0 (0.0)	~ ~	0 (0.5)	~ ~
Korea	73 (3.5)	568 (2.3)	12 (2.4)	555 (6.1)	11 (1.9)	556 (5.0)	4 (2.3)	575 (7.6)
Kuwait	r 16 (5.5)	419 (6.8)	24 (5.9)	443 (7.6)	30 (7.5)	418 (5.6)	29 (7.9)	425 (12.4)
Latvia (LSS)	s 27 (2.2)	488 (3.7)	18 (2.1)	483 (4.6)	27 (2.1)	488 (3.4)	29 (2.4)	480 (3.4)
Lithuania	r 35 (2.0)	476 (4.4)	10 (1.3)	472 (8.1)	21 (2.2)	475 (5.8)	34 (2.4)	479 (5.0)
Netherlands	34 (3.0)	548 (10.8)	35 (3.1)	562 (6.9)	22 (3.5)	586 (8.4)	9 (1.9)	561 (10.0)
New Zealand	30 (3.9)	511 (6.6)	40 (4.2)	528 (7.2)	21 (3.4)	549 (9.4)	9 (2.5)	515 (16.0)
Norway	s 35 (5.0)	522 (4.2)	34 (4.7)	530 (3.6)	15 (4.1)	527 (6.8)	17 (4.1)	518 (6.0)
Portugal	36 (2.1)	482 (2.9)	17 (2.2)	481 (3.7)	19 (2.5)	484 (4.7)	28 (2.0)	473 (3.8)
Romania	66 (2.3)	481 (5.3)	10 (1.3)	484 (7.3)	12 (1.5)	501 (9.3)	12 (1.6)	499 (8.5)
Russian Federation	40 (2.3)	531 (5.2)	6 (1.3)	530 (10.8)	32 (2.9)	533 (5.8)	22 (2.9)	549 (5.7)
Scotland	- -	- -	- -	- -	- -	- -	- -	- -
Singapore	19 (3.2)	601 (13.7)	31 (4.1)	604 (10.3)	17 (3.4)	598 (15.4)	32 (4.4)	623 (9.5)
Slovak Republic	r 1 (0.8)	~ ~	9 (2.9)	533 (13.9)	42 (4.6)	545 (5.9)	48 (5.0)	543 (5.6)
Slovenia	r 29 (2.2)	561 (3.1)	27 (2.7)	556 (5.4)	27 (2.7)	554 (3.3)	18 (2.2)	561 (4.7)
Spain	r 40 (4.3)	515 (3.7)	14 (3.6)	517 (6.1)	17 (3.4)	529 (3.9)	29 (4.3)	513 (3.9)
Sweden	x x	x x	x x	x x	x x	x x	x x	x x
Switzerland	x x	x x	x x	x x	x x	x x	x x	x x
Thailand	r 62 (6.0)	526 (5.8)	20 (4.7)	527 (9.0)	7 (3.5)	527 (14.8)	11 (4.1)	543 (13.0)
United States	x x	x x	x x	x x	x x	x x	x x	x x

[1]Based on most frequent response for: checking answers, test and exams, routine computations, solving complex problems, and exploring number concepts.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.16

Teachers' Reports on Ways in Which Calculators Are Used At Least Once or Twice a Week - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students by Type of Use: Never or Hardly Ever Use Calculators	Checking Answers	Tests and Exams	Routine Computations	Solving Complex Problems	Exploring Number Concepts
Australia	x x	x x	x x	x x	x x	x x
Austria	r 61 (3.0)	r 5 (1.4)	r 2 (0.9)	r 5 (1.4)	r 3 (1.0)	r 2 (0.6)
Belgium (Fl)	r 61 (4.5)	r 17 (3.8)	r 14 (2.9)	r 20 (3.9)	r 20 (3.3)	r 8 (2.6)
Belgium (Fr)	s 31 (5.9)	s 27 (4.6)	s 23 (4.5)	s 29 (4.8)	s 23 (4.5)	s 12 (3.7)
Canada	r 16 (2.7)	r 34 (3.9)	r 23 (4.0)	r 39 (4.2)	r 32 (4.0)	s 21 (3.6)
Colombia	r 50 (5.2)	r 20 (5.1)	r 9 (2.7)	r 21 (5.4)	r 17 (3.6)	r 18 (3.5)
Cyprus	s 51 (3.9)	s 23 (4.1)	s 17 (3.4)	s 29 (3.5)	s 28 (4.0)	s 11 (2.3)
Czech Republic	r 22 (1.9)	r 39 (2.9)	r 17 (2.9)	r 37 (2.9)	r 29 (2.9)	r 11 (2.1)
Denmark	s 56 (5.8)	s 12 (4.4)	s 8 (3.7)	s 14 (4.6)	s 10 (3.4)	s 3 (2.2)
England	x x	x x	x x	x x	x x	x x
France	r 17 (2.4)	r 29 (3.7)	r 24 (3.4)	r 39 (3.1)	r 19 (3.3)	r 12 (3.1)
Germany	s 40 (4.5)	s 40 (4.7)	s 16 (4.4)	s 43 (4.8)	s 28 (4.6)	s 16 (4.5)
Greece	64 (4.0)	22 (3.5)	6 (1.9)	23 (3.3)	16 (2.8)	8 (2.2)
Hong Kong	59 (5.8)	5 (2.7)	8 (3.3)	16 (4.1)	7 (3.2)	6 (3.0)
Hungary	r 31 (2.9)	s 39 (3.1)	s 22 (2.8)	s 44 (3.2)	s 50 (3.1)	s 54 (3.5)
Iceland	s 31 (8.3)	s 27 (4.8)	s 19 (4.6)	s 32 (5.0)	s 30 (4.9)	s 20 (4.4)
Iran, Islamic Rep.	68 (5.3)	1 (0.9)	4 (1.9)	3 (1.8)	6 (1.8)	4 (1.5)
Ireland	s 54 (4.8)	s 12 (3.1)	s 4 (1.7)	s 15 (3.4)	s 7 (2.3)	s 2 (1.1)
Israel	s 53 (8.8)	s 7 (4.9)	s 8 (5.5)	s 13 (6.2)	s 9 (5.3)	s 6 (4.9)
Japan	91 (2.4)	0 (0.5)	0 (0.0)	0 (0.0)	0 (0.5)	0 (0.0)
Korea	73 (3.5)	5 (2.4)	5 (2.4)	10 (2.7)	8 (2.2)	8 (2.6)
Kuwait	r 16 (5.5)	r 40 (8.3)	r 27 (7.1)	r 53 (10.0)	r 43 (6.9)	r 38 (8.0)
Latvia (LSS)	s 27 (2.2)	s 44 (2.6)	s 25 (2.5)	s 55 (2.2)	s 38 (2.4)	s 14 (2.3)
Lithuania	r 35 (2.0)	s 48 (2.1)	s 16 (2.0)	s 49 (1.8)	s 46 (2.2)	s 15 (2.0)
Netherlands	34 (3.0)	23 (2.5)	13 (2.5)	r 28 (2.4)	r 14 (2.3)	r 5 (1.6)
New Zealand	30 (3.9)	6 (1.8)	5 (1.8)	27 (3.8)	11 (2.8)	6 (2.3)
Norway	s 35 (5.0)	s 24 (4.8)	s 14 (3.9)	s 27 (4.9)	- -	- -
Portugal	36 (2.1)	40 (2.2)	12 (1.9)	39 (2.0)	30 (2.5)	17 (2.1)
Romania	66 (2.3)	17 (1.8)	r 4 (0.9)	r 19 (1.7)	r 19 (1.8)	r 5 (1.0)
Russian Federation	40 (2.3)	44 (2.5)	14 (1.9)	50 (2.1)	43 (2.6)	27 (2.7)
Scotland	- -	- -	- -	- -	- -	- -
Singapore	19 (3.2)	42 (4.7)	33 (4.3)	39 (4.9)	38 (4.7)	31 (4.2)
Slovak Republic	r 1 (0.8)	r 70 (4.1)	r 29 (4.7)	r 81 (3.8)	r 60 (4.8)	r 59 (4.6)
Slovenia	r 29 (2.2)	r 30 (2.5)	r 12 (1.8)	r 34 (2.9)	r 28 (2.6)	r 15 (2.3)
Spain	r 40 (4.3)	r 33 (4.8)	r 13 (3.3)	r 34 (4.7)	r 36 (4.9)	r 19 (3.5)
Sweden	x x	x x	x x	x x	x x	x x
Switzerland	x x	x x	x x	x x	x x	x x
Thailand	r 62 (6.0)	s 8 (3.5)	s 0 (0.4)	r 14 (4.7)	s 17 (5.0)	s 11 (3.9)
United States	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table 5.17

Teachers' Reports on Frequency of Using Computers in Science Class To Solve Exercises or Problems - Upper Grade (Eighth Grade*)

Country		Never or Almost Never		Some Lessons		Most or Every Lesson	
		Percent of Students	**Mean Achievement**	**Percent of Students**	**Mean Achievement**	**Percent of Students**	**Mean Achievement**
Australia		x x	x x	x x	x x	x x	x x
Austria	r	85 (2.6)	565 (3.1)	14 (2.6)	547 (7.1)	1 (0.2)	~ ~
Belgium (Fl)	r	98 (1.0)	555 (5.9)	2 (1.0)	~ ~	0 (0.0)	~ ~
Belgium (Fr)	s	95 (2.0)	483 (3.5)	5 (2.0)	491 (13.5)	0 (0.0)	~ ~
Canada	r	76 (3.3)	536 (2.9)	23 (3.4)	535 (9.9)	0 (0.4)	~ ~
Colombia	r	95 (2.5)	413 (4.5)	3 (1.4)	439 (51.1)	2 (2.1)	~ ~
Cyprus	s	92 (1.1)	456 (2.6)	8 (1.1)	483 (7.5)	0 (0.0)	~ ~
Czech Republic		93 (2.0)	573 (4.6)	6 (1.7)	603 (11.0)	2 (1.1)	~ ~
Denmark	s	63 (5.9)	482 (4.4)	35 (5.8)	475 (5.2)	2 (2.0)	~ ~
England	s	70 (3.3)	567 (6.9)	30 (3.3)	558 (7.3)	0 (0.0)	~ ~
France		97 (1.2)	499 (2.5)	3 (1.2)	508 (11.4)	0 (0.0)	~ ~
Germany	s	95 (1.8)	536 (6.2)	5 (1.8)	539 (23.1)	0 (0.0)	~ ~
Greece		93 (3.2)	498 (2.2)	6 (3.2)	481 (5.0)	0 (0.2)	~ ~
Hong Kong		95 (2.5)	523 (5.3)	4 (2.2)	487 (38.3)	1 (1.2)	~ ~
Hungary		- -	- -	- -	- -	- -	- -
Iceland	s	73 (6.1)	489 (4.5)	22 (6.0)	484 (4.0)	5 (1.7)	479 (9.2)
Iran, Islamic Rep.		99 (0.5)	469 (2.4)	1 (0.5)	~ ~	0 (0.0)	~ ~
Ireland	s	96 (1.4)	540 (6.0)	4 (1.4)	588 (14.8)	0 (0.0)	~ ~
Israel	r	75 (8.0)	538 (8.3)	24 (7.9)	498 (13.3)	1 (1.1)	~ ~
Japan		84 (2.8)	572 (2.0)	16 (2.8)	569 (5.8)	0 (0.0)	~ ~
Korea		96 (1.7)	566 (2.2)	4 (1.7)	555 (8.3)	0 (0.0)	~ ~
Kuwait	r	78 (7.7)	427 (4.5)	21 (7.6)	420 (7.5)	1 (0.9)	~ ~
Latvia (LSS)	s	91 (1.5)	485 (2.6)	6 (1.3)	483 (6.5)	3 (0.8)	479 (9.6)
Lithuania	r	96 (1.1)	477 (4.2)	3 (0.9)	482 (13.6)	1 (0.5)	~ ~
Netherlands	r	85 (2.6)	559 (7.4)	15 (2.6)	578 (7.9)	0 (0.0)	~ ~
New Zealand		90 (2.7)	526 (4.7)	10 (2.7)	527 (12.5)	0 (0.0)	~ ~
Norway	s	96 (1.9)	525 (2.3)	4 (1.9)	523 (12.8)	0 (0.0)	~ ~
Portugal		99 (0.5)	480 (2.5)	0 (0.3)	~ ~	0 (0.4)	~ ~
Romania	r	94 (1.3)	487 (4.7)	4 (1.1)	504 (11.9)	2 (0.7)	~ ~
Russian Federation		88 (1.7)	538 (4.6)	8 (1.5)	534 (8.0)	3 (1.0)	528 (15.1)
Scotland		- -	- -	- -	- -	- -	- -
Singapore		95 (1.5)	606 (5.8)	5 (1.5)	625 (22.3)	0 (0.0)	~ ~
Slovak Republic	r	96 (2.0)	546 (3.9)	4 (2.0)	514 (7.8)	0 (0.0)	~ ~
Slovenia	r	60 (3.1)	556 (3.5)	26 (3.1)	559 (4.3)	15 (2.2)	558 (5.3)
Spain	r	92 (2.7)	519 (2.1)	7 (2.5)	501 (8.6)	1 (0.9)	~ ~
Sweden		x x	x x	x x	x x	x x	x x
Switzerland	s	78 (4.3)	527 (4.9)	22 (4.3)	510 (12.7)	0 (0.0)	~ ~
Thailand	r	92 (3.6)	530 (5.3)	3 (2.2)	521 (15.5)	5 (2.9)	513 (8.2)
United States		x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.18

Students' Reports on Frequency of Using Computers in Science Class[1] Upper Grade (Eighth Grade*)

Country	Percent of Students Responding At Least Once in a While				
	Science (Integrated)	Science Subject Areas			
		Biology	Chemistry	Earth Science	Physics
Australia	16 (1.4)	. .	. .	. .	. .
Austria	23 (2.4)	. .	. .	. .	. .
Belgium (Fl)	. .	9 (1.1)	. .	8 (0.9)	x x
[2] **Belgium (Fr)**	x x	x x	. .	. .	x x
Canada	24 (1.5)	. .	. .	. .	. .
Colombia	6 (0.5)	. .	. .	. .	. .
Cyprus	23 (1.1)	. .	. .	. .	. .
Czech Republic	. .	2 (0.5)	5 (1.5)	6 (2.3)	6 (1.9)
[3] *Denmark*	. .	36 (2.9)	. .	r 39 (2.6)	17 (2.1)
England	36 (2.5)	. .	. .	. .	. .
[4] **France**	. .	8 (1.5)	. .	. .	12 (1.5)
Germany	. .	10 (0.9)	s 13 (1.6)	. .	15 (1.6)
Greece	. .	. .	22 (1.0)	23 (1.4)	24 (1.2)
Hong Kong	11 (0.9)	. .	. .	. .	. .
Hungary	. .	5 (0.5)	7 (0.9)	6 (0.6)	8 (0.8)
Iceland	. .	11 (2.5)	x x	x x	s 12 (2.4)
Iran, Islamic Rep.	9 (0.9)	. .	. .	. .	. .
Ireland	8 (1.3)	. .	. .	. .	. .
Israel	21 (4.0)	. .	. .	. .	. .
Japan	16 (2.4)	. .	. .	. .	. .
Korea	9 (0.8)	. .	. .	. .	. .
Kuwait	19 (1.8)	. .	. .	. .	. .
Latvia (LSS)	. .	3 (0.4)	5 (0.6)	. .	8 (1.3)
Lithuania	. .	4 (0.5)	6 (0.7)	6 (0.6)	8 (0.8)
[5] *Netherlands*	. .	r 11 (1.9)	. .	16 (2.6)	12 (1.7)
New Zealand	20 (2.2)	. .	. .	. .	. .
Norway	12 (1.3)	. .	. .	. .	. .
[6] **Portugal**	. .	4 (0.4)	. .	. .	7 (0.8)
Romania	. .	21 (1.0)	24 (1.1)	23 (1.1)	25 (1.3)
Russian Federation	. .	4 (0.8)	s 38 (1.9)	6 (1.0)	8 (1.0)
Scotland	32 (2.0)	. .	. .	. .	. .
Singapore	7 (1.3)	. .	. .	. .	. .
Slovak Republic	. .	2 (0.3)	4 (0.7)	3 (0.3)	5 (0.8)
Slovenia	. .	8 (0.8)	13 (0.9)	. .	20 (1.5)
Spain	9 (1.3)	. .	. .	. .	. .
Sweden	. .	18 (2.0)	s 17 (1.7)	r 25 (2.1)	r 23 (2.0)
Switzerland	13 (1.5)	. .	. .	. .	. .
Thailand	9 (1.0)	. .	. .	. .	. .
United States	35 (2.2)	. .	. .	. .	. .

[1] Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2] Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3] Physics data for Denmark are for students taking physics/chemistry classes.
[4] Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5] Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6] Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

How Much Science Homework Are Students Assigned?

Although teachers often give students time to begin or review homework assignments in class, homework is generally considered a method of extending the time spent on regular classroom lessons. Table 5.19 presents teachers' reports about how often they assign science homework and the typical lengths of such assignments. Internationally, most eighth-grade students are assigned science homework at least once a week, although more than half of the students in Belgium (Flemish), Belgium (French), the Czech Republic, Denmark, Hong Kong, Japan, Korea, Scotland, and Slovenia are taught by teachers who reported that they assign homework less than once a week. Most typically, the majority of students were assigned up to 30 minutes of science homework once or twice a week. Students in Colombia, Cyprus, Greece and Iran are among those reporting most science homework, but even in those countries, less than 20% of students are taught by teachers who assign more than 30 minutes of science homework as often as three times a week.

Homework generally has its biggest impact when it is commented on and graded by teachers. Table 5.20 presents teachers' reports about their use of students' written science homework. In most countries, for at least 70% of the students, teachers reported at least sometimes, if not always, correcting homework assignments and returning those assignments to students. The exceptions were Austria, Germany, Hungary, Iran, Japan, the Netherlands, Norway, and the Slovak Republic.

Many teachers do not count homework directly in determining grades, using it more as a method to monitor students' understanding and correct misconceptions. In general for the TIMSS countries, teachers reported that science homework assignments contributed only sometimes to students' grades or marks. In some countries, however, it had even less impact on grades. According to their teachers, homework never or only rarely contributed to the grades for the majority of the students in Austria, the Czech Republic, Denmark, France, Hong Kong, Hungary, Ireland, Japan, Latvia (LSS), Lithuania, the Netherlands, Norway, Romania, Singapore, the Slovak Republic, Slovenia, Switzerland, and Thailand. At the other end of the continuum, teachers reported that homework always contributed to the grades for the majority of the students in Colombia, Kuwait, Portugal, the Russian Federation, and Spain.

Table 5.19

Teachers' Reports About the Amount of Science Homework Assigned Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers						
	Never Assigning Homework	Assigning Homework Less Than Once a Week		Assigning Homework Once or Twice a Week		Assigning Homework Three Times a Week or More Often	
		30 Minutes or Less	More Than 30 Minutes	30 Minutes or Less	More Than 30 Minutes	30 Minutes or Less	More Than 30 Minutes
Australia	x x	x x	x x	x x	x x	x x	x x
Austria	- -	- -	- -	- -	- -	- -	- -
Belgium (Fl)	r 16 (2.9)	72 (4.1)	4 (1.3)	7 (2.2)	0 (0.4)	1 (0.9)	0 (0.0)
Belgium (Fr)	s 4 (2.0)	57 (5.4)	4 (1.9)	31 (4.8)	2 (1.5)	2 (1.1)	1 (0.6)
Canada	r 4 (1.8)	16 (2.5)	4 (2.8)	47 (4.1)	8 (2.2)	18 (2.4)	2 (1.3)
Colombia	r 1 (1.4)	5 (2.1)	8 (2.2)	26 (4.1)	37 (5.2)	11 (3.0)	11 (3.0)
Cyprus	s 1 (1.3)	1 (0.6)	0 (0.0)	27 (3.6)	12 (3.1)	45 (4.6)	14 (3.8)
Czech Republic	r 4 (1.3)	75 (3.6)	0 (0.2)	21 (3.4)	0 (0.0)	0 (0.1)	0 (0.0)
Denmark	s 15 (4.7)	49 (6.4)	5 (3.2)	26 (5.6)	0 (0.0)	6 (2.7)	0 (0.0)
England	s 0 (0.0)	10 (2.1)	2 (0.8)	54 (3.3)	32 (3.0)	2 (1.4)	0 (0.1)
France	2 (0.9)	31 (3.6)	3 (1.2)	54 (3.6)	6 (1.5)	5 (1.5)	0 (0.0)
Germany	s 3 (1.5)	41 (4.1)	0 (0.4)	43 (3.8)	0 (0.4)	12 (2.8)	0 (0.0)
Greece	0 (0.0)	9 (2.3)	1 (0.9)	28 (3.1)	11 (3.4)	34 (3.5)	17 (3.1)
Hong Kong	1 (1.1)	37 (5.3)	21 (4.6)	36 (5.5)	4 (2.2)	1 (1.2)	0 (0.0)
Hungary	2 (0.7)	27 (2.3)	1 (0.4)	21 (2.3)	1 (0.5)	42 (2.5)	6 (1.2)
Iceland	s 3 (1.9)	23 (3.9)	2 (1.4)	49 (6.1)	12 (5.6)	11 (6.6)	0 (0.0)
Iran, Islamic Rep.	2 (1.3)	7 (3.1)	9 (3.3)	26 (5.8)	41 (5.4)	3 (1.1)	13 (2.8)
Ireland	s 0 (0.4)	5 (2.1)	0 (0.2)	34 (4.1)	4 (1.8)	53 (4.6)	4 (1.5)
Israel	r 0 (0.0)	19 (6.5)	0 (0.0)	48 (8.0)	13 (6.3)	18 (6.9)	3 (2.8)
Japan	10 (2.3)	55 (4.2)	14 (3.4)	12 (3.1)	5 (2.1)	4 (1.4)	0 (0.5)
Korea	2 (1.0)	39 (3.7)	11 (2.6)	29 (3.9)	10 (2.4)	8 (2.7)	0 (0.4)
Kuwait	r 0 (0.0)	0 (0.0)	0 (0.0)	20 (6.5)	3 (2.5)	68 (5.8)	9 (4.2)
Latvia (LSS)	s 1 (0.6)	23 (1.9)	1 (0.6)	58 (2.6)	3 (1.1)	14 (1.6)	1 (0.4)
Lithuania	r 1 (0.4)	19 (1.9)	0 (0.3)	62 (2.5)	4 (1.0)	13 (1.6)	1 (0.6)
Netherlands	r 0 (0.4)	11 (2.2)	0 (0.0)	76 (3.3)	3 (1.0)	9 (2.0)	1 (0.6)
New Zealand	0 (0.2)	12 (2.0)	2 (1.0)	54 (3.9)	2 (0.5)	30 (3.7)	0 (0.0)
Norway	s 0 (0.0)	11 (3.5)	1 (1.2)	65 (5.1)	9 (2.9)	14 (3.6)	0 (0.0)
Portugal	0 (0.2)	14 (2.4)	2 (0.9)	59 (3.0)	5 (1.2)	19 (2.7)	1 (0.8)
Romania	8 (1.2)	35 (2.3)	2 (0.6)	34 (2.0)	8 (1.3)	6 (1.2)	6 (1.0)
Russian Federation	0 (0.0)	1 (0.5)	0 (0.2)	65 (2.8)	16 (2.4)	12 (2.6)	6 (1.2)
Scotland	s 2 (1.4)	62 (4.8)	4 (1.7)	30 (4.5)	2 (1.3)	0 (0.2)	0 (0.0)
Singapore	0 (0.0)	14 (3.5)	3 (1.8)	49 (4.4)	28 (3.8)	6 (2.3)	0 (0.4)
Slovak Republic	r 2 (1.2)	37 (4.8)	0 (0.0)	59 (4.7)	0 (0.0)	2 (1.4)	0 (0.0)
Slovenia	r 3 (1.1)	56 (3.4)	2 (0.6)	37 (3.5)	2 (0.9)	0 (0.3)	0 (0.0)
Spain	r 0 (0.0)	8 (2.8)	4 (1.9)	45 (4.9)	5 (2.1)	30 (4.5)	8 (2.6)
Sweden	x x	x x	x x	x x	x x	x x	x x
Switzerland	s 4 (1.1)	43 (5.0)	3 (1.4)	38 (5.2)	3 (1.4)	8 (2.7)	1 (1.1)
Thailand	r 0 (0.0)	7 (3.0)	7 (3.4)	34 (6.4)	40 (6.7)	6 (2.8)	7 (3.0)
United States	x x	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are unavailable.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.20

Teachers' Reports on Their Use of Students' Written Science Homework[1] Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers: Collecting, Correcting and then Returning Assignments to Students				Using Homework to Contribute Towards Students' Grades or Marks			
	Never	Rarely	Sometimes	Always	Never	Rarely	Sometimes	Always
Australia	x x	x x	x x	x x	x x	x x	x x	x x
Austria	s 24 (3.1)	16 (2.7)	31 (2.9)	29 (3.8)	s 29 (3.8)	34 (4.1)	26 (3.7)	12 (2.7)
Belgium (Fl)	r 6 (2.0)	16 (4.0)	15 (3.3)	63 (4.7)	r 16 (4.0)	24 (6.1)	29 (4.1)	31 (5.0)
Belgium (Fr)	s 6 (2.6)	3 (1.9)	35 (5.9)	56 (6.4)	s 5 (2.8)	14 (3.9)	53 (6.2)	28 (5.1)
Canada	s 1 (0.7)	3 (1.7)	53 (5.2)	43 (5.1)	s 7 (2.2)	12 (2.2)	48 (3.9)	33 (3.6)
Colombia	r 0 (0.0)	1 (0.9)	14 (5.2)	85 (5.2)	r 1 (1.0)	5 (2.0)	40 (4.8)	54 (4.9)
Cyprus	s 5 (1.8)	15 (3.5)	51 (4.4)	29 (4.3)	s 0 (0.0)	6 (2.0)	46 (4.4)	49 (4.7)
Czech Republic	r 10 (1.9)	11 (2.1)	37 (3.4)	41 (3.1)	r 28 (3.6)	35 (3.5)	30 (3.2)	7 (1.3)
Denmark	s 14 (5.0)	8 (3.3)	31 (5.8)	46 (6.7)	s 41 (6.6)	17 (5.0)	29 (6.5)	13 (4.9)
England	s 1 (0.7)	2 (0.9)	31 (3.4)	66 (3.6)	s 3 (1.2)	8 (1.6)	45 (3.0)	44 (3.5)
France	7 (1.8)	18 (3.1)	45 (3.7)	30 (3.1)	25 (2.8)	28 (3.4)	39 (4.2)	8 (1.9)
Germany	s 3 (1.3)	28 (4.3)	56 (4.9)	13 (2.9)	s 17 (2.9)	22 (3.5)	52 (4.7)	9 (2.8)
Greece	6 (1.8)	17 (2.6)	43 (3.7)	34 (3.4)	2 (0.9)	12 (2.6)	41 (3.6)	45 (3.9)
Hong Kong	0 (0.0)	4 (2.3)	17 (3.7)	79 (3.8)	26 (5.3)	27 (5.1)	26 (5.0)	21 (5.1)
Hungary	14 (1.6)	32 (2.5)	39 (2.3)	15 (1.7)	16 (2.0)	39 (2.5)	34 (2.5)	11 (1.7)
Iceland	s 2 (1.4)	22 (7.2)	54 (7.6)	22 (4.0)	s 4 (3.1)	12 (4.5)	51 (8.1)	33 (6.8)
Iran, Islamic Rep.	17 (6.4)	22 (4.3)	26 (5.0)	35 (5.2)	9 (3.0)	25 (5.7)	43 (5.6)	23 (4.4)
Ireland	s 4 (1.9)	15 (3.2)	45 (4.7)	36 (4.3)	s 23 (3.9)	31 (4.3)	37 (4.5)	8 (2.6)
Israel	r 6 (4.4)	19 (6.8)	45 (8.8)	29 (6.3)	r 8 (4.5)	16 (5.4)	51 (8.9)	25 (5.8)
Japan	23 (4.4)	21 (3.6)	23 (3.9)	33 (4.5)	20 (3.2)	35 (3.8)	23 (3.8)	21 (3.6)
Korea	1 (0.7)	5 (2.2)	58 (4.0)	35 (3.6)	6 (1.8)	18 (3.0)	57 (3.9)	20 (3.0)
Kuwait	r 0 (0.0)	0 (0.0)	4 (2.9)	96 (2.9)	r 0 (0.0)	0 (0.0)	26 (6.9)	74 (6.9)
Latvia (LSS)	s 5 (1.2)	11 (1.7)	43 (2.3)	41 (2.5)	s 37 (3.2)	29 (3.0)	21 (2.1)	13 (1.7)
Lithuania	r 5 (1.1)	12 (1.5)	39 (2.3)	44 (2.1)	s 39 (2.7)	14 (2.0)	33 (2.6)	13 (2.3)
Netherlands	r 36 (3.0)	34 (2.8)	29 (3.3)	1 (0.7)	r 44 (3.2)	23 (2.9)	25 (3.6)	8 (1.7)
New Zealand	3 (1.3)	10 (2.5)	50 (3.9)	37 (3.9)	12 (2.7)	17 (2.9)	58 (3.5)	12 (2.6)
Norway	s 5 (2.4)	24 (4.6)	54 (5.6)	17 (4.1)	s 7 (2.8)	27 (4.7)	53 (4.8)	13 (3.8)
Portugal	5 (1.3)	18 (2.4)	46 (3.2)	30 (2.9)	1 (0.7)	4 (1.3)	37 (3.0)	57 (3.2)
Romania	r 9 (1.4)	11 (1.7)	33 (2.7)	47 (2.9)	r 12 (1.6)	18 (1.9)	46 (2.8)	24 (2.2)
Russian Federation	1 (0.5)	4 (1.0)	29 (2.9)	66 (2.8)	1 (0.5)	5 (0.8)	30 (2.2)	65 (2.5)
Scotland	- -	- -	- -	- -	- -	- -	- -	- -
Singapore	0 (0.0)	2 (1.5)	13 (3.2)	85 (3.2)	30 (4.3)	26 (3.7)	37 (4.8)	7 (2.8)
Slovak Republic	r 11 (3.2)	20 (4.3)	46 (5.1)	22 (3.7)	r 38 (4.5)	31 (4.6)	25 (4.2)	6 (2.2)
Slovenia	r 9 (1.8)	15 (2.3)	49 (3.4)	27 (2.9)	r 36 (3.6)	37 (3.5)	24 (3.0)	3 (1.1)
Spain	r 2 (1.3)	7 (2.3)	26 (4.3)	66 (4.3)	r 2 (1.7)	6 (2.3)	40 (4.2)	51 (4.5)
Sweden	x x	x x	x x	x x	x x	x x	x x	x x
Switzerland	s 8 (2.6)	18 (4.3)	51 (5.6)	22 (4.2)	s 28 (4.4)	35 (5.1)	35 (5.6)	2 (1.8)
Thailand	r 0 (0.0)	1 (0.5)	21 (5.2)	78 (5.2)	s 9 (3.9)	18 (4.5)	47 (6.6)	26 (5.4)
United States	x x	x x	x x	x x	x x	x x	x x	x x

[1]Based on those teachers who assign homework.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

What Assessment and Evaluation Procedures Do Teachers Use?

Teachers in participating countries were asked about the importance they place on different types of assessment and how they use assessment information. Their responses to these two questions are presented in Tables 5.21 and 5.22, respectively. The weight given each type of assessment varied greatly from country to country. The most heavily weighted type of assessment was teacher-made tests requiring explanations, observations of students, and students' responses in class. One or more of these assessment types was weighted heavily for 80% or more of the students in many European and Eastern European countries. In contrast, teachers were less in agreement about assessment approaches within Canada, England, Hong Kong, Ireland, Korea, New Zealand, and Thailand, where no type of assessment was weighted heavily for as many as 80% of the students. Internationally, the least weight reportedly was given to external standardized tests. In no participating country did as many as 80% of the eighth-grade students have science teachers who reported giving quite a lot or a great deal of weight to this type of assessment.

As might be anticipated, science teachers in most countries reported using assessment information to provide grades or marks, to provide student feedback, to diagnose learning problems, and to plan future lessons. Teachers in fewer countries reported considerable use of assessment information to report to parents or for the purpose of tracking or making program assignments.

As reported in Table 5.23, eighth-grade students reported quite a lot of testing in science classes. Among countries where science is taught as an integrated subject, the majority of the students reported having frequent (pretty often or almost always) quizzes and tests in Austria, Canada, Colombia, Cyprus, England, Hong Kong, Iran, Ireland, Kuwait, Singapore, Spain, Thailand, and the United States. Where the science subjects are taught separately, the majority reported frequent quizzes and tests in Belgium (Flemish), France, Germany, Greece, Lithuania, the Netherlands, Portugal, Romania, the Russian Federation, Slovenia, Spain, and Sweden. Countries with relatively little testing in science classes included Japan and Korea (integrated science), and the Czech Republic, Denmark, Hungary, Iceland, Latvia (LSS), and the Slovak Republic (separate science subjects).

Table 5.21

Teachers' Reports on the Types of Assessment Given "Quite A Lot" or "A Great Deal" of Weight in Assessing Students' Work in Science Class - Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers Relying on Different Types of Assessment: External Standardized Tests	Teacher-Made Tests Requiring Explanations	Teacher-Made Objective Tests	Homework Assignments	Projects or Practical Exercises	Observations of Students	Students' Responses in Class
Australia	x x	x x	x x	x x	x x	x x	x x
Austria	r 5 (1.6)	r 74 (3.0)	r 20 (3.3)	s 20 (3.2)	r 41 (3.6)	r 97 (1.2)	r 84 (2.4)
Belgium (Fl)	r 11 (5.3)	r 92 (1.8)	r 28 (4.7)	r 20 (4.1)	r 39 (4.6)	r 48 (4.2)	r 50 (4.3)
Belgium (Fr)	s 6 (2.5)	s 84 (3.8)	s 33 (5.4)	s 41 (5.2)	s 34 (6.0)	s 67 (5.5)	s 61 (5.2)
Canada	r 8 (2.0)	r 75 (3.8)	r 49 (4.7)	r 50 (3.9)	r 76 (3.9)	r 36 (3.1)	r 32 (3.7)
Colombia	r 18 (3.7)	r 75 (4.3)	r 63 (4.0)	r 94 (2.1)	r 84 (3.0)	r 85 (3.0)	r 87 (3.4)
Cyprus	s 24 (4.3)	s 79 (3.4)	s 68 (4.0)	s 91 (2.6)	s 76 (4.1)	s 82 (3.4)	s 98 (1.5)
Czech Republic	r 40 (2.8)	93 (1.3)	r 37 (3.2)	10 (1.7)	r 48 (4.4)	r 72 (2.9)	94 (1.6)
Denmark	s 30 (5.5)	s 63 (5.9)	s 24 (5.6)	s 41 (5.9)	s 91 (3.1)	s 87 (4.2)	s 89 (3.7)
England	x x	s 68 (2.5)	x x	s 66 (2.6)	s 74 (2.4)	s 65 (2.9)	s 61 (3.2)
France	20 (2.6)	89 (2.1)	44 (3.7)	37 (3.7)	51 (3.7)	71 (3.6)	68 (3.9)
Germany	s 5 (2.5)	s 84 (3.5)	s 10 (2.4)	s 30 (4.4)	s 55 (4.7)	s 72 (4.9)	s 86 (2.3)
Greece	25 (3.5)	91 (2.0)	55 (4.1)	64 (3.9)	53 (4.4)	85 (2.5)	97 (1.5)
Hong Kong	22 (4.6)	49 (5.7)	78 (5.1)	53 (5.7)	41 (5.5)	43 (5.6)	43 (4.7)
Hungary	46 (2.8)	89 (1.8)	36 (2.3)	42 (2.8)	82 (2.1)	71 (2.4)	88 (1.7)
Iceland	s 5 (1.6)	s 94 (2.8)	s 55 (6.6)	s 87 (4.9)	s 48 (7.5)	s 42 (7.7)	s 43 (7.6)
Iran, Islamic Rep.	19 (3.6)	89 (2.9)	59 (6.0)	45 (5.3)	52 (5.0)	42 (5.6)	93 (2.1)
Ireland	s 28 (3.8)	s 69 (4.4)	s 32 (4.4)	s 67 (4.9)	s 63 (4.8)	s 69 (4.9)	s 76 (4.4)
Israel	s 21 (7.9)	r 69 (8.4)	r 92 (4.2)	r 35 (7.4)	r 48 (7.8)	r 60 (6.5)	r 71 (7.9)
Japan	16 (3.2)	72 (3.2)	45 (4.0)	44 (4.2)	88 (2.8)	79 (3.8)	69 (3.8)
Korea	s 23 (4.5)	s 41 (4.2)	s 41 (4.2)	s 16 (3.6)	s 55 (4.7)	s 38 (4.9)	s 38 (4.6)
Kuwait	r 22 (6.7)	r 84 (5.5)	r 90 (4.4)	r 67 (6.7)	r 52 (6.5)	r 67 (6.8)	r 85 (4.3)
Latvia (LSS)	s 62 (2.5)	s 81 (2.3)	s 65 (2.6)	s 74 (2.5)	s 89 (1.7)	s 80 (2.3)	s 97 (0.9)
Lithuania	s 15 (1.6)	s 48 (2.6)	s 29 (2.8)	s 36 (2.7)	s 41 (3.0)	s 36 (2.8)	s 82 (2.3)
Netherlands	r 60 (3.7)	r 90 (2.4)	r 64 (3.4)	r 11 (2.8)	r 25 (3.3)	r 17 (2.6)	r 14 (2.7)
New Zealand	10 (2.3)	63 (3.8)	56 (4.4)	30 (4.0)	66 (4.1)	53 (4.4)	36 (4.2)
Norway	s 6 (2.1)	s 95 (2.2)	s 8 (2.8)	s 56 (4.6)	s 68 (5.1)	s 68 (4.6)	s 74 (5.0)
Portugal	13 (2.0)	88 (1.9)	53 (2.9)	81 (2.5)	71 (2.9)	88 (2.1)	94 (1.6)
Romania	r 21 (2.2)	82 (1.8)	72 (2.1)	r 72 (2.3)	68 (2.1)	90 (1.3)	99 (0.6)
Russian Federation	- -	96 (1.3)	63 (2.9)	77 (2.9)	74 (3.0)	97 (1.1)	- -
Scotland	- -	- -	- -	- -	- -	- -	- -
Singapore	- -	80 (3.4)	61 (4.4)	48 (4.7)	77 (4.2)	47 (4.7)	46 (4.7)
Slovak Republic	r 76 (4.0)	r 97 (1.7)	r 24 (3.9)	r 27 (4.1)	r 76 (4.5)	r 93 (2.4)	r 99 (0.9)
Slovenia	r 46 (3.4)	r 89 (2.0)	r 29 (3.5)	r 39 (3.7)	r 76 (3.1)	r 76 (3.2)	r 88 (2.4)
Spain	r 8 (2.6)	r 97 (1.6)	r 43 (4.4)	r 76 (3.9)	r 62 (4.2)	r 88 (3.4)	r 92 (2.9)
Sweden	x x	x x	x x	x x	x x	x x	x x
Switzerland	s 11 (2.8)	s 88 (3.6)	s 20 (4.0)	s 13 (3.1)	s 46 (5.0)	s 54 (5.6)	s 61 (5.1)
Thailand	s 20 (5.1)	r 63 (5.9)	r 81 (4.5)	r 64 (5.7)	r 70 (5.7)	r 67 (5.7)	r 68 (5.8)
United States	x x	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.22

Teachers' Reports on Ways Assessment Information Is Used "Quite A Lot" or "A Great Deal" - Science - Upper Grade (Eighth Grade*)

Country	Percent of Students Taught by Teachers Using Assessment Information					
	To Provide Grades or Marks	To Provide Student Feedback	To Diagnose Learning Problems	To Report to Parents	To Assign Students to Programs or Tracks	To Plan for Future Lessons
Australia	x x	x x	x x	x x	x x	x x
Austria	- -	r 66 (3.3)	r 51 (3.2)	r 36 (4.3)	r 4 (1.2)	r 29 (3.0)
Belgium (Fl)	r 71 (3.6)	r 61 (5.1)	r 65 (4.8)	r 65 (4.1)	r 59 (5.0)	r 33 (5.0)
Belgium (Fr)	s 83 (4.4)	s 69 (6.2)	s 84 (5.2)	s 39 (5.4)	- -	s 73 (4.9)
Canada	r 90 (3.0)	r 82 (2.6)	r 55 (4.3)	r 78 (3.2)	s 29 (4.0)	r 59 (4.1)
Colombia	r 70 (4.5)	r 95 (2.0)	r 85 (3.4)	r 54 (4.8)	r 22 (4.4)	r 86 (3.4)
Cyprus	s 93 (2.0)	s 85 (2.9)	s 95 (2.4)	s 83 (3.0)	s 63 (4.8)	s 84 (3.2)
Czech Republic	94 (1.4)	r 92 (1.8)	97 (0.9)	r 53 (3.1)	r 19 (3.1)	r 79 (2.7)
Denmark	s 41 (5.5)	s 75 (5.7)	s 50 (6.0)	s 36 (6.2)	s 67 (6.1)	s 83 (5.0)
England	x x	x x	x x	x x	x x	x x
France	91 (1.8)	92 (1.9)	91 (1.7)	52 (3.4)	38 (3.8)	72 (3.4)
Germany	s 81 (3.4)	s 83 (3.5)	s 82 (3.5)	s 41 (4.4)	s 20 (3.6)	s 72 (4.1)
Greece	95 (1.7)	88 (2.6)	93 (2.0)	91 (2.1)	35 (4.3)	72 (3.5)
Hong Kong	73 (5.5)	64 (5.0)	74 (3.8)	13 (4.1)	5 (2.5)	63 (5.4)
Hungary	58 (2.6)	67 (2.4)	90 (1.7)	84 (1.9)	85 (1.7)	72 (2.1)
Iceland	s 73 (7.4)	s 67 (5.5)	s 55 (5.9)	s 43 (5.3)	s 6 (2.9)	s 70 (7.3)
Iran, Islamic Rep.	85 (3.4)	r 63 (4.6)	73 (5.7)	61 (4.6)	52 (5.6)	73 (3.8)
Ireland	s 60 (4.0)	s 81 (3.4)	s 77 (4.2)	s 70 (4.0)	s 31 (4.5)	s 75 (3.9)
Israel	r 85 (6.9)	s 74 (8.9)	r 82 (7.2)	s 78 (5.8)	r 59 (8.6)	r 91 (4.9)
Japan	79 (3.6)	68 (4.3)	64 (4.5)	15 (2.9)	16 (3.0)	54 (4.4)
Korea	44 (4.1)	34 (3.9)	50 (4.0)	6 (1.8)	4 (1.6)	41 (3.9)
Kuwait	r 83 (6.7)	r 69 (7.6)	r 76 (6.2)	r 47 (8.3)	r 76 (6.7)	r 83 (6.3)
Latvia (LSS)	s 93 (1.4)	s 91 (1.5)	s 92 (1.7)	s 22 (1.8)	s 47 (2.4)	s 91 (1.7)
Lithuania	r 80 (1.9)	r 55 (2.5)	r 56 (2.9)	r 42 (2.5)	r 35 (2.6)	r 73 (2.5)
Netherlands	r 91 (2.1)	r 57 (4.2)	r 42 (3.6)	r 55 (3.5)	r 58 (3.6)	r 42 (3.7)
New Zealand	91 (2.4)	83 (3.3)	59 (4.1)	84 (2.9)	21 (3.0)	58 (3.7)
Norway	s 70 (4.9)	s 63 (5.2)	s 24 (4.3)	s 15 (3.2)	s 15 (3.2)	s 61 (5.1)
Portugal	92 (1.9)	87 (1.9)	97 (1.1)	63 (3.3)	37 (3.0)	89 (1.9)
Romania	97 (0.8)	86 (1.9)	r 90 (1.3)	70 (2.3)	75 (2.2)	90 (1.6)
Russian Federation	94 (1.5)	81 (2.4)	95 (1.2)	29 (2.6)	77 (2.5)	95 (1.4)
Scotland	- -	- -	- -	- -	- -	- -
Singapore	76 (4.1)	88 (3.2)	82 (3.7)	33 (4.2)	31 (4.3)	73 (4.2)
Slovak Republic	r 80 (4.4)	r 85 (3.5)	r 83 (3.7)	r 63 (4.9)	r 13 (2.9)	r 76 (4.0)
Slovenia	r 66 (3.2)	r 95 (1.4)	r 87 (2.4)	r 61 (3.3)	r 30 (2.8)	r 83 (2.7)
Spain	r 95 (1.9)	r 89 (3.0)	r 92 (2.6)	r 91 (2.6)	r 64 (4.1)	r 90 (3.1)
Sweden	x x	x x	x x	x x	x x	x x
Switzerland	s 79 (4.4)	s 85 (3.8)	s 71 (4.5)	s 32 (4.8)	s 18 (4.0)	s 69 (5.1)
Thailand	r 73 (5.1)	r 84 (4.7)	r 86 (4.8)	r 47 (6.1)	r 76 (4.3)	r 88 (4.4)
United States	x x	x x	x x	x x	x x	x x

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (-) indicates data are not available.
An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students.
An "x" indicates teacher response data available for <50% of students.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 5.23

Students' Reports on Frequency of Having a Quiz or Test in Their Science Lessons[1] - Upper Grade (Eighth Grade*)

	Country	Percent of Students Responding Pretty Often or Almost Always				
		Science (Integrated)	Science Subject Areas			
			Biology	Chemistry	Earth Science	Physics
	Australia	44 (1.2)	. .	. .	. .	. .
	Austria	75 (1.5)	. .	. .	. .	. .
	Belgium (Fl)	. .	71 (2.0)	. .	68 (1.8)	x x
2	**Belgium (Fr)**	x x	x x	. .	. .	x x
	Canada	60 (1.4)	. .	. .	. .	. .
	Colombia	75 (1.9)	. .	. .	. .	. .
	Cyprus	78 (1.1)	. .	. .	. .	. .
	Czech Republic	. .	32 (2.3)	37 (2.1)	30 (1.7)	34 (1.8)
3	*Denmark*	. .	27 (1.9)	. .	r 32 (1.6)	48 (1.9)
	England	54 (2.0)	. .	. .	. .	. .
4	**France**	. .	67 (1.7)	. .	. .	83 (1.4)
	Germany	. .	57 (2.2)	x x	. .	50 (2.1)
	Greece	. .	. .	57 (1.3)	51 (1.2)	56 (1.2)
	Hong Kong	62 (2.6)	. .	. .	. .	. .
	Hungary	. .	21 (1.4)	25 (1.3)	19 (1.1)	24 (1.3)
	Iceland	. .	16 (2.5)	x x	x x	x x
	Iran, Islamic Rep.	66 (1.4)	. .	. .	. .	. .
	Ireland	50 (1.5)	. .	. .	. .	. .
	Israel	47 (2.9)	. .	. .	. .	. .
	Japan	32 (2.2)	. .	. .	. .	. .
	Korea	22 (1.3)	. .	. .	. .	. .
	Kuwait	66 (1.9)	. .	. .	. .	. .
	Latvia (LSS)	. .	26 (1.5)	20 (1.1)	. .	16 (1.1)
	Lithuania	. .	55 (2.2)	67 (1.6)	50 (2.2)	69 (1.4)
5	*Netherlands*	. .	r 54 (2.7)	. .	50 (2.5)	45 (1.9)
	New Zealand	49 (1.7)	. .	. .	. .	. .
	Norway	45 (1.7)	. .	. .	. .	. .
6	**Portugal**	. .	57 (1.4)	. .	. .	53 (1.3)
	Romania	. .	73 (1.3)	76 (1.2)	73 (1.4)	75 (1.1)
	Russian Federation	. .	57 (2.1)	73 (1.4)	57 (1.1)	74 (1.0)
	Scotland	46 (1.4)	. .	. .	. .	. .
	Singapore	74 (1.4)	. .	. .	. .	. .
	Slovak Republic	. .	30 (1.8)	48 (2.3)	29 (2.1)	38 (1.6)
	Slovenia	. .	44 (1.9)	52 (1.9)	. .	53 (1.9)
	Spain	75 (1.4)	. .	. .	. .	. .
	Sweden	. .	60 (1.9)	x x	r 66 (1.5)	r 63 (2.0)
	Switzerland	49 (1.4)	. .	. .	. .	. .
	Thailand	62 (1.5)	. .	. .	. .	. .
	United States	77 (1.4)	. .	. .	. .	. .

[1]Countries administered either an integrated science or separate subject area form of the questionnaire. A dot (.) denotes questions not administered by design. Percentages for separate science subject areas are based only on those students taking each subject.
[2]Data for Belgium (Fr) are reported for students in both integrated science classes and separate biology and physics classes.
[3]Physics data for Denmark are for students taking physics/chemistry classes.
[4]Biology data for France are for students taking biology/geology classes; physics data are for students taking physics/chemistry classes.
[5]Physics data for the Netherlands include students in both physics classes and physics/chemistry classes.
[6]Biology data for Portugal are for students taking natural science classes; physics data are for students taking physical science classes.
*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3). Background data for Bulgaria and South Africa are unavailable.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate. An "x" indicates a <50% student response rate.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix A

Overview of TIMSS Procedures: Science Achievement Results for Seventh- and Eighth-Grade Students

History

TIMSS represents the continuation of a long series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). Since its inception in 1959, the IEA has conducted more than 15 studies of cross-national achievement in curricular areas such as mathematics, science, language, civics, and reading. IEA conducted its First International Science Study (FISS) in 1970-71, and the Second International Science Study (SISS) in 1983-84. The First and Second International Mathematics Studies (FIMS and SIMS) were conducted in 1964 and 1980-82, respectively. Since the subjects of mathematics and science are related in many respects, the third studies were conducted together as an integrated effort.[1]

The number of participating countries and the inclusion of both mathematics and science resulted in TIMSS becoming the largest, most complex IEA study to date and the largest international study of educational achievement ever undertaken. Traditionally, IEA studies have systematically worked toward gaining more in-depth understanding of how various factors contribute to the overall outcomes of schooling. Particular emphasis has been given to refining our understanding of students' opportunity to learn as this opportunity becomes successively defined and implemented by curricular and instructional practices. In an effort to extend what had been learned from previous studies and provide contextual and explanatory information, the magnitude of TIMSS expanded beyond the already substantial task of measuring achievement in two subject areas to also include a thorough investigation of curriculum and how it is delivered in classrooms around the world.

The Components of TIMSS

Continuing the approach of previous IEA studies, TIMSS addressed three conceptual levels of curriculum. The **intended curriculum** is composed of the mathematics and science instructional and learning goals as defined at the system level. The **implemented curriculum** is the mathematics and science curriculum as interpreted by teachers and made available to students. The **attained curriculum** is the mathematics and science content that students have learned and their attitudes towards these subjects. To aid in meaningful interpretation and comparison of results, TIMSS

[1] Because a substantial amount of time has elapsed since earlier IEA studies in mathematics and science, curriculum and testing methods in these two subjects have undergone many changes. Since TIMSS has devoted considerable energy toward reflecting the most current educational and measurement practices, changes in items and methods as well as differences in the populations tested make comparisons of TIMSS results with those of previous studies very difficult. The focus of TIMSS is not on measuring achievement trends, but rather on providing up-to-date information about the current quality of education in mathematics and science.

also collected extensive information about the social and cultural contexts for learning, many of which are related to variation among different educational systems.

Even though slightly fewer countries completed all the steps necessary to have their data included in this report, nearly 50 countries participated in one or more of the various components of the TIMSS data collection effort, including the curriculum analysis. To gather information about the intended curriculum, mathematics and science specialists within each participating country worked section-by-section through curriculum guides, textbooks, and other curricular materials to categorize aspects of these materials in accordance with detailed specifications derived from the TIMSS mathematics and science curriculum frameworks.[2] Initial results from this component of TIMSS can be found in two companion volumes: *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intention in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* [3] This component of TIMSS is conducted by researchers at Michigan State University.

To measure the attained curriculum, TIMSS tested more than half a million students in mathematics and science at five grade levels. TIMSS included testing at three separate populations:

Population 1. Students enrolled in the two adjacent grades that contained the largest proportion of 9-year-old students at the time of testing – third- and fourth-grade students in most countries.

Population 2. Students enrolled in the two adjacent grades that contained the largest proportion of 13-year-old students at the time of testing – seventh- and eighth-grade students in most countries.

Population 3. Students in their final year of secondary education. As an additional option, countries could test two special subgroups of these students:

1) Students taking advanced courses in mathematics,
2) Students taking physics.

Countries participating in the study were required to administer tests to the students in the two grades at Population 2, but could choose whether or not to participate at the other levels. In about half of the countries at Populations 1 and 2, subsets of the upper-grade students who completed the written tests also participated in a performance assessment. In the performance assessment, students engaged in a number of hands-on mathematics and science activities. The students designed experiments, tested

[2] Robitaille, D.F., McKnight, C., Schmidt, W., Britton, E., Raizen, S., and Nicol, C. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science.* Vancouver, B.C.: Pacific Educational Press.

[3] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics.* Dordrecht, The Netherlands: Kluwer Academic Publishers. Schmidt, W.H., Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G., (in press). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, The Netherlands: Kluwer Academic Publishers.

hypotheses, and recorded their findings. For example, in one task, students were asked to design and conduct a controlled experiment to measure the effect of water temperature on the rate at which tablets dissolve, requiring organization and interpretation of data to draw conclusions and explain results. Figure A.1 shows the countries that participated in the various components of TIMSS achievement testing.

TIMSS also administered a broad array of questionnaires to collect data about how the curriculum is implemented in classrooms, including the instructional practices used to deliver it. The questionnaires also were used to collect information about the social and cultural contexts for learning. Questionnaires were administered at the **country level** about decision-making and organizational features within their educational systems. The **students** who were tested answered questions pertaining to their attitudes towards mathematics and science, classroom activities, home background, and out-of-school activities. The mathematics and science **teachers** of sampled students responded to questions about teaching emphasis on the topics in the curriculum frameworks, instructional practices, textbook usage, professional training and education, and their views on mathematics and science. The heads of **schools** responded to questions about school staffing and resources, mathematics and science course offerings, and teacher support. In addition, a volume was compiled that presents descriptions of the educational systems of the participating countries.[4]

With its enormous array of data, TIMSS has numerous possibilities for policy-related research, focused studies related to students' understandings of mathematics and science subtopics and processes, and integrated analyses linking the various components of TIMSS. The initial round of reports is only the beginning of a number of research efforts and publications aimed at increasing our understanding of how mathematics and science education functions across countries, investigating what impacts student performance, and helping to improve mathematics and science education.

[4] Robitaille D.F. (in press). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*. Vancouver, B.C.: Pacific Educational Press.

Figure A.1

Countries Participating in Additional Components of TIMSS Testing

Country	Population 1		Population 2		Population 3		
	Written Test	Performance Assessment	Written Test	Performance Assessment	Mathematics & Science Literacy	Advanced Mathematics	Physics
Argentina			○				
Australia	○	○	○	○	○	○	○
Austria	○		○		○	○	○
Belgium (Fl)			○				
Belgium (Fr)			○				
Bulgaria			○				
Canada	○	○	○	○	○	○	○
Colombia			○	○			
Cyprus	○	○	○	○	○	○	○
Czech Republic	○	○	○	○	○	○	○
Denmark			○	○	○	○	○
England	○		○	○			
France			○		○	○	○
Germany			○		○	○	○
Greece	○		○		○	○	○
Hong Kong	○	○	○	○			
Hungary	○		○		○		
Iceland	○		○		○		
Indonesia	○		○				
Iran, Islamic Rep.	○	○	○	○			
Ireland	○		○				
Israel	○	○	○	○	○	○	○
Italy	○		○		○		
Japan	○		○				○
Korea	○		○				
Kuwait	○		○				
Latvia	○		○				○
Lithuania			○		○	○	
Mexico	○		○		○	○	○
Netherlands	○		○		○		
New Zealand	○	○	○	○	○		
Norway	○		○	○	○		○
Philippines			○				
Portugal	○	○	○	○			
Romania			○	○			
Russian Federation			○		○	○	○
Scotland	○		○	○			
Singapore	○		○	○			
Slovak Republic			○				
Slovenia	○	○	○	○	○	○	○
South Africa			○		○		
Spain			○	○			
Sweden			○	○	○	○	○
Switzerland			○	○	○	○	○
Thailand	○		○				
United States	○	○	○	○	○	○	○

Developing the TIMSS Science Test

The TIMSS curriculum framework underlying the science tests at all three populations was developed by groups of science educators with input from the TIMSS National Research Coordinators (NRCs). As shown in Figure A.2, the science curriculum framework contains three dimensions or aspects. The **content** aspect represents the subject matter content of school science. The **performance expectations** aspect describes, in a non-hierarchical way, the many kinds of performances or behaviors that might be expected of students in school science. The **perspectives** aspect focuses on the development of students' attitudes, interest, and motivations in science.[5]

Working within the science curriculum framework, science test specifications were developed for Population 2 that included items representing a wide range of science topics and eliciting a range of skills from the students. The tests were developed through an international consensus involving input from experts in science and measurement specialists. The TIMSS Subject Matter Advisory Committee, including distinguished scholars from 10 countries, ensured that the test reflected current thinking and priorities in the sciences. The items underwent an iterative development and review process, with one of the pilot testing efforts involving 43 countries. Every effort was made to help ensure that the tests represented the curricula of the participating countries and that the items did not exhibit any bias towards or against particular countries, including modifying specifications in accordance with data from the curriculum analysis component, obtaining ratings of the items by subject-matter specialists within the participating countries, and conducting thorough statistical item analysis of data collected in the pilot testing. The final forms of the test were endorsed by the NRCs of the participating countries.[6] In addition, countries had an opportunity to match the content of the test to their curricula at the seventh and eighth grades. They identified items measuring topics not covered in their intended curriculum. The information from this Test-Curriculum Matching Analysis indicates that omitting such items has little effect on the overall pattern of results (see Appendix B).

Table A.1 presents the five content areas included in the Population 2 science test and the numbers of items and score points in each category. Distributions also are included for the five performance categories derived from the performance expectations aspect of the curriculum framework. Approximately one-fourth of the items were in the free-response format, requiring students to generate and write their own answers. Designed to represent approximately one-third of students' response time, some free-response questions asked for short answers while others required extended

[5] The complete TIMSS curriculum frameworks can be found in Robitaille, D.F. et al. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science*. Vancouver, B.C.: Pacific Educational Press.

[6] For a full discussion of the TIMSS test development effort, please see: Garden, R.A. and Orpwood, G. (1996). "TIMSS Test Development" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College; and Garden, R.A. (1996). "Development of the TIMSS Achievement Items" in D.F. Robitaille and R.A. Garden (eds.), *TIMSS Monograph No.2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Educational Press.

Figure A.2

The Three Aspects and Major Categories of the Science Framework

Content

- Earth sciences
- Life sciences
- Physical sciences
- Science, technology, and mathematics
- History of science and technology
- Environmental issues
- Nature of science
- Science and other disciplines

Performance Expectations

- Understanding
- Theorizing, analyzing, and solving problems
- Using tools, routine procedures and science processes
- Investigating the natural world
- Communicating

Perspectives

- Attitudes
- Careers
- Participation
- Increasing interest
- Safety
- Habits of mind

Table A.1

Distribution of Science Items by Content Reporting Category and Performance Category - Population 2

Content Category	Percentage of Items	Total Number of Items	Number of Multiple-Choice Items	Number of Free-Response Items[1]	Number of Score Points[2]
Earth Science	16	22	17	5	24
Life Science	30	40	31	9	44
Physics	30	40	28	12	42
Chemistry	14	19	15	4	21
Environmental Issues and the Nature of Science	10	14	11	3	15

Performance Category	Percentage of Items	Total Number of Items	Number of Multiple-Choice Items	Number of Free-Response Items[1]	Number of Score Points[2]
Understanding Simple Information	40	55	53	2	55
Understanding Complex Information	29	39	29	10	41
Theorizing, Analyzing, and Solving Problems	21	28	9	19	36
Using Tools, Routine Procedures, and Science Processes	6	8	8	0	8
Investigating the Natural World	4	5	3	2	6

[1]Free-Response Items include both short-answer and extended-response types.
[2]In scoring the tests correct answers to most items were worth one point. However, responses to some constructed-response items were evaluated for partial credit with a fully correct answer awarded up to three points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

responses where students needed to show their work or provide explanations for their answers. The remaining questions used a multiple-choice format. In scoring the tests, correct answers to most questions were worth one point. Consistent with the approach of allotting students longer response time for the constructed-response questions than for multiple-choice questions, however, responses to some of these questions (particularly those requiring extended responses) were evaluated for partial credit with a fully correct answer being awarded two or even three points (see later section on scoring). This, in addition to the fact that several items had two parts, means that the total number of score points available for analysis somewhat exceeds the number of items included in the test.

The TIMSS instruments were prepared in English and translated into 30 additional languages. In addition, it sometimes was necessary to adapt the international versions for cultural purposes, including the 11 countries that tested in English. This process represented an enormous effort for the national centers, with many checks along the way. The translation effort included: (1) developing explicit guidelines for translation and cultural adaptation, (2) translation of the instruments by the national centers in accordance with the guidelines and using two or more independent translations, (3) consultation with subject-matter experts regarding cultural adaptations to ensure that the meaning and difficulty of items did not change, (4) verification of the quality of the translations by professional translators from an independent translation company, (5) corrections by the national centers in accordance with the suggestions made, (6) verification that corrections were implemented, and (7) a series of statistical checks after the testing to detect items that did not perform comparably across countries.[7]

[7] More details about the translation verification procedures can be found in Mullis, I.V.S., Kelly, D.L., and Haley, K. (1996). "Translation Verification Procedures" in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College; and Maxwell, B. (1996). "Translation and Cultural Adaptation of the TIMSS Instruments" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study: Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

TIMSS Test Design

Not all of the students in Population 2 responded to all of the science items. To ensure broad subject matter coverage without overburdening individual students, TIMSS used a rotated design that included both the mathematics and science items. Thus, the same students participated in both the mathematics and science testing. The TIMSS Population 2 test consisted of eight booklets, with each booklet requiring 90 minutes of student response time. In accordance with the design, the mathematics and science items were assembled into 26 different clusters (labeled A through Z). Eight of the clusters were designed to take students 12 minutes to complete; 10 of the clusters, 22 minutes; and 8 clusters, 10 minutes. In all, the design provided a total of 396 unique testing minutes, 198 for mathematics and 198 for science. Cluster A was a core cluster assigned to all booklets. The remaining clusters were assigned to the booklets in accordance with the rotated design so that representative samples of students responded to each cluster.[8]

Sample Implementation and Participation Rates

The selection of valid and efficient samples is crucial to the quality and success of an international comparative study such as TIMSS. The accuracy of the survey results depends on the quality of sampling information available and on the quality of the sampling activities themselves. For TIMSS, NRCs worked on all phases of sampling with staff from Statistics Canada. NRCs received training in how to select the school and student samples and in the use of the sampling software. In consultation with the TIMSS sampling referee (Keith Rust, WESTAT, Inc.), staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample execution. This documentation was used by the International Study Center in consultation with Statistics Canada, the sampling referee, and the Technical Advisory Committee, to evaluate the quality of the samples.

In a few situations where it was not possible to implement TIMSS testing for the entire internationally desired definition of Population 2 (all students in the two adjacent grades with the greatest proportion of 13-year-olds), countries were permitted to define a national desired population that did not include part of the internationally desired population. Table A.2 shows any differences in coverage between the international and national desired populations. Most participants achieved 100% coverage (36 out of 42). The countries with less than 100% coverage are annotated in tables in this report. In some instances, countries, as a matter of practicality, needed to define their tested population according to the structure of school systems, but in Germany and Switzerland, parts of the country were simply unwilling to take part

[8] The design is fully documented in Adams, R. and Gonzalez, E. (1996). "Design of the TIMSS Achievement Instruments" in D.F. Robitaille and R.A. Garden (eds.), *TIMSS Monograph No. 2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Education Press and Adams, R. and Gonzalez, E. (1996). "TIMSS Test Design" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table A.2

Coverage of TIMSS Target Population

The International Desired Population is defined as follows:
Population 2 - All students enrolled in the two adjacent grades with the largest proportion of 13-year-old students at the time of testing.

Country	International Desired Population		National Desired Population		
	Coverage	Notes on Coverage	School-Level Exclusions	Within-Sample Exclusions	Overall Exclusions
Australia	100%		0.2%	0.7%	0.8%
Austria	100%		2.9%	0.2%	3.1%
Belgium (Fl)	100%		3.8%	0.0%	3.8%
Belgium (Fr)	100%		4.5%	0.0%	4.5%
Bulgaria	100%		0.6%	0.0%	0.6%
Canada	100%		2.4%	2.1%	4.5%
Colombia	100%		3.8%	0.0%	3.8%
Cyprus	100%		0.0%	0.0%	0.0%
Czech Republic	100%		4.9%	0.0%	4.9%
Denmark	100%		0.0%	0.0%	0.0%
[2] England	100%		8.4%	2.9%	11.3%
France	100%		2.0%	0.0%	2.0%
[1] Germany	88%	15 of 16 regions*	8.8%	0.9%	9.7%
Greece	100%		1.5%	1.3%	2.8%
Hong Kong	100%		2.0%	0.0%	2.0%
Hungary	100%		3.8%	0.0%	3.8%
Iceland	100%		1.7%	2.9%	4.5%
Iran, Islamic Rep.	100%		0.3%	0.0%	0.3%
Ireland	100%		0.0%	0.4%	0.4%
[1] Israel	74%	Hebrew Public Education System	3.1%	0.0%	3.1%
Japan	100%		0.6%	0.0%	0.6%
Korea	100%		2.2%	1.6%	3.8%
Kuwait	100%		0.0%	0.0%	0.0%
[1] Latvia (LSS)	51%	Latvian-speaking schools	2.9%	0.0%	2.9%
[1] Lithuania	84%	Lithuanian-speaking schools	6.6%	0.0%	6.6%
Netherlands	100%		1.2%	0.0%	1.2%
New Zealand	100%		1.3%	0.4%	1.7%
Norway	100%		0.3%	1.9%	2.2%
Philippines	91%	2 provinces and autonomous regions excluded	6.5%	0.0%	6.5%
Portugal	100%		0.0%	0.3%	0.3%
Romania	100%		2.8%	0.0%	2.8%
Russian Federation	100%		6.1%	0.2%	6.3%
Scotland	100%		0.3%	1.9%	2.2%
Singapore	100%		4.6%	0.0%	4.6%
Slovak Republic	100%		7.4%	0.1%	7.4%
Slovenia	100%		2.4%	0.2%	2.6%
South Africa	100%		9.6%	0.0%	9.6%
Spain	100%		6.0%	2.7%	8.7%
Sweden	100%		0.0%	0.9%	0.9%
[1] Switzerland	86%	22 of 26 cantons	4.4%	0.8%	5.3%
Thailand	100%		6.2%	0.0%	6.2%
United States	100%		0.4%	1.7%	2.1%

[1]National Desired Population does not cover all of International Desired Population. Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population.
* One region (Baden-Wuerttemberg) did not participate.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

in TIMSS. Because coverage fell below 65% for Latvia, the Latvian results have been labeled "Latvia (LSS)," for Latvian Speaking Schools, throughout the report.

Within the desired population, countries could define a population that excluded a small percent (less than 10%) of certain kinds of schools or students that would be very difficult or resource intensive to test (e. g., schools for students with special needs or schools that were very small or located in extremely remote areas). Table A.2 also shows that the degree of such exclusions was small. Only England exceeded the 10% limit, and this is annotated in the tables in this report.

Countries were required to test the two adjacent grades with the greatest proportion of 13-year-olds. Table A.3 presents, for each country, the percentage of 13-year-olds in the lower grade tested, the percentage in the upper grade, and the percentage in both the upper and lower grades combined.

Within countries, TIMSS used a two-stage sample design at Population 2, where the first stage involved selecting 150 public and private schools within each country. Within each school, the basic approach required countries to use random procedures to select one mathematics class at the eighth grade and one at the seventh grade (or the corresponding upper and lower grades in that country). All of the students in those two classes were to participate in the TIMSS testing. This approach was designed to yield a representative sample of 7,500 students per country, with approximately 3,750 students at each grade.[9] Typically, between 450 and 3,750 students responded to each item at each grade level, depending on the booklets in which the items were located.

Countries were required to obtain a participation rate of at least 85% of both the schools and the students, or a combined rate (the product of school and student participation) of 75%. Tables A.4 through A.8 present the participation rates and achieved sample sizes for the eighth and seventh grades.

[9] The sample design for TIMSS is described in detail in Foy, P., Rust, K. and Schleicher, A. (1996). "TIMSS Sample Design" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table A.3

Coverage of 13-Year-Old Students

Country	Percent of 13-Year-Olds in Lower Grade (Seventh Grade*)	Percent of 13-Year-Olds in Upper Grade (Eighth Grade*)	Percent of 13-Year-Olds in Both Grades
Australia	64	28	92
Austria	62	27	89
Belgium (Fl)	46	49	94
Belgium (Fr)	41	46	87
Bulgaria	58	37	95
Canada	48	43	91
Colombia	30	15	45
Cyprus	28	70	98
Czech Republic	73	17	90
Denmark	35	64	98
England	57	42	99
France	44	35	78
Germany	71	2	73
Greece	11	85	96
Hong Kong	44	46	90
Hungary	65	24	89
Iceland	16	83	100
Iran, Islamic Rep.	47	25	72
Ireland	69	17	86
Israel	–	–	–
Japan	91	9	100
Korea	70	28	98
Kuwait	–	–	–
Latvia (LSS)	60	26	86
Lithuania	64	26	90
Netherlands	59	31	90
New Zealand	52	47	99
Norway	43	57	100
Philippines	–	–	–
Portugal	44	32	76
Romania	67	9	76
Russian Federation	50	44	95
Scotland	24	75	99
Singapore	82	15	97
Slovak Republic	73	22	95
Slovenia	65	2	67
South Africa	36	20	55
Spain	46	39	85
Sweden	45	54	99
Switzerland	48	44	92
Thailand	58	20	78
United States	58	33	91

*Seventh and eighth grades in most countries; see Table 2 for more information about the grades tested in each country.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower (seventh) grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.4

School Participation Rates and Sample Sizes - Upper Grade (Eighth Grade*)

Country	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	75	77	214	214	158	3	161
Austria	41	84	159	159	62	62	124
Belgium (Fl)	61	94	150	150	92	49	141
Belgium (Fr)	57	79	150	150	85	34	119
Bulgaria	72	74	167	167	111	4	115
Canada	90	91	413	388	363	1	364
Colombia	91	93	150	150	136	4	140
Cyprus	100	100	55	55	55	0	55
Czech Republic	96	100	150	149	143	6	149
Denmark	93	93	158	157	144	0	144
England	56	85	150	144	80	41	121
France	86	86	151	151	127	0	127
Germany	72	93	153	150	102	32	134
Greece	87	87	180	180	156	0	156
Hong Kong	82	82	105	104	85	0	85
Hungary	100	100	150	150	150	0	150
Iceland	98	98	161	132	129	0	129
Iran, Islamic Rep.	100	100	192	191	191	0	191
Ireland	84	89	150	149	125	7	132
Israel	45	46	100	100	45	1	46
Japan	92	95	158	158	146	5	151
Korea	100	100	150	150	150	0	150
Kuwait	100	100	69	69	69	0	69
Latvia (LSS)	83	83	170	169	140	1	141
Lithuania	96	96	151	151	145	0	145
Netherlands	24	63	150	150	36	59	95
New Zealand	91	99	150	150	137	12	149
Norway	91	97	150	150	136	10	146
Philippines	96 **	97 **	200	200	192	1	193
Portugal	95	95	150	150	142	0	142
Romania	94	94	176	176	163	0	163
Russian Federation	97	100	175	175	170	4	174
Scotland	79	83	153	153	119	8	127
Singapore	100	100	137	137	137	0	137
Slovak Republic	91	97	150	150	136	9	145
Slovenia	81	81	150	150	121	0	121
South Africa	60	64	180	180	107	7	114
Spain	96	100	155	154	147	6	153
Sweden	97	97	120	120	116	0	116
Switzerland	93	95	259	258	247	3	250
Thailand	99	99	150	150	147	0	147
United States	77	85	220	217	169	14	183

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table A.5

Student Participation Rates and Sample Sizes - Upper Grade (Eighth Grade*)

Country	Within School Student Participation (Weighted Percentage)	Number of Sampled Students in Participating Schools	Number of Students Withdrawn from Class/School	Number of Students Excluded	Number of Students Eligible	Number of Students Absent	Total Number of Students Assessed
Australia	92	8027	63	61	7903	650	7253
Austria	95	2969	14	4	2951	178	2773
Belgium (Fl)	97	2979	1	0	2978	84	2894
Belgium (Fr)	91	2824	0	1	2823	232	2591
Bulgaria	86	2300	0	0	2300	327	1973
Canada	93	9240	134	206	8900	538	8362
Colombia	94	2843	6	0	2837	188	2649
Cyprus	97	3045	15	0	3030	107	2923
Czech Republic	92	3608	6	0	3602	275	3327
Denmark	93	2487	0	0	2487	190	2297
England	91	2015	37	60	1918	142	1776
France	95	3141	0	0	3141	143	2998
Germany	87	3318	0	35	3283	413	2870
Greece	97	4154	27	23	4104	114	3990
Hong Kong	98	3415	12	0	3403	64	3339
Hungary	87	3339	0	0	3339	427	2912
Iceland	90	2025	10	65	1950	177	1773
Iran, Islamic Rep.	98	3770	20	0	3750	56	3694
Ireland	91	3411	28	10	3373	297	3076
Israel	98	1453	6	0	1447	32	1415
Japan	95	5441	0	0	5441	300	5141
Korea	95	2998	31	0	2967	47	2920
Kuwait	83	1980	3	0	1977	322	1655
Latvia (LSS)	90	2705	19	0	2686	277	2409
Lithuania	87	2915	2	0	2913	388	2525
Netherlands	95	2112	14	1	2097	110	1987
New Zealand	94	4038	121	12	3905	222	3683
Norway	96	3482	26	49	3407	140	3267
Philippines	91 **	6586	93	0	6493	492	6001
Portugal	97	3589	70	13	3506	115	3391
Romania	96	3899	0	0	3899	174	3725
Russian Federation	95	4311	42	10	4259	237	4022
Scotland	88	3289	0	46	3243	380	2863
Singapore	95	4910	18	0	4892	248	4644
Slovak Republic	95	3718	5	3	3710	209	3501
Slovenia	95	2869	15	8	2846	138	2708
South Africa	97	4793	0	0	4793	302	4491
Spain	95	4198	27	102	4069	214	3855
Sweden	93	4483	71	28	4384	309	4075
Switzerland	98	4989	16	24	4949	94	4855
Thailand	100	5850	0	0	5850	0	5850
United States	92	8026	104	108	7814	727	7087

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.6

School Participation Rates and Sample Sizes - Lower Grade (Seventh Grade*)

Country	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	75	76	214	213	156	3	159
Austria	43	86	159	159	63	62	125
Belgium (Fl)	61	93	150	150	91	49	140
Belgium (Fr)	57	80	150	150	85	35	120
Bulgaria	75	77	150	150	101	3	104
Canada	90	90	413	390	366	1	367
Colombia	91	93	150	150	136	4	140
Cyprus	100	100	55	55	55	0	55
Czech Republic	96	100	150	150	144	6	150
Denmark	88	88	158	154	137	0	137
England	57	85	150	145	81	41	122
France	87	87	151	151	126	0	126
Germany	70	90	153	153	101	31	132
Greece	87	87	180	180	156	0	156
Hong Kong	83	83	105	104	86	0	86
Hungary	99	99	150	150	149	0	149
Iceland	97	97	161	149	144	0	144
Iran, Islamic Rep.	100	100	192	192	192	0	192
Ireland	82	87	150	148	122	7	129
Israel	–	–	–	–	–	–	–
Japan	92	95	158	158	146	5	151
Korea	100	100	150	150	150	0	150
Kuwait	–	–	–	–	–	–	–
Latvia (LSS)	83	84	170	169	141	1	142
Lithuania	96	96	151	151	145	0	145
Netherlands	23	61	150	150	34	58	92
New Zealand	90	99	150	150	135	13	148
Norway	84	96	150	147	124	17	141
Philippines	97 **	97 **	200	200	194	0	194
Portugal	94	94	150	150	141	0	141
Romania	94	94	176	175	162	0	162
Russian Federation	97	100	175	175	170	4	174
Scotland	79	85	153	153	120	9	129
Singapore	100	100	137	137	137	0	137
Slovak Republic	91	97	150	150	136	9	145
Slovenia	81	81	150	150	122	0	122
South Africa	83	85	161	161	133	4	137
Spain	96	100	155	154	147	6	153
Sweden	96	96	160	160	154	0	154
Switzerland	90	94	217	217	200	6	206
Thailand	99	99	150	150	146	0	146
United States	77	84	220	214	165	14	179

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.

**Participation rates for the Philippines are unweighted.

A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.7

Student Participation Rates and Sample Sizes - Lower Grade (Seventh Grade*)

Country	Within School Student Participation (Weighted Percentage)	Number of Sampled Students in Participating Schools	Number of Students Withdrawn from Class/School	Number of Students Excluded	Number of Students Eligible	Number of Students Absent	Total Number of Students Assessed
Australia	93	6067	26	21	6020	421	5599
Austria	95	3196	22	5	3169	156	3013
Belgium (Fl)	97	2857	3	0	2854	86	2768
Belgium (Fr)	95	2418	0	1	2417	125	2292
Bulgaria	87	2080	0	0	2080	282	1798
Canada	95	8962	89	248	8625	406	8219
Colombia	93	2840	2	0	2838	183	2655
Cyprus	98	3028	17	0	3011	82	2929
Czech Republic	92	3641	11	0	3630	285	3345
Denmark	86	2408	0	0	2408	335	2073
England	92	2031	31	67	1933	130	1803
France	95	3164	0	0	3164	148	3016
Germany	87	3388	0	37	3351	458	2893
Greece	97	4166	30	78	4058	127	3931
Hong Kong	98	3507	11	0	3496	83	3413
Hungary	94	3266	0	0	3266	200	3066
Iceland	92	2243	11	72	2160	203	1957
Iran, Islamic Rep.	99	3789	18	0	3771	36	3735
Ireland	91	3480	23	17	3440	313	3127
Israel	–	–	–	–	–	–	–
Japan	96	5337	0	0	5337	207	5130
Korea	94	2996	51	0	2945	38	2907
Kuwait	–	–	–	–	–	–	–
Latvia (LSS)	91	2853	7	0	2846	279	2567
Lithuania	89	2852	3	0	2849	318	2531
Netherlands	95	2220	23	0	2197	100	2097
New Zealand	95	3471	98	17	3356	172	3184
Norway	96	2629	8	53	2568	99	2469
Philippines	93 **	6283	29	1	6253	401	5852
Portugal	96	3594	80	4	3510	148	3362
Romania	95	3938	0	0	3938	192	3746
Russian Federation	96	4408	39	11	4358	220	4138
Scotland	90	3313	0	81	3232	319	2913
Singapore	98	3744	19	0	3725	84	3641
Slovak Republic	95	3797	10	3	3784	184	3600
Slovenia	95	3058	12	4	3042	144	2898
South Africa	96	5532	0	0	5532	231	5301
Spain	95	4087	38	116	3933	192	3741
Sweden	95	3055	27	36	2992	161	2831
Switzerland	99	4199	14	44	4141	56	4085
Thailand	100	5845	0	0	5845	0	5845
United States	94	4295	42	85	4168	282	3886

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.
**Participation rates for the Philippines are unweighted.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table A.8

Overall Participation Rates
Upper and Lower Grades (Eighth and Seventh Grades*)

Country	Upper Grade: Overall Participation Before Replacement (Weighted Percentage)	Upper Grade: Overall Participation After Replacement (Weighted Percentage)	Lower Grade: Overall Participation Before Replacement (Weighted Percentage)	Lower Grade: Overall Participation After Replacement (Weighted Percentage)
Australia	69	70	69	71
Austria	39	80	41	82
Belgium (Fl)	59	91	59	91
Belgium (Fr)	52	72	54	76
Bulgaria	62	63	65	67
Canada	84	84	86	86
Colombia	85	87	84	86
Cyprus	97	97	98	98
Czech Republic	89	92	88	92
Denmark	86	86	76	76
England	51	77	52	78
France	82	82	82	82
Germany	63	81	61	78
Greece	84	84	84	84
Hong Kong	81	81	81	81
Hungary	87	87	93	93
Iceland	88	88	89	89
Iran, Islamic Rep.	98	98	99	99
Ireland	76	81	75	79
Israel	44	45	–	–
Japan	87	90	88	91
Korea	95	95	94	94
Kuwait	83	83	–	–
Latvia (LSS)	75	75	75	76
Lithuania	83	83	86	86
Netherlands	23	60	22	58
New Zealand	86	94	85	94
Norway	87	93	81	92
Philippines	87**	88**	90**	90**
Portugal	92	92	90	90
Romania	89	89	89	89
Russian Federation	93	95	93	95
Scotland	69	73	71	76
Singapore	95	95	98	98
Slovak Republic	86	91	86	92
Slovenia	77	77	77	77
South Africa	58	62	79	82
Spain	91	94	91	95
Sweden	90	90	91	91
Switzerland	92	94	89	93
Thailand	99	99	99	99
United States	71	78	72	79

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
** Participation rates for the Philippines are unweighted.
A dash (–) indicates data are unavailable. Israel and Kuwait did not test the lower grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Indicating Compliance with Sampling Guidelines in the Report

Figure A.3 shows how countries have been grouped in tables reporting achievement results. Countries that achieved acceptable participation rates – 85% of both the schools and students, or a combined rate (the product of school and student participation) of 75% – with or without replacement schools, and that complied with the TIMSS guidelines for grade selection and classroom sampling are shown in the first panel of Figure A.3. Countries that met the guidelines only after including replacement schools are annotated. These countries (25 at the eighth grade and 27 at the seventh grade) appear in the tables in Chapters 1, 2, and 3 ordered by achievement.

Countries not reaching at least 50% school participation without the use of replacement schools, or that failed to reach the sampling participation standard even with the inclusion of replacement schools, are shown in the second panel of Figure A.3. These countries are presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are shown in tables in Chapters 4 and 5 in italics.

To provide a better curricular match, four countries (i.e., Colombia, Germany, Romania, and Slovenia) elected to test their seventh- and eighth-grade students even though that meant not testing the two grades with the most 13-year-olds and led to their students being somewhat older than in the other countries. These countries are also presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are shown in tables in Chapters 4 and 5 in italics.

For a variety of reasons, three countries (Denmark, Greece, and Thailand) did not comply with the guidelines for sampling classrooms. Their results are also presented in a separate section of the achievement tables in Chapters 1, 2, and 3 in alphabetical order, and are italicized in tables in Chapters 4 and 5. At the eighth grade, Israel, Kuwait, and South Africa also had difficulty complying with the classroom selection guidelines, but in addition had other difficulties (Kuwait tested a single grade with relatively few 13-year-olds; Israel and South Africa had low sampling participation rates), and so these countries are also presented in separate sections in tables in Chapters 1, 2, and 3, and are italicized in tables in Chapters 4 and 5. At the seventh grade, South Africa had a better sampling participation rate, and is presented in the same section of tables as Denmark, Greece and Thailand. Israel and Kuwait did not test at the seventh grade.

Because the Philippines was unable to document clearly the school sampling procedures used, its results are not presented in the main body of the report. A small set of results for the Philippines can be found in Appendix C.

Figure A.3

Countries Grouped for Reporting of Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates

Eighth Grade	Seventh Grade
Countries satisfying guidelines for sample participation rates, grade selection and sampling procedures	
[†] Belgium (Fl) Canada Cyprus Czech Republic [†2] England France Hong Kong Hungary Iceland Iran, Islamic Rep. Ireland Japan Korea [1] Latvia [1] Lithuania New Zealand Norway Portugal Russian Federation Singapore Slovak Republic Spain Sweden [1] Switzerland [†] United States	[†] Belgium (Fr) [†] Belgium (Fl) Canada Cyprus Czech Republic [†2] England France Hong Kong Hungary Iceland Iran, Islamic Rep. Ireland Japan Korea [1] Latvia (LSS) [1] Lithuania New Zealand Norway Portugal Russian Federation [†] Scotland Singapore Slovak Republic Spain Sweden [1] Switzerland [†] United States
Countries not satisfying guidelines for sample participation	
Australia Austria Belgium (Fr) Bulgaria Netherlands Scotland	Australia Austria Bulgaria Netherlands
Countries not meeting age/grade specifications (high percentage of older students)	
Colombia [†1] Germany Romania Slovenia	Colombia [†1] Germany Romania Slovenia
Countries with unapproved sampling procedures at the classroom level	
Denmark Greece Thailand	Denmark Greece [1] South Africa Thailand
Countries with unapproved sampling procedures at classroom level and not meeting other guidelines	
[1] Israel Kuwait South Africa	
Countries with unapproved sampling procedures at school level	
[3] Philippines	[3] Philippines

[†]Met guidelines for sample participation rates only after replacement schools were included.

[1]National Desired Population does not cover all of International Desired Population (see Table 1). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table 1).

[3]TIMSS was unable to compute sampling weights for the Philippines. Selected unweighted achievement results for the Philippines are presented in Appendix C.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Data Collection

Each participating country was responsible for carrying out all aspects of the data collection, using standardized procedures developed for the study. Training manuals were developed for school coordinators and test administrators that explained procedures for receipt and distribution of materials as well as for the activities related to the testing sessions. The test administrator manuals covered procedures for test security, standardized scripts to regulate directions and timing, rules for answering students' questions, and steps to ensure that identification on the test booklets and questionnaires corresponded to the information on the forms used to track students.

Each country was responsible for conducting quality control procedures and describing this effort as part of the NRC's report documenting procedures used in the study. In addition, the International Study Center considered it essential to establish some method to monitor compliance with standardized procedures. NRCs were asked to nominate a person, such as a retired school teacher, to serve as quality control monitor for their countries, and in almost all cases, the International Study Center adopted the NRCs' first suggestion. The International Study Center developed manuals for the quality control monitors and briefed them in two-day training sessions about TIMSS, the responsibilities of the national centers in conducting the study, and their own roles and responsibilities.

The quality control monitors interviewed the NRCs about data collection plans and procedures. They also selected a sample of approximately 10 schools to visit where they observed testing sessions and interviewed school coordinators.[10] Quality control monitors observed test administrations and interviewed school coordinators in 37 countries, and interviewed school coordinators or test administrators in 3 additional countries.

The results of the interviews indicate that, in general, NRCs had prepared well for data collection and, despite the heavy demands of the schedule and shortages of resources, were in a position to conduct the data collection in an efficient and professional manner. Similarly, the TIMSS tests appeared to have been administered in compliance with international procedures, including the activities preliminary to the testing session, the activities during the testing sessions, and the school-level activities related to receiving, distributing, and returning materials from the national centers.

[10] The results of the interviews and observations by the quality control monitors are presented in Martin, M.O., Hoyle, C.D., and Gregory, K.D. (1996). "Monitoring the TIMSS Data Collection" and "Observing the TIMSS Test Administration" both in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection*. Chestnut Hill, MA: Boston College.

Scoring the Free-Response Items

Because approximately one-third of the written test time was devoted to free-response items, TIMSS needed to develop procedures for reliably evaluating student responses within and across countries. Scoring utilized two-digit codes with rubrics specific to each item. Development of the rubrics was led by the Norwegian TIMSS national center. The first digit designates the correctness level of the response. The second digit, combined with the first digit, represents a diagnostic code used to identify specific types of approaches, strategies, or common errors and misconceptions. Although not specifically used in this report, analyses of responses based on the second digit should provide insight into ways to help students better understand science concepts and problem-solving approaches.

To meet the goal of implementing reliable scoring procedures based on the TIMSS rubrics, the International Study Center prepared guides containing the rubrics and explanations of how to implement them together with example student responses for the various rubric categories. These guides, together with more examples of student responses for practice in applying the rubrics, were used as a basis for an ambitious series of regional training sessions. The training sessions were designed to assist representatives of national centers who would then be responsible for training personnel in their respective countries to apply the two-digit codes reliably.[11]

To gather and document empirical information about the within-country agreement among scorers, TIMSS developed a procedure whereby systematic subsamples of approximately 10% of the students' responses were to be coded independently by two different readers. To provide information about the cross-country agreement among scorers, TIMSS conducted a special study at Population 2, where 39 scorers from 21 of the participating countries evaluated common sets of students' responses to more than half of the free-response items.

Table A.9 shows the average and range of the within-country exact percent of agreement between scorers on the free-response items in the Population 2 science test for 26 countries. Unfortunately, lack of resources precluded several countries from providing this information. A high percent of exact agreement was observed, with averages across the items for the correctness score ranging from 88% to 100% and an overall average of 95% across the 26 countries.

The cross-country coding reliability study involved 350 students' responses for each of 14 mathematics and 17 science items, totaling 10,850 responses in all. The responses were random samples from the within-country reliability samples from seven English-test countries: Australia, Canada, England, Ireland, New Zealand, Singapore, and

[11] The procedures used in the training sessions are documented in Mullis, I.V.S., Garden, R.A., and Jones, C.A. (1996). "Training for Scoring the TIMSS Free-Response Items" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table A.9

TIMSS Within-Country Free-Response Coding Reliability Data for Population 2 Science Items*

Country	Correctness Score Agreement			Diagnostic Score Agreement		
	Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement		Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement	
		Min	Max		Min	Max
Australia	91	69	99	78	48	97
Belgium (Fl)	100	95	100	98	82	100
Bulgaria	91	63	100	81	50	100
Canada	92	76	100	80	59	99
Colombia	97	83	100	91	73	100
Czech Republic	96	87	100	90	61	100
England	97	90	100	91	65	100
France	99	95	100	97	89	100
Germany	94	81	100	84	66	100
Hong Kong	94	72	100	87	56	100
Iceland	95	74	100	83	22	98
Iran, Islamic Rep.	88	67	100	73	33	99
Ireland	95	87	100	89	69	100
Japan	100	96	100	98	87	100
Netherlands	92	75	100	79	17	100
New Zealand	97	90	100	90	63	100
Norway	95	87	100	91	71	100
Portugal	96	88	100	91	75	100
Russian Federation	96	87	100	91	73	100
Scotland	89	73	99	74	52	96
Singapore	98	92	100	95	86	100
Slovak Republic	92	62	100	81	43	100
Spain	95	85	100	88	73	98
Sweden	94	80	100	83	54	99
Switzerland	98	93	100	93	85	99
United States	97	90	100	89	74	100
AVERAGE	95	82	100	87	63	99

*Based on 33 science items, including 4 multiple-part items.
Note: Percent agreement was computed separately for each part, and each part was treated as a separate item in computing averages and ranges.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

the United States. The responses were presented to the scorers according to a rotated design whereby each response was coded by 7 to 18 different scorers. This design resulted in a large number of comparisons between coders, approximately 10,000 or more for each item.

Table A.10 presents the percent of exact agreement for the 17 science items and the scorers involved in the international study. For comparison purposes, it also shows the average and range of the percent of exact agreement for each of the items within the 26 countries submitting data about their scoring reliability. The percent of exact agreement for each science item was fairly high on the correctness score agreement. Most measures fell between 80% and 99%, although measures for three items were between 72% and 78%. In general, the average international correctness score agreement for the science items was not as high as the within-country agreement (86% as opposed to 94%), but results are acceptable, and to be expected given the nature of the science items and the nature of the international coding reliability study. The TIMSS data from the reliability studies indicate that scoring procedures were robust for the science items, especially for the correctness score used for the analyses in this report.[12]

[12] Details about the reliability studies can be found in Mullis, I.V.S. and Smith, T.A. (1996). "Quality Control Steps for Free-Response Scoring" in M.O. Martin and I.V.S. Mullis (eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College.

Table A.10

Percent Exact Agreement for Coding of Science Items for International and Within-Country Reliability Studies

Item Label	Total Valid Comparisons in International Study	Correctness Score Agreement				Diagnostic Code Agreement			
		International Study	Within-Country Study			International Study	Within-Country Study		
			Average	Min	Max		Average	Min	Max
O10	9078	99	99	95	100	98	97	80	100
O17	46035	94	97	77	100	74	86	64	100
Q18	9150	93	96	81	100	85	91	54	100
K19	12600	93	95	83	100	67	80	52	99
P03	46050	92	97	88	100	78	88	58	100
K10	46050	91	96	90	100	79	91	79	99
[1] W01A	9150	90	95	83	100	71	87	67	99
[1] W01B	9150	89	95	87	100	77	89	74	98
R04	45930	89	96	90	100	70	84	65	98
P06	46050	88	93	74	100	74	87	64	100
O14	9150	88	96	86	100	83	91	65	100
R05	9122	86	95	86	100	72	87	61	100
O16	45930	86	95	81	100	59	80	53	96
Q17	46034	82	93	74	100	66	87	65	100
P05	9150	80	93	82	100	59	82	47	100
W02	46050	78	92	75	100	70	89	69	99
Q12	12600	75	91	74	100	51	78	55	100
R03	9129	72	90	70	100	50	82	59	100
AVERAGE SCIENCE ITEMS		86	94	81	100	70	86	62	99

[1]Two-part items; each part is analyzed separately.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Test Reliability

Table A.11 displays the science test reliability coefficient for each country for the lower and upper grades (usually seventh and eighth grades). This coefficient is the median KR-20 reliability across the eight test booklets. Median reliabilities in the lower grade ranged from 0.83 in the United States and the Philippines to 0.68 in Portugal and in the upper grade from 0.84 in Australia, Bulgaria, and the Philippines to 0.69 in Kuwait. The international median, shown in the last row of the table, is the median of the reliability coefficients for all countries. These international medians are 0.77 for the lower grade and 0.78 for the upper grade.

Data Processing

To ensure the availability of comparable, high quality data for analysis, TIMSS engaged in a rigorous set of quality control steps to create the international database.[13] TIMSS prepared manuals and software for countries to use in entering their data so the information would be in a standardized international format before being forwarded to the IEA Data Processing Center in Hamburg for creation of the international database. Upon arrival at the IEA Data Processing Center, the data from each country underwent an exhaustive cleaning process. The data-cleaning process involved several iterative steps and procedures designed to identify, document, and correct deviations from the international instruments, file structures, and coding schemes. This process also emphasized consistency of information within national data sets and appropriate linking among the many student, teacher, and school data files.

Throughout the process, the data were checked and double-checked by the IEA Data Processing Center, the International Study Center, and the national centers. The national centers were contacted regularly and given multiple opportunities to review the data for their countries. In conjunction with the Australian Council for Educational Research (ACER), the International Study Center conducted a review of items statistics for each of the cognitive items in each of the countries to identify poorly performing items. Twenty-one countries had one or more items deleted (in most cases, one). Usually the poor statistics (negative point-biserials for the key, large item-by-country interactions, and statistics indicating lack of fit with the model) were a result of translation, adaptation, or printing deviations.

[13] These steps are detailed in Jungclaus, H. and Bruneforth, M. (1996). "Data Consistency Checking Across Countries" in M.O. Martin and D.L. Kelly (eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table A.11

Cronbach's Alpha Reliability Coefficients[1] - TIMSS Science Test Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Lower Grade	Upper Grade
Australia	0.81	0.84
Austria	0.80	0.81
Belgium (Fl)	0.68	0.78
Belgium (Fr)	0.72	0.79
Bulgaria	0.81	0.84
Canada	0.79	0.78
Colombia	0.69	0.72
Cyprus	0.74	0.79
Czech Republic	0.75	0.78
Denmark	0.77	0.77
England	0.82	0.83
France	0.71	0.73
Germany	0.80	0.82
Greece	0.78	0.77
Hong Kong	0.78	0.78
Hungary	0.80	0.79
Iceland	0.74	0.75
Iran, Islamic Rep.	0.71	0.71
Ireland	0.78	0.82
Israel	–	0.83
Japan	0.76	0.79
Korea	0.79	0.79
Kuwait	–	0.69
Latvia (LSS)	0.74	0.76
Lithuania	0.75	0.75
Netherlands	0.74	0.76
New Zealand	0.80	0.82
Norway	0.77	0.78
Philippines	0.83	0.84
Portugal	0.68	0.75
Romania	0.81	0.82
Russian Federation	0.79	0.79
Scotland	0.79	0.82
Singapore	0.81	0.77
Slovak Republic	0.77	0.81
Slovenia	0.77	0.78
South Africa	0.78	0.82
Spain	0.75	0.73
Sweden	0.76	0.77
Switzerland	0.74	0.78
Thailand	0.70	0.72
United States	0.83	0.83
International Median	0.77	0.78

*Seventh and eighth grade in most countries; see Table 2 for more information about the grades tested in each country. Israel and Kuwait did not test the lower grade.

[1]The reliability coefficient for each country is the median KR-20 reliability across the eight test booklets. The international median is the median of the reliability coefficients for all countries.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

IRT Scaling and Data Analysis

Two general analysis approaches were used for this report – item response theory scaling methods and average percent correct technology. The overall science results were summarized using an item response theory (IRT) scaling method (Rasch model). This scaling method produces a science score by averaging the responses of each student to the items which they took in a way that takes into account the difficulty of each item. The methodology used in TIMSS includes refinements that enable reliable scores to be produced even though individual students responded to relatively small subsets of the total science item pool. Analyses of the response patterns of students from participating countries indicated that, although the items in the test address a wide range of science content, the performance of the students across the items was sufficiently consistent that it could be usefully summarized in a single science score.

The IRT methodology was preferred for developing comparable estimates of performance for all students, since students answered different test items depending upon which of the eight test booklets they received. The IRT analysis provides a common scale on which performance can be compared across countries. In addition to providing a basis for estimating mean achievement, scale scores permit estimates of how students within countries vary and provide information on percentiles of performance. The scale was standardized using students from both the grades tested. When all participating countries and grades are treated equally, the TIMSS scale average is 500 and the standard deviation is 100. Since the countries varied in size, each country was reweighted to contribute equally to the mean and standard deviation of the scale. The average of the scale scores was constructed to be the average of the 41 means of participants that were available at the eighth grade and the 39 means at the seventh grade. The average and standard deviation of the scale scores are arbitrary and do not affect scale interpretations.

The analytic approach underlying the results in Chapters 2 and 3 of this report involved calculating the percentage of correct answers for each item for each participating country (as well as the percentages of different types of incorrect responses). The percents correct were averaged to summarize science performance overall and in each of the content areas for each country as a whole and by gender. For items with more than one part, each part was analyzed separately in calculating the average percents correct. Also, for items with more than one point awarded for full credit, the average percents correct reflect an average of the points received by students in each country. This was achieved by including the percent of students receiving one score point as well as the percentage receiving two score points and three score points in the calculations. Thus, the average percents correct are based on the number of score points rather than the number of items, per se. An exception to this is the international average percents correct reported for example items, where the values reflect the percent of students receiving full credit.

Estimating Sampling Error

Because the statistics presented in this report are estimates of national performance based on samples of students, rather than the values that could be calculated if every student in every country would have answered every question, it is important to have measures of the degree of uncertainty of the estimates. The jackknife procedure was used to estimate the standard error associated with each statistic presented in this report. The use of confidence intervals, based on the standard errors, provides a way to make inferences about the population means and proportions in a manner that reflects the uncertainty associated with the sample estimates. An estimated sample statistic plus or minus two standard errors represents a 95% confidence interval for the corresponding population result.

Appendix B

The Test-Curriculum Matching Analysis

When comparing student achievement across countries, it is important that the comparisons be as "fair" as possible. TIMSS has worked towards this goal in a number of ways, including providing detailed procedures for standardizing the population definitions, sampling, test translations, test administration, scoring, and database formation. Developing the TIMSS tests involved the interaction of experts in the sciences with representatives of the participating countries and testing specialists.[1] The National Research Coordinators (NRCs) from each country formally approved the TIMSS test, thus accepting it as being sufficiently fair to compare their students' science achievement with that of students from other countries.

Although the TIMSS test was developed to represent a set of agreed-upon science content areas, there are differences among the curricula of participating countries that result in various science topics being taught at different grades. To restrict test items not only to those topics in the curricula of all countries but also to those covered in the same sequence in all participating countries would severely limit test coverage and restrict the research questions about international differences that TIMSS is designed to address. The TIMSS tests, therefore, inevitably contain some items measuring topics unfamiliar to some students in some countries.

The Test-Curriculum Matching Analysis (TCMA) was developed and conducted to investigate the appropriateness of the TIMSS science test for seventh- and eighth-grade students in the participating countries, and to show how student performance for individual countries varied when based only on the test questions that were judged to be relevant to their own curriculum.[2]

To gather data about the extent to which the TIMSS tests were relevant to the curriculum of the participating countries, TIMSS asked the NRC of each country to report whether or not each item was in their country's intended curriculum at each of the two grades being tested. The NRC was asked to choose a person or persons who were very familiar with the curricula at the grades being tested to make the determination. Since an item might be in the curriculum for some but not all students in a country, an item was determined appropriate if it was in the intended curriculum for more than 50% of the students. The NRCs had considerable flexibility in selecting items and may have considered items inappropriate for other reasons. All participating countries except Thailand returned the information for analysis.

Tables B.1 and B.2 present the TCMA results for the eighth and seventh grades, respectively. The first row of each table indicates that at both grades the countries varied substantially in the number of items considered appropriate. At the eighth

[1] See Appendix A for more information on the test development.

[2] Because there also may be curriculum areas covered in some countries that are not covered by the TIMSS tests, the TCMA does not provide complete information about how well the TIMSS tests cover the curricula of the countries.

grade, more than half of the countries indicated that items representing three-quarters or more of the score points (110 out of a possible 146) were appropriate,[3] with the percent ranging from 100% in Spain, Iceland, and the United States to approximately 40% in Korea (59 score points) and French-speaking Belgium (58 score points). Fewer items were selected at the seventh grade, but nearly half of the countries selected at least 60%, with several selecting at least three-quarters of the score points. All items were selected at the seventh grade as well as the eighth grade in both the United States and Iceland. At the seventh grade there were also several countries, including Korea and Japan, which retained about 30% or less. That lower percentages of items were selected for the TCMA at the seventh grade is consistent with the instrument-development process, which put more emphasis on the upper-grade curriculum.

Since most countries indicated that some items were not included in their intended curricula at the two grades tested, the question becomes whether the inclusion of these items had any effect on the international performance comparisons.[4] The TCMA results provide a method for answering this question, providing evidence that it is reasonable to make cross-national comparisons on the basis of the TIMSS science test.

Each of the first columns in Tables B.1 and B.2 shows the overall average percent correct for each country (as discussed in Chapter 2 and reproduced here for convenience in making comparisons). The countries are presented in the order of their overall performance, from highest to lowest. To interpret these tables, reading across a row provides the average percent correct for the students in the country identified by that row on the items selected by each of the countries named across the top of the table. For example, at the eighth grade, Singapore, where the average percent correct was 72% on its own set of items, also had 72% for the items selected by Korea, 73% for those selected by Japan, 69% for those selected by the Czech Republic, and so forth. The column for a country shows how each of the other countries performed on the subset of items selected for its own students. Using the set of items selected by Hong Kong as an example, on average, 71% of these items were answered correctly by the Singaporean students, 65% by the Korean students, 66% by the Japanese, and so forth. The shaded diagonal elements in each table show how each country performed on the subset of items that it selected based on its own curriculum. Thus, the Hong Kong students themselves averaged 59% correct responses on the items identified by Hong Kong for the analysis.

[3] Of the 135 items in the test, some items were assigned more score points than others. In particular, some items had two parts, and some extended-response items were scored on a two-point scale and others on a three-point scale. The total number of score points available for analysis was 146. The TCMA uses the score points in order to give the same weight to items that they received in the test scoring.

[4] It should be noted that the performance levels presented in Tables B.1 and B.2 are based on average percents correct as was done in Chapter 2, which is different from the average scale scores that were presented in Chapter 1. The cost and delay of scaling would have been prohibitive for the TCMA analyses.

Table B.1 Test-Curriculum Matching Analysis Results - Science - Upper Grade (Eighth Grade*)

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table B.3 for corresponding standard errors)

Instructions: Read ***across*** the row to compare that country's performance based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** to compare performance for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	**Singapore**	**Korea**	**Japan**	**Czech Republic**	*Netherlands*	*Bulgaria*	*Slovenia*	*Austria*	**England**	**Hungary**	**Belgium (Fl)**	*Australia*	**Slovak Republic**	**Sweden**	**Canada**	**Ireland**	**United States**	**Russian Federation**	*Germany*	**New Zealand**
(Number of Score Points Included)	*146***	*109*	*59*	*86*	*136*	*102*	*112*	*140*	*131*	*124*	*129*	*98*	*133*	*129*	*125*	*121*	*90*	*146*	*96*	*129*	*126*
Singapore	70 (1.0)	72	72	73	69	72	70	69	70	71	69	69	70	70	71	71	72	70	70	70	72
Korea	66 (0.3)	66	67	68	66	67	66	66	66	66	65	67	65	66	66	67	67	66	68	66	67
Japan	65 (0.3)	66	65	70	65	68	66	66	67	66	65	66	65	66	66	67	66	65	68	66	67
Czech Republic	64 (0.8)	65	66	67	64	66	65	64	65	63	65	64	64	66	66	66	67	64	67	64	65
Netherlands	62 (1.0)	63	62	66	63	66	63	62	63	63	63	64	62	63	64	65	64	62	64	63	65
Bulgaria	62 (1.0)	64	65	65	62	64	64	62	63	61	62	61	61	63	63	62	63	62	66	62	62
Slovenia	62 (0.5)	62	63	64	62	63	62	62	63	61	62	63	61	63	63	63	63	62	64	62	63
Austria	61 (0.7)	63	65	65	61	63	62	62	63	61	62	61	61	63	63	63	64	61	64	62	63
England	61 (0.6)	62	62	63	62	64	61	61	62	62	62	63	61	62	62	64	63	61	62	61	64
Hungary	61 (0.6)	62	63	64	60	62	61	61	61	60	62	61	61	63	62	62	61	61	64	61	62
Belgium (Fl)	60 (1.1)	61	62	64	61	64	60	60	61	60	61	62	60	62	62	63	63	60	62	61	62
Australia	60 (0.7)	61	61	62	60	62	60	60	60	60	60	60	60	61	61	62	62	60	60	60	62
Slovak Republic	59 (0.6)	60	59	63	60	61	60	59	61	58	60	59	59	61	60	61	62	59	63	60	60
Sweden	59 (0.6)	58	60	63	59	61	59	59	59	58	59	58	59	60	61	60	60	59	61	59	61
Canada	59 (0.5)	59	58	61	59	61	59	59	59	59	59	59	59	59	60	61	61	59	60	59	61
Ireland	58 (0.9)	59	60	59	59	60	58	58	59	59	59	59	58	59	60	60	62	58	59	58	60
United States	58 (1.0)	59	60	60	58	60	58	58	59	59	59	59	58	59	60	60	61	58	59	58	60
Russian Federation	58 (0.8)	59	61	62	59	61	59	58	59	58	59	58	58	60	60	60	61	58	65	59	59
Germany	58 (1.0)	59	60	62	58	60	58	58	59	58	58	58	58	59	59	60	60	58	61	59	60
New Zealand	58 (0.8)	58	58	60	58	60	58	57	58	58	58	58	58	58	59	59	59	58	58	58	60
Norway	58 (0.4)	56	56	61	58	60	57	58	58	58	58	58	58	58	59	59	59	58	58	58	60
Hong Kong	58 (1.0)	59	58	61	58	60	59	58	59	58	57	57	57	58	59	59	59	58	61	58	60
Israel	57 (1.1)	57	57	60	57	59	57	57	58	56	58	58	57	58	58	58	59	57	58	57	58
Switzerland	56 (0.5)	57	56	60	56	59	56	57	57	56	57	57	56	58	58	59	57	56	58	57	58
Spain	56 (0.4)	56	57	58	56	57	56	56	57	55	56	56	55	57	56	57	57	56	57	55	57
Scotland	55 (1.0)	56	55	58	56	58	56	55	56	56	56	56	55	56	56	57	57	55	56	55	58
France	54 (0.6)	54	54	57	54	56	53	54	54	54	55	54	53	55	55	56	55	54	56	54	55
Iceland	52 (0.9)	51	51	55	52	55	53	52	53	52	52	53	51	53	53	54	52	52	54	53	55
Greece	52 (0.5)	53	53	54	52	53	53	52	53	52	53	52	52	53	53	53	53	52	53	52	53
Denmark	51 (0.6)	50	49	54	51	53	51	51	52	51	51	52	50	52	52	53	51	51	53	51	53
Belgium (Fr)	50 (0.7)	50	50	54	50	53	51	50	51	49	51	51	50	51	52	52	51	50	53	51	52
Latvia (LSS)	50 (0.6)	51	52	55	50	52	51	50	51	51	51	51	50	52	51	52	51	50	54	51	51
Portugal	50 (0.6)	51	53	53	50	52	50	50	51	50	51	49	50	51	51	51	52	50	52	50	51
Romania	50 (0.8)	51	52	52	50	51	50	50	51	49	50	51	50	52	50	51	52	50	54	50	50
Lithuania	49 (0.7)	50	51	53	49	51	50	49	50	48	50	49	49	51	50	50	51	49	55	49	49
Iran, Islamic Rep.	47 (0.6)	49	51	50	48	48	49	47	49	48	48	48	48	49	48	49	49	47	51	48	48
Cyprus	47 (0.4)	48	47	50	47	48	47	47	48	47	47	47	46	48	48	48	50	47	49	47	48
Kuwait	43 (0.9)	43	42	45	43	44	44	43	44	43	42	43	42	43	43	44	44	43	44	43	44
Colombia	39 (0.8)	39	40	41	39	40	39	39	40	39	39	40	39	39	39	40	41	39	40	38	40
South Africa	27 (1.3)	28	27	29	27	28	27	27	28	27	26	27	26	27	27	27	29	27	30	27	27
International Average	**55 (0.7)**	**56**	**56**	**59**	**56**	**58**	**56**	**56**	**56**	**56**	**56**	**56**	**55**	**57**	**57**	**57**	**57**	**55**	**58**	**56**	**57**

Country	**Norway**	**Hong Kong**	*Israel*	**Switzerland**	**Spain**	*Scotland*	**France**	**Iceland**	*Greece*	*Denmark*	*Belgium (Fr)*	**Latvia (LSS)**	**Portugal**	*Romania*	**Lithuania**	**Iran, Islamic Rep.**	**Cyprus**	*Kuwait*	*Colombia*	*South Africa*
(Number of Score Points Included)	*111*	*68*	*102*	*105*	*146*	*97*	*73*	*146*	*111*	*70*	*58*	*113*	*133*	*99*	*120*	*87*	*78*	*131*	*112*	*74*
Singapore	70	71	71	72	70	71	71	70	71	72	70	68	70	71	71	69	72	70	72	73
Korea	67	65	66	68	66	67	67	66	65	67	67	65	65	65	68	65	66	66	67	65
Japan	66	66	66	68	65	67	65	65	65	68	67	65	65	65	67	65	66	66	65	66
Czech Republic	65	65	65	67	64	64	65	64	65	66	68	62	64	64	66	64	66	64	66	65
Netherlands	64	64	64	66	62	63	64	62	63	66	67	61	62	63	64	61	65	62	63	61
Bulgaria	63	62	62	65	62	61	64	62	62	64	62	60	62	63	64	61	64	61	64	64
Slovenia	63	62	62	65	62	62	64	62	62	63	66	60	61	60	64	61	63	61	63	63
Austria	63	63	62	64	61	61	63	61	63	64	64	59	61	62	63	62	64	61	63	62
England	63	63	62	64	61	62	61	61	63	64	63	59	61	61	63	61	64	61	63	61
Hungary	62	60	61	63	61	59	62	61	62	61	63	59	61	60	63	61	64	60	62	61
Belgium (Fl)	63	63	62	64	60	61	62	60	61	65	65	59	60	60	62	59	63	60	62	59
Australia	61	60	60	62	60	60	60	60	61	62	64	58	59	59	61	59	62	60	61	60
Slovak Republic	61	62	60	62	59	59	61	59	60	61	62	58	59	60	62	60	63	59	60	61
Sweden	61	60	60	63	59	60	61	59	59	62	63	57	58	59	61	58	61	59	60	59
Canada	60	60	60	62	59	59	59	59	60	61	62	58	58	58	61	57	61	58	60	59
Ireland	60	60	60	61	58	59	59	58	60	61	60	57	58	58	60	57	61	58	60	57
United States	60	59	59	61	58	58	60	58	59	62	63	57	58	57	60	56	61	58	60	58
Russian Federation	60	60	60	61	58	59	60	58	59	61	61	57	58	59	61	59	61	59	60	61
Germany	59	59	58	61	58	58	59	58	59	60	61	56	57	58	60	57	61	58	59	59
New Zealand	59	59	59	60	58	58	58	58	59	60	60	56	57	57	59	56	60	58	59	57
Norway	60	60	58	62	58	59	57	58	58	62	61	57	57	58	60	56	60	58	59	58
Hong Kong	58	59	58	61	58	58	60	58	58	59	62	56	57	57	59	57	59	57	60	60
Israel	58	58	58	59	57	57	57	57	58	60	60	55	57	57	59	56	61	57	58	56
Switzerland	58	58	57	60	56	56	57	56	57	59	60	55	56	57	58	56	59	56	58	56
Spain	58	56	56	57	56	55	55	56	57	58	58	53	55	55	57	55	59	55	57	55
Scotland	57	57	56	58	55	56	55	55	57	57	57	53	55	56	57	55	59	55	57	55
France	55	54	55	57	54	54	57	54	54	55	59	53	53	53	57	52	56	53	54	52
Iceland	55	53	53	55	52	52	52	52	52	55	57	51	51	52	54	51	55	52	53	51
Greece	53	53	53	54	52	52	52	52	54	52	53	50	52	52	54	52	55	52	54	54
Denmark	53	51	52	54	51	52	52	51	51	55	57	49	50	50	53	50	53	51	51	50
Belgium (Fr)	52	51	51	54	50	50	52	50	50	52	56	49	50	50	53	49	53	50	51	49
Latvia (LSS)	51	52	52	53	50	50	52	50	50	51	54	49	50	51	52	50	52	50	51	51
Portugal	51	49	50	52	50	49	52	50	51	52	54	48	50	49	52	49	54	50	52	49
Romania	51	49	50	51	50	48	52	50	49	52	52	47	50	48	51	50	51	49	52	51
Lithuania	50	50	50	51	49	49	51	49	49	50	53	47	49	50	52	49	50	49	50	51
Iran, Islamic Rep.	49	49	47	49	47	47	48	47	49	47	47	47	48	50	49	50	52	48	50	48
Cyprus	48	49	48	50	47	47	48	47	48	48	50	45	47	47	49	47	51	47	49	48
Kuwait	45	43	42	44	43	42	44	43	44	44	43	42	43	44	44	43	47	43	45	43
Colombia	40	39	40	41	39	39	39	39	40	42	41	36	39	38	40	38	41	38	41	39
South Africa	27	28	27	28	27	26	28	27	27	28	29	26	27	27	28	27	28	26	28	28
International Average	**57**	**57**	**56**	**58**	**55**	**56**	**57**	**55**	**56**	**58**	**58**	**54**	**55**	**56**	**57**	**55**	**58**	**55**	**57**	**56**

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
**Of the 135 items in the science test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 146 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses. Standard errors for scores based on subsets of items are provided in Table B.3.
Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).
Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table B.2 Test-Curriculum Matching Analysis Results - Science - Lower Grade (Seventh Grade*)

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table B.4 for corresponding standard errors)

Instructions: Read *across* the row to compare that country's performance based on the test items included by each of the countries across the top.
Read *down* the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the *diagonal* to compare performance for each different country based on its own decisions about the test items to include.

Country	Average Percent Correct on All Items	Singapore	Korea	Japan	Czech Republic	*Slovenia*	Belgium (Fl)	*Bulgaria*	*Netherlands*	England	Hungary	*Austria*	Slovak Republic	United States	Canada	*Australia*	Hong Kong	*Germany*	Ireland	Sweden	New Zealand	Norway	Switzerland	Russian Federation	Spain	Scotland	Iceland	France	Belgium (Fr)	*Romania*	*Greece*	*Denmark*	Iran, Islamic Rep.	Latvia (LSS)	Portugal	Cyprus	*Colombia*	Lithuania	*South Africa*
(Number of Score Points Included)	146**	83	43	45	108	132	46	105	34	104	98	52	111	146	78	94	32	88	60	86	110	92	36	49	132	49	146	26	23	91	72	20	48	46	81	29	79	108	26
Singapore	61 (1.2)	66	65	65	62	62	62	63	63	63	61	65	62	61	65	66	62	63	65	67	65	64	66	65	62	66	61	68	61	64	63	68	63	62	62	66	64	64	66
Korea	61 (0.4)	63	64	67	62	62	63	64	65	63	61	67	63	61	65	63	60	65	63	66	65	63	68	67	62	65	61	69	61	62	64	68	61	62	63	63	65	62	68
Japan	59 (0.3)	60	61	67	60	60	60	61	63	61	58	63	62	59	62	61	59	64	59	66	62	61	64	66	60	63	59	65	63	61	62	66	61	59	60	65	62	59	65
Czech Republic	58 (0.8)	60	61	64	61	59	60	61	63	59	59	64	62	58	60	60	55	63	62	65	62	61	63	64	59	59	58	65	65	62	61	62	62	57	59	59	63	61	61
Slovenia	57 (0.5)	59	60	61	58	58	59	58	60	57	58	61	60	57	58	59	55	61	62	62	59	60	63	62	57	59	57	65	65	59	59	60	61	57	59	58	61	59	61
Belgium (Fl)	57 (0.5)	58	58	60	59	58	60	58	65	58	59	61	60	57	61	59	59	62	60	66	61	63	66	63	59	61	57	61	64	59	62	66	63	57	59	58	64	59	58
Bulgaria	56 (1.0)	57	60	60	57	57	58	60	60	57	56	61	60	56	58	57	54	59	59	63	59	59	60	62	57	56	56	62	61	58	57	62	57	53	57	55	60	58	59
Netherlands	56 (0.7)	58	59	58	58	56	58	57	63	57	56	59	59	56	59	58	57	60	59	64	60	60	65	60	58	61	56	62	62	58	61	62	59	57	59	60	62	58	59
England	56 (0.6)	57	56	57	56	56	56	57	60	58	55	56	57	56	58	58	55	58	57	62	60	59	62	58	57	60	56	56	59	57	58	58	59	54	57	55	59	58	59
Hungary	56 (0.6)	57	57	57	57	56	56	57	61	55	56	59	58	56	56	58	52	59	59	60	58	58	60	62	56	53	56	60	60	58	57	61	59	52	56	51	60	58	57
Austria	55 (0.6)	58	56	58	55	56	57	56	60	55	56	60	59	55	57	57	53	59	58	62	59	59	62	59	56	55	55	60	63	59	58	59	59	54	57	57	60	58	58
Slovak Republic	54 (0.6)	56	58	61	57	54	55	56	58	55	55	60	58	54	55	56	53	59	59	60	57	58	60	61	55	56	54	61	58	57	56	59	59	54	55	54	58	56	57
United States	54 (1.1)	55	54	54	55	54	56	55	59	55	54	54	56	54	56	56	54	55	57	60	58	57	61	56	55	58	54	59	59	56	58	57	56	54	57	54	58	56	58
Canada	54 (0.5)	55	56	55	54	54	55	55	59	55	54	56	56	54	57	56	53	55	55	61	58	57	62	57	55	58	54	58	57	56	57	57	57	53	56	54	58	56	57
Australia	54 (0.7)	56	57	56	54	54	54	56	58	55	53	55	56	54	55	56	52	57	56	60	57	56	61	56	55	57	54	57	59	56	57	54	57	52	55	53	57	56	58
Hong Kong	53 (1.2)	56	57	57	54	54	56	56	60	55	52	58	54	53	56	55	54	56	55	60	57	55	61	59	54	58	53	60	60	55	55	54	55	52	54	51	56	54	61
Germany	53 (0.8)	55	55	57	53	54	54	55	58	53	53	57	56	53	55	55	51	57	55	60	57	56	60	57	54	52	53	59	60	55	56	58	56	51	54	53	58	55	56
Ireland	52 (0.7)	54	52	51	52	52	54	52	53	53	53	52	54	52	53	55	53	53	56	57	55	55	59	53	53	57	52	52	53	54	55	55	56	54	54	52	56	54	53
Sweden	51 (0.5)	53	53	56	53	52	52	53	57	53	52	54	53	51	54	53	50	56	54	59	56	56	60	56	53	53	51	55	59	53	55	58	53	52	53	54	57	53	54
New Zealand	50 (0.7)	52	50	51	51	50	50	52	54	52	50	51	52	50	52	53	50	53	51	56	55	54	58	51	52	53	50	53	54	52	54	52	53	50	52	51	55	52	52
Norway	50 (0.6)	51	53	54	52	51	50	52	57	51	50	52	53	50	53	52	49	54	53	58	54	55	59	54	52	52	50	52	55	52	55	58	53	50	52	52	56	52	52
Switzerland	50 (0.4)	53	52	54	50	51	52	51	55	51	51	55	53	50	52	52	49	55	53	57	54	54	60	55	52	52	50	56	56	52	53	55	54	50	52	51	56	51	52
Russian Federation	50 (0.8)	52	51	55	51	51	52	51	57	51	51	53	53	50	52	51	50	53	55	57	52	53	59	61	51	53	50	52	56	52	54	58	53	52	53	54	57	52	53
Spain	49 (0.4)	50	49	50	50	49	50	50	52	50	50	50	52	49	50	50	47	51	51	55	52	53	54	51	50	51	49	53	54	51	52	52	52	49	51	48	53	52	49
Scotland	48 (0.8)	50	50	50	49	48	49	50	51	50	48	49	50	48	51	51	49	50	50	54	52	52	55	50	49	53	48	50	51	50	50	49	51	46	49	46	52	50	52
Iceland	46 (0.6)	47	48	49	48	46	47	49	53	47	46	46	49	46	47	47	44	49	49	53	50	50	51	50	48	47	46	49	53	48	49	48	49	44	48	43	51	48	51
France	46 (0.6)	48	49	50	46	47	47	47	48	48	47	51	48	46	48	47	45	49	46	53	49	50	55	50	47	50	46	57	50	48	48	51	47	44	47	44	50	47	48
Belgium (Fr)	45 (0.7)	47	49	48	45	46	47	47	49	46	45	50	47	45	47	46	44	48	47	52	48	49	53	50	46	48	45	54	52	47	47	46	49	42	46	40	49	46	47
Romania	45 (0.7)	46	45	47	46	45	47	47	50	45	45	49	48	45	45	46	42	47	48	50	46	47	48	50	45	44	45	52	51	47	47	46	48	43	46	43	48	47	50
Greece	45 (0.5)	45	45	47	46	44	44	46	48	46	45	45	46	45	45	48	43	47	45	49	48	47	48	46	45	47	45	50	46	47	48	48	47	43	46	45	48	47	51
Denmark	44 (0.4)	45	46	49	45	44	45	46	50	45	44	48	47	44	47	45	42	49	45	53	47	48	53	51	45	46	44	48	52	46	48	52	47	41	46	44	49	45	47
Iran, Islamic Rep.	42 (0.6)	46	41	44	43	43	44	45	44	43	42	41	43	42	44	45	42	45	46	46	44	44	44	44	41	42	42	43	44	44	43	48	45	40	42	40	45	45	47
Latvia (LSS)	42 (0.5)	44	43	46	42	42	45	43	47	43	42	45	44	42	44	43	41	45	46	48	44	45	48	48	42	43	42	47	49	44	44	50	45	41	44	41	47	43	44
Portugal	41 (0.5)	43	41	42	41	41	42	42	43	41	41	44	44	41	42	42	37	43	45	47	44	44	45	45	42	43	41	47	44	42	44	47	45	42	45	42	46	44	42
Cyprus	40 (0.4)	43	42	43	40	40	42	41	42	42	41	44	42	40	42	42	40	42	43	45	42	43	45	43	40	45	40	47	43	43	42	48	44	40	41	44	43	42	45
Lithuania	38 (0.7)	40	39	44	37	38	41	39	42	39	38	42	40	38	40	38	36	41	42	44	40	40	45	46	38	40	38	41	44	40	40	45	40	38	40	38	44	39	43
Colombia	35 (0.7)	37	36	35	35	35	36	37	39	35	35	37	37	35	34	36	33	35	38	40	37	37	34	36	35	38	35	39	40	37	38	36	39	33	37	34	38	38	39
South Africa	26 (1.0)	27	27	28	26	25	27	26	28	26	25	27	27	26	25	26	26	27	29	29	27	27	27	30	26	26	26	28	27	27	27	26	27	25	26	25	27	27	30
International Average	**50 (0.7)**	**52**	**52**	**53**	**51**	**50**	**51**	**51**	**54**	**51**	**50**	**53**	**52**	**50**	**52**	**52**	**49**	**53**	**52**	**56**	**53**	**53**	**56**	**54**	**51**	**52**	**50**	**55**	**54**	**52**	**52**	**54**	**53**	**49**	**51**	**50**	**54**	**52**	**53**

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.
**Of the 135 items in the science test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 146 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses. Standard errors for scores based on subsets of items are provided in Table B.4.
Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).
Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

The international averages of each country's selected items presented across the last row of the tables show that the selection of items for the participating countries varied somewhat in average difficulty, ranging from 55% to 59% at the eighth grade and from 49% to 56% at seventh grade. Despite these differences, the overall picture provided by both Tables B.1 and B.2 reveals that different item selections do not make a major difference in how well countries perform relative to each other. The items selected by some countries were more difficult than those selected by others. The relative performance of countries on the various item selections did vary somewhat, but generally not in a statistically significant manner.[5]

Comparing the diagonal element for a country with the overall average percentage correct shows the difference between performance on this subset of items and performance on the test as a whole. In general, there were only small increases in each country's performance on its own subset of items. To illustrate, the average percent correct for eighth-grade students in Singapore was 70%. The diagonal element shows that Singaporean students had about the same average percent correct (72%) based on the smaller set of items selected as relevant to the curriculum in Singapore as they did overall. In the eighth grade, most countries had a difference of less than 5 percentage points between the two performance measures, with the largest difference of 7% for the Russian Federation (65% compared to 58%). Performance differences between the entire TIMSS test and the subset of items selected for the TCMA were, in general, somewhat larger for seventh-grade students, including a few countries with an average performance that was about 10 percentage points higher on the subsets of items selected for the TCMA for their own students – Switzerland, France, and the Russian Federation. Even these increases are not particularly large, however, considering that France and Switzerland both selected less than one-quarter of the items at the seventh grade.

It is clear that the selection of items does not have a major effect on the general relationship among countries. Countries that had substantially higher or lower performance on the overall test in comparison to each other also had higher or lower relative performance on the different sets of items selected for the TCMA. For example, at the eighth grade, Singapore had the highest average percent correct on the test as a whole and on all of the different item selections, with Japan, Korea, and the Czech Republic among the four highest-performing countries in all cases. Although there are some changes in the ordering of countries based on the items selected for the TCMA, most of these differences are within the boundaries of sampling error. As the most extreme example, consider the 49 score points selected by the Russian Federation for the seventh grade. The Russian students did substantially better on these items than on the test as a whole, with 61% correct responses to these items, on average, compared to 50% average correct on the items on the test as a whole.

[5] Small differences in performance in these tables are not statistically significant. The standard errors for the estimated average percent correct statistics can found in Tables B.3 and B.4. We can say with 95% confidence that the value for the entire population will fall between the sample estimate plus or minus two standard errors.

However, all other countries also did better on these particular items, with an international average of 54% for the items selected by the Russian Federation compared with 50% on the test as a whole. Only 8 of the 22 countries that performed better than the Russian students on the overall test also did so on the items selected by the Russian Federation. However, 10 countries with the same or higher overall performance were within 5 percentage points of the Russian students on these items.

The TCMA results provide evidence that the TIMSS science test provides a reasonable basis for comparing achievement for the participating countries. This result is not unexpected, since making the test as fair as possible was a major consideration in test development. The fact that the majority of countries indicated that most items were appropriate for their students means that the different average percent correct estimates were based substantially on the same items. Insofar as countries rejected items that would be difficult for their own students, these items tended to be difficult for students in other countries as well. The analysis shows that omitting such items tends to improve the results for that country, but also tends to improve the results for all other countries, so that the overall pattern of results is largely unaffected.

Table B.3 Standard Errors for the Test-Curriculum Matching Analysis Results - Science - Upper Grade (Eighth Grade*)

See Table B.1 for the Test-Curriculum Matching Analysis Results

Instructions: Read *across* the row for the standard error for the score based on the test items included by each of the countries across the top.

Read *down* the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.

Read along the *diagonal* for the standard error for the score for each different country based on its own decisions about the test items to include.

Country	Average Percent Correct on All Items	Singapore	Korea	Japan	Czech Republic	*Netherlands*	*Bulgaria*	*Slovenia*	*Austria*	England	Hungary	Belgium (Fl)	*Australia*	Slovak Republic	Sweden	Canada	Ireland	United States	Russian Federation	*Germany*	New Zealand	Norway	Hong Kong	*Israel*	Switzerland	Spain	*Scotland*	France	Iceland	*Greece*	*Denmark*	*Belgium (Fr)*	Latvia (LSS)	Portugal	*Romania*	Lithuania	Iran, Islamic Rep.	Cyprus	*Kuwait*	*Colombia*	*South Africa*
(Number of Score Points Included)	146**	109	59	86	136	102	112	140	131	124	129	98	133	129	125	121	90	146	96	129	126	111	68	102	105	146	97	73	146	111	70	58	113	133	99	120	87	78	131	112	74
Singapore	70 (1.0)	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.9	1.0	1.0	1.0	0.9	0.9	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9	1.1	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0
Korea	66 (0.4)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4
Japan	65 (0.3)	0.3	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3
Czech Republic	64 (0.8)	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.9	0.8	0.9	0.9
Netherlands	62 (1.1)	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.1	1.0	1.2	1.1	1.0	1.1	1.2	1.0	1.1	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.1	0.9
Bulgaria	62 (1.0)	1.0	1.3	0.9	0.9	1.0	1.0	1.0	0.9	0.9	1.0	0.9	1.0	1.0	1.0	0.9	0.9	1.0	1.0	0.9	0.9	1.0	0.9	1.0	0.9	1.0	0.9	1.1	1.0	0.9	0.9	0.9	1.0	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.1
Slovenia	62 (0.5)	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6
Austria	61 (0.7)	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
England	61 (0.6)	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
Hungary	61 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
Belgium (Fl)	60 (1.1)	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.1	1.2	1.0	1.2	1.1	1.0	1.1	1.2	1.2	1.1	1.2	1.2	1.2
Australia	60 (0.7)	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7
Slovak Republic	59 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sweden	59 (0.6)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6
Canada	59 (0.5)	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5
Ireland	58 (0.9)	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
United States	58 (1.0)	0.9	1.0	1.0	0.9	1.0	1.0	1.0	0.9	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0
Russian Federation	58 (0.8)	0.8	0.9	0.8	0.7	0.7	0.8	0.8	0.8	0.7	0.8	0.6	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8
Germany	58 (1.0)	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
New Zealand	58 (0.8)	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.8	0.9	0.9
Norway	58 (0.4)	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Hong Kong	58 (1.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0
Israel	57 (1.1)	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.1	1.0	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.0	1.0	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1
Switzerland	58 (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Spain	58 (0.4)	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Scotland	55 (1.0)	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
France	54 (0.6)	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Iceland	52 (0.9)	0.8	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.1	0.9	0.9	1.0	0.8	1.0	0.9	0.8	1.0	0.9	0.9	0.9	0.9	0.8
Greece	52 (0.5)	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.6
Denmark	51 (0.6)	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.6
Belgium (Fr)	50 (0.7)	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7
Latvia (LSS)	50 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Portugal	50 (0.6)	0.6	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
Romania	50 (0.8)	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.9	0.9
Lithuania	49 (0.7)	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Iran, Islamic Rep.	47 (0.6)	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Cyprus	47 (0.4)	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.5	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4
Kuwait	43 (0.9)	1.0	1.0	1.1	0.8	1.0	0.9	0.9	0.9	1.0	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.8	0.9	1.0	0.9	0.9	1.0	0.9	1.0	0.9	1.0	1.0
Colombia	39 (0.8)	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.9
South Africa	27 (1.3)	1.3	1.2	1.4	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.4	1.3	1.4	1.3	1.3	1.3	1.3	1.2	1.3	1.4	1.3	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.3
International Average	**55 (0.7)**	**0.7**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.

**Of the 135 items in the science test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 146 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses. The matrix contains standard errors corresponding to the average percent of correct responses based on TCMA subsets of items, as displayed in Table B.1. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).

Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table B.4 Standard Errors for the Test-Curriculum Matching Analysis Results - Science - Lower Grade (Seventh Grade*)

See Table B.3 for the Test-Curriculum Matching Analysis Results

Instructions: Read ***across*** the row for the standard error for the score based on the test items included by each of the countries across the top.

Read ***down*** the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.

Read along the ***diagonal*** for the standard error for the score for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	Singapore	Korea	Japan	Czech Republic	*Slovenia*	Belgium (Fl)	*Bulgaria*	*Netherlands*	England	Hungary	*Austria*	Slovak Republic	United States	Canada	*Australia*	Hong Kong	*Germany*	Ireland	Sweden	New Zealand	Norway	Switzerland	Russian Federation	Spain	Scotland	Iceland	France	Belgium (Fr)	*Romania*	*Greece*	*Denmark*	Iran, Islamic Rep.	Latvia (LSS)	Portugal	Cyprus	*Colombia*	Lithuania	*South Africa*
(Number of Score Points Included)	*146***	*83*	*44*	*46*	*108*	*132*	*45*	*106*	*34*	*105*	*98*	*53*	*111*	*146*	*79*	*94*	*33*	*88*	*60*	*86*	*110*	*93*	*36*	*49*	*132*	*50*	*146*	*26*	*23*	*92*	*72*	*20*	*48*	*46*	*81*	*29*	*79*	*109*	*26*
Singapore	61 (1.2)	1.3	1.3	1.3	1.3	1.2	1.3	1.2	1.4	1.3	1.2	1.3	1.2	1.2	1.3	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.3	1.1	1.2	1.3	1.2	1.5	1.3	1.2	1.3	1.4	1.2	1.3	1.3	1.4	1.3	1.2	1.3
Korea	61 (0.4)	0.4	0.5	0.4	0.4	0.4	0.5	0.4	0.6	0.4	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.4	0.6	0.6	0.4	0.5	0.7	0.5	0.5	0.4	0.6	0.4	0.4	0.5
Japan	59 (0.3)	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.3	0.4	0.5	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.4
Czech Republic	58 (0.8)	0.7	1.0	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.9	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	1.1	0.8	0.7	0.9	0.8	0.9	0.8	0.9	0.8	0.8	0.8
Slovenia	57 (0.5)	0.5	0.6	0.6	0.5	0.5	0.4	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.5	0.7	0.5	0.5	0.5	0.7	0.5	0.5	0.7
Belgium (Fl)	57 (0.5)	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.6	0.6	0.7	0.5	0.5	0.6	0.6	0.7	0.6	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.5	0.8	0.7	0.5	0.6	0.7	0.6	0.6	0.6	0.8	0.6	0.5	0.6
Bulgaria	56 (1.0)	1.0	1.1	1.1	1.0	1.0	1.1	1.1	1.1	1.0	1.0	1.2	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.2	1.0	1.2	1.4	0.9	1.0	1.1	1.0	1.0	0.9	1.0	1.0	1.0	1.1
Netherlands	56 (0.7)	0.7	0.9	0.8	0.7	0.7	0.8	0.7	0.9	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.9	0.8	0.7	0.8	0.8	0.8	1.0	0.8	0.8	0.8	0.7	0.9	1.0	0.7	0.9	1.1	0.9	0.9	0.9	1.0	0.9	0.7	0.8
England	56 (0.6)	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.7	0.6	0.7	0.6	0.6	0.6	0.8	0.7	0.6	0.7	0.6	0.8	0.7	0.6	0.7	0.8	0.6	0.7	0.7	0.8	0.7	0.7	0.7
Hungary	56 (0.6)	0.6	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.7	0.6	0.6	0.7	0.8	0.6	0.6	0.7	0.6	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7
Austria	55 (0.6)	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.7	0.8	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.8	0.6	0.8	0.8	0.6	0.7	0.8	0.7	0.7	0.7	0.8	0.6	0.6	0.7
Slovak Republic	54 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.6	0.7	0.6	0.7	0.6	0.6	0.7
United States	54 (1.1)	1.0	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.0	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.0	1.1	1.1	1.3	1.1	1.2	1.1	1.3	1.1	1.0	1.1
Canada	54 (0.5)	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.7	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.6	0.5	0.6	0.8	0.5	0.5	0.7	0.5	0.5	0.5	0.6	0.5	0.5	0.7
Australia	54 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Hong Kong	53 (1.2)	1.3	1.3	1.3	1.3	1.2	1.1	1.2	1.3	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.1	1.2	1.3	1.2	1.4	1.2	1.2	1.4	1.2	1.4	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.3	1.2	1.2	1.2
Germany	53 (0.8)	0.8	0.9	0.8	0.9	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.9	0.8	0.9	0.9	0.8	0.9	1.1	0.8	0.9	0.9	1.0	0.9	0.9	0.9
Ireland	52 (0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.9	0.9	0.7	0.8	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.7
Sweden	51 (0.5)	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.7	0.6	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.5	0.6	0.8	0.5	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.6	0.7
New Zealand	50 (0.7)	0.7	0.8	0.8	0.7	0.7	0.6	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.6	0.7	0.7	0.7	0.9	0.7	0.7	0.8	0.7	1.0	0.8	0.7	0.8	0.8	0.7	0.8	0.7	0.9	0.7	0.7	0.8
Norway	50 (0.6)	0.6	1.1	0.7	0.7	0.6	0.7	0.7	0.8	0.6	0.7	0.8	0.6	0.6	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.8	0.6	0.8	1.0	0.7	0.6	0.8	0.8	0.6	0.6	0.7	0.6	0.6	0.8
Switzerland	50 (0.4)	0.4	0.5	0.5	0.4	0.4	0.5	0.4	0.5	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.5	0.4	0.5	0.5	0.4	0.6	0.5	0.4	0.5	0.4	0.7	0.5	0.4	0.5	0.6	0.4	0.5	0.4	0.6	0.5	0.4	0.5
Russian Federation	50 (0.8)	0.8	0.8	0.7	0.8	0.8	0.9	0.8	0.8	0.7	0.8	0.9	0.8	0.8	0.7	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	1.0	0.9	0.8	0.8	1.0	0.9	0.7	0.7	0.8	0.7	0.8	1.0
Spain	49 (0.4)	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.4	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.5	0.6	0.5	0.5	0.6	0.5	0.6	0.5	0.6	0.4	0.4	0.6
Scotland	48 (0.8)	0.8	0.9	0.8	0.8	0.8	0.7	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.9	0.8	0.7	0.8	0.8	0.8	1.0	0.8	0.8	0.8	0.8	1.0	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.8	0.8	0.8
Iceland	46 (0.6)	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.9	0.7	0.7	0.9	0.6	0.6	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.6	0.8	0.7	0.7	0.6	0.8	0.7	0.7	0.6	0.9	0.7	0.7	0.8
France	46 (0.6)	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.6	0.6	0.6	0.6	0.8	0.8	0.6	0.7	0.8	0.6	0.7	0.6	0.8	0.6	0.6	0.7
Belgium (Fr)	45 (0.7)	0.6	0.7	0.8	0.6	0.7	0.7	0.6	0.8	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.8	0.7	0.8	0.8	0.6	0.8	1.0	0.7	0.8	0.7	0.9	0.7	0.6	0.8
Romania	45 (0.8)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.8
Greece	45 (0.5)	0.5	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.7	0.6	0.5	0.6	0.5	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.5	0.7
Denmark	44 (0.4)	0.4	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.4	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.4	0.6	0.7	0.5	0.5	0.7	0.6	0.5	0.4	0.6	0.4	0.4	0.6
Iran, Islamic Rep.	42 (0.6)	0.6	0.9	0.8	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.8	0.6	0.6	0.7	0.8	0.6	0.9	0.6	0.6	0.8	0.6	0.7	0.7	0.7	0.8	0.8	0.6	0.7	0.7	0.9	0.7	0.6	0.7
Latvia (LSS)	42 (0.5)	0.6	0.6	0.6	0.6	0.5	0.7	0.6	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.7	0.5	0.5	0.6	0.5	0.8	0.7	0.5	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.5	0.8
Portugal	41 (0.5)	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.8	0.5	0.6	0.5	0.7	0.5	0.5	0.5
Cyprus	40 (0.4)	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.5	0.4	0.5	0.6	0.4	0.5	0.6	0.5	0.5	0.4	0.6	0.4	0.4	0.4
Lithuania	38 (0.7)	0.8	0.8	0.8	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.7	0.8	0.7	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.9	0.8	0.7	0.8
Colombia	35 (0.7)	0.6	0.9	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.6	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.7	0.7	1.0	0.8	0.8	1.0	1.0	0.6	0.7	1.0	0.8	0.8	0.6
South Africa	26 (1.0)	1.0	1.1	1.0	1.0	1.0	0.9	1.0	1.2	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	0.9	1.1	1.1	1.1	1.2	0.9	1.1	1.1	1.0	1.1	1.2	1.0	1.1	1.1	1.0	1.0	1.1	1.1	1.1	1.0	1.1
International Average	**50 (0.7)**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.8**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.

**Of the 135 items in the science test, some items had two parts and some extended-response items were scored on a two- or three-point scale, resulting in 146 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses. The matrix contains standard errors corresponding to the average percent of correct responses based on TCMA subsets of items, as displayed in Table B.2. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures (see Figure A.3 for details).

Because population coverage falls below 65% Latvia is annotated LSS for Latvian Speaking Schools only.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix C

Selected Science Achievement Results for the Philippines

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Table C.1

Philippines - Selected Achievement Results in the Sciences - Unweighted Data

Distributions of Achievement in the Sciences - Seventh Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
395 (2.8)	7	14.0	235 (1.5)	317 (2.7)	386 (4.0)	468 (4.9)	583 (5.2)

Distributions of Achievement in the Sciences - Sixth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
382 (1.8)	6	12.9	223 (4.1)	311 (4.9)	373 (2.8)	451 (3.1)	566 (1.6)

Gender Differences in Achievement in the Sciences - Seventh Grade

Boys Mean	Girls Mean	Difference
392 (3.1)	397 (2.8)	5 (4.2)

Gender Differences in Achievement in the Sciences - Sixth Grade

Boys Mean	Girls Mean	Difference
381 (2.3)	383 (1.8)	2 (2.9)

Percentages of Students Achieving International Marker Levels in the Sciences Seventh Grade

Top 10% Level	Top Quarter Level	Top Half Level
1 (0.1)	4 (0.3)	13 (0.7)

Percentages of Students Achieving International Marker Levels in the Sciences Sixth Grade

Top 10% Level	Top Quarter Level	Top Half Level
2 (0.1)	6 (0.2)	18 (0.5)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table C.1 (Continued)

Philippines - Selected Achievement Results in the Sciences - Unweighted Data

Average Percent Correct by Science Content Areas - Seventh Grade

Science Overall	Earth Science	Life Science	Physics	Chemistry	Environmental Issues & the Nature of Science
38 (0.5)	40 (0.6)	38 (0.5)	39 (0.5)	31 (0.5)	38 (0.5)

Average Percent Correct by Science Content Areas -Sixth Grade

Science Overall	Earth Science	Life Science	Physics	Chemistry	Environmental Issues & the Nature of Science
35 (0.3)	37 (0.4)	38 (0.4)	36 (0.3)	27 (0.3)	36 (0.5)

Average Percent Correct for Boys and Girls by Science Content Areas Seventh Grade

Science Overall		Earth Science		Life Science		Physics	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
37 (0.6)	38 (0.5)	40 (0.6)	40 (0.6)	38 (0.6)	39 (0.5)	39 (0.6)	38 (0.5)

Chemistry		Environmental Issues & the Nature of Science	
Boys	Girls	Boys	Girls
31 (0.6)	31 (0.5)	36 (0.6)	40 (0.6)

Average Percent Correct for Boys and Girls by Science Content Areas Sixth Grade

Science Overall		Earth Science		Life Science		Physics	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
35 (0.4)	36 (0.3)	37 (0.5)	37 (0.4)	37 (0.5)	39 (0.4)	37 (0.4)	35 (0.3)

Chemistry		Environmental Issues & the Nature of Science	
Boys	Girls	Boys	Girls
27 (0.4)	27 (0.4)	35 (0.6)	37 (0.5)

*Seventh or Eighth grades in most countries; see Table 2 for information about the grades tested in the Philippines.
() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix D

Selected Science Achievement Results for Denmark, Sweden, and Switzerland (German-Speaking) – Eighth Grade

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Table D.1

Denmark - Selected Achievement Results in the Sciences

Distributions of Science Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
523 (3.3)	8	14.9	371 (6.5)	464 (5.1)	520 (4.5)	588 (4.0)	673 (4.9)

Gender Differences in Science Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
538 (3.9)	509 (4.0)	28 (5.5)

Percentages of Students Achieving International Marker Levels in Science Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
4 (0.5)	14 (1.0)	35 (1.3)

Average Percent Correct by Science Content Areas - Eighth Grade

Science Overall	Earth Science	Life Science	Physics	Chemsitry	Environmental Issues & the Nature of Science
57 (0.7)	55 (0.8)	62 (0.8)	58 (0.7)	49 (0.9)	55 (1.2)

Average Percent Correct for Boys and Girls by Science Content Areas Eighth Grade

Science Overall		Earth Science		Life Science		Physics	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
60 (0.8)	54 (0.8)	60 (0.9)	51 (1.1)	63 (0.9)	61 (1.0)	62 (0.9)	55 (0.9)

Chemistry		Environmental Issues & the Nature of Science	
Boys	Girls	Boys	Girls
54 (1.3)	45 (1.1)	56 (1.6)	55 (1.5)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table D.2

Sweden - Selected Achievement Results in the Sciences

Distributions of Science Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
570 (4.1)	8	14.9	419 (2.5)	507 (8.1)	566 (4.3)	637 (5.6)	724 (1.6)

Gender Differences in Science Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
574 (4.7)	567 (4.4)	7 (6.4)

Percentages of Students Achieving International Marker Levels in Science Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
13 (1.0)	29 (1.4)	56 (2.1)

Average Percent Correct by Science Content Areas - Eighth Grade

Science Overall	Earth Science	Life Science	Physics	Chemsitry	Environmental Issues & the Nature of Science
64 (0.8)	64 (0.9)	69 (0.9)	63 (0.8)	63 (1.1)	57 (1.2)

Average Percent Correct for Boys and Girls by Science Content Areas Eighth Grade

Science Overall		Earth Science		Life Science		Physics	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
65 (1.0)	63 (0.9)	66 (1.1)	62 (1.1)	68 (1.1)	70 (0.9)	65 (1.0)	61 (0.9)

Chemistry		Environmental Issues & the Nature of Science	
Boys	Girls	Boys	Girls
65 (1.4)	60 (1.2)	57 (1.5)	58 (1.6)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table D.3

Switzerland (German Speaking) - Selected Achievement Results in the Sciences

Distributions of Science Achievement - Eighth Grade

Mean	Years of Formal Schooling	Average Age	5th Percentile (Scale Score)	25th Percentile (Scale Score)	50th Percentile (Scale Score)	75th Percentile (Scale Score)	95th Percentile (Scale Score)
565 (3.1)	8	15.1	416 (4.8)	501 (2.1)	563 (4.3)	631 (3.8)	718 (5.2)

Gender Differences in Science Achievement - Eighth Grade

Boys Mean	Girls Mean	Difference
578 (4.0)	553 (3.7)	26 (5.4)

Percentages of Students Achieving International Marker Levels in Science Eighth Grade

Top 10% Level	Top Quarter Level	Top Half Level
11 (0.8)	28 (1.3)	54 (1.7)

Average Percent Correct by Science Content Areas - Eighth Grade

Science Overall	Earth Science	Life Science	Physics	Chemsitry	Environmental Issues & the Nature of Science
63 (0.5)	64 (0.7)	66 (0.6)	63 (0.6)	57 (0.8)	57 (1.1)

Average Percent Correct for Boys and Girls by Science Content Areas Eighth Grade

Science Overall		Earth Science		Life Science		Physics	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
65 (0.7)	60 (0.7)	67 (1.0)	61 (0.9)	67 (0.7)	65 (0.7)	68 (0.7)	60 (0.9)

Chemistry		Environmental Issues & the Nature of Science	
Boys	Girls	Boys	Girls
62 (1.3)	53 (1.1)	58 (1.5)	55 (1.3)

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Appendix E

Percentiles and Standard Deviations of Science Achievement

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Table E.1

Percentiles of Achievement in the Sciences Upper Grade (Eighth Grade*)

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	371 (6.6)	475 (4.6)	545 (6.5)	619 (3.9)	720 (1.4)
Austria	395 (6.0)	499 (4.1)	558 (3.7)	623 (6.0)	721 (2.6)
Belgium (Fl)	416 (5.3)	499 (6.6)	548 (4.9)	609 (4.5)	680 (1.4)
Belgium (Fr)	332 (5.4)	415 (3.9)	472 (5.3)	532 (4.5)	609 (5.7)
Bulgaria	386 (5.2)	488 (2.0)	560 (7.3)	641 (4.3)	747 (6.9)
Canada	380 (3.7)	472 (4.2)	529 (4.0)	594 (3.0)	685 (3.8)
Colombia	291 (8.3)	358 (6.4)	410 (5.8)	467 (8.8)	533 (2.6)
Cyprus	316 (1.4)	403 (2.8)	462 (3.0)	526 (2.9)	605 (4.2)
Czech Republic	438 (4.9)	513 (2.9)	570 (5.3)	634 (5.1)	716 (4.5)
Denmark	334 (5.4)	423 (3.8)	477 (3.6)	541 (3.2)	615 (3.0)
England	380 (2.0)	484 (5.2)	549 (5.9)	625 (4.7)	727 (6.7)
France	374 (3.9)	446 (4.6)	498 (3.9)	553 (3.1)	623 (4.6)
Germany	362 (9.3)	463 (6.6)	535 (8.5)	602 (4.2)	691 (5.5)
Greece	363 (3.8)	439 (2.3)	495 (2.2)	557 (3.0)	643 (1.4)
Hong Kong	376 (10.6)	467 (7.1)	524 (7.2)	583 (4.1)	669 (1.4)
Hungary	408 (6.1)	497 (5.2)	552 (4.2)	616 (4.2)	703 (2.5)
Iceland	363 (0.6)	442 (5.3)	491 (3.8)	555 (6.9)	623 (14.7)
Iran, Islamic Rep.	355 (4.3)	422 (2.5)	467 (2.8)	520 (2.3)	592 (6.8)
Ireland	383 (2.6)	471 (10.1)	536 (5.0)	605 (4.9)	694 (1.9)
Israel	356 (14.7)	460 (9.1)	526 (10.4)	591 (5.3)	694 (11.1)
Japan	421 (0.5)	514 (4.3)	573 (1.5)	632 (1.8)	715 (1.7)
Korea	408 (1.2)	504 (1.8)	564 (2.4)	629 (4.1)	719 (1.4)
Kuwait	316 (7.1)	380 (5.4)	427 (3.4)	484 (4.9)	551 (2.7)
Latvia (LSS)	353 (4.4)	432 (5.4)	482 (2.4)	540 (3.0)	625 (6.5)
Lithuania	346 (2.7)	421 (8.5)	476 (5.8)	533 (3.1)	613 (5.3)
Netherlands	419 (11.7)	505 (9.3)	561 (6.0)	619 (5.0)	701 (8.8)
New Zealand	364 (6.9)	458 (6.3)	524 (5.5)	594 (3.6)	692 (3.7)
Norway	385 (3.8)	470 (1.9)	526 (3.0)	588 (1.9)	671 (4.7)
Portugal	362 (4.4)	429 (1.1)	477 (1.4)	531 (2.1)	602 (5.3)
Romania	321 (3.8)	420 (8.5)	484 (5.2)	556 (6.7)	653 (6.6)
Russian Federation	386 (8.5)	474 (8.1)	535 (5.3)	606 (3.6)	697 (8.0)
Scotland	357 (7.7)	451 (4.3)	513 (6.7)	584 (6.3)	686 (6.2)
Singapore	457 (5.2)	541 (7.4)	603 (7.4)	674 (6.5)	768 (6.1)
Slovak Republic	396 (7.1)	484 (8.8)	543 (5.6)	607 (4.3)	696 (2.3)
Slovenia	421 (2.9)	501 (4.7)	556 (4.2)	620 (3.6)	709 (4.6)
South Africa	185 (2.8)	261 (4.7)	313 (3.6)	376 (9.2)	526 (15.3)
Spain	393 (4.0)	465 (1.7)	514 (2.9)	571 (3.1)	649 (3.3)
Sweden	386 (5.5)	476 (6.2)	533 (5.2)	598 (4.1)	686 (1.7)
Switzerland	371 (3.9)	460 (5.2)	524 (4.9)	587 (4.6)	669 (0.9)
Thailand	409 (2.3)	479 (4.5)	525 (5.6)	575 (4.8)	646 (4.2)
United States	359 (6.3)	465 (7.7)	537 (6.5)	608 (5.4)	705 (8.6)

*Eighth grade in most countries; see Table 2 for more information about the grades tested in each country.
() Standard errors appear in parentheses.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table E.2

Percentiles of Achievement in the Sciences Lower Grade (Seventh Grade*)

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	339 (6.7)	437 (7.9)	504 (3.6)	576 (3.1)	676 (9.4)
Austria	368 (12.8)	460 (5.1)	521 (3.5)	583 (6.0)	671 (6.0)
Belgium (Fl)	412 (3.7)	480 (4.7)	526 (3.2)	579 (5.2)	648 (1.0)
Belgium (Fr)	312 (7.5)	391 (2.2)	443 (3.8)	494 (7.1)	572 (1.6)
Bulgaria	360 (8.6)	464 (2.6)	530 (7.4)	601 (7.8)	701 (10.5)
Canada	358 (8.6)	441 (3.1)	496 (1.6)	559 (4.0)	653 (4.4)
Colombia	271 (8.1)	338 (5.6)	386 (4.2)	439 (5.2)	505 (2.8)
Cyprus	279 (8.1)	364 (3.4)	422 (2.1)	480 (3.8)	559 (1.8)
Czech Republic	398 (2.7)	479 (5.3)	534 (6.3)	587 (7.4)	671 (9.6)
Denmark	298 (2.8)	386 (1.3)	436 (3.1)	501 (2.6)	581 (20.6)
England	342 (6.9)	444 (3.6)	511 (4.4)	584 (11.0)	678 (8.9)
France	330 (3.3)	402 (3.3)	453 (5.9)	502 (1.4)	574 (2.0)
Germany	345 (7.6)	439 (7.3)	499 (5.1)	564 (8.3)	655 (4.3)
Greece	306 (1.0)	389 (5.0)	448 (4.1)	510 (2.4)	593 (2.7)
Hong Kong	350 (8.9)	440 (5.3)	497 (7.3)	556 (4.0)	633 (5.1)
Hungary	363 (5.9)	458 (7.6)	519 (5.8)	581 (5.1)	668 (7.2)
Iceland	346 (3.5)	412 (5.9)	458 (3.4)	513 (4.0)	593 (1.5)
Iran, Islamic Rep.	324 (6.9)	387 (1.6)	433 (3.0)	486 (4.9)	557 (5.1)
Ireland	348 (5.4)	435 (6.1)	494 (5.1)	558 (7.4)	645 (6.4)
Japan	387 (3.8)	477 (1.1)	530 (2.3)	589 (2.7)	672 (6.6)
Korea	379 (8.4)	478 (5.1)	538 (2.1)	598 (4.0)	677 (9.5)
Latvia (LSS)	311 (5.2)	385 (4.2)	432 (2.2)	490 (3.6)	562 (4.8)
Lithuania	273 (3.2)	355 (5.1)	400 (4.3)	455 (4.7)	536 (2.8)
Netherlands	389 (5.4)	467 (5.9)	518 (4.0)	574 (4.6)	642 (5.6)
New Zealand	324 (6.6)	416 (7.7)	481 (5.6)	548 (3.2)	642 (9.7)
Norway	344 (2.3)	431 (5.5)	483 (4.4)	543 (4.2)	621 (11.0)
Portugal	317 (2.4)	381 (3.0)	425 (2.9)	476 (4.3)	549 (1.7)
Romania	290 (6.1)	384 (7.3)	450 (6.3)	523 (5.7)	614 (10.2)
Russian Federation	333 (8.0)	419 (5.9)	480 (5.7)	549 (6.6)	648 (11.7)
Scotland	323 (10.3)	407 (6.0)	465 (5.2)	534 (5.5)	631 (4.7)
Singapore	380 (8.1)	480 (11.2)	548 (9.9)	613 (7.7)	708 (4.1)
Slovak Republic	374 (3.8)	453 (8.5)	507 (3.4)	565 (5.0)	652 (6.2)
Slovenia	395 (9.1)	471 (1.7)	523 (3.7)	590 (2.7)	675 (6.0)
South Africa	178 (3.8)	258 (3.4)	310 (4.7)	369 (6.7)	486 (15.6)
Spain	350 (1.4)	422 (3.4)	474 (2.5)	532 (4.0)	612 (2.9)
Sweden	351 (4.6)	434 (3.9)	485 (3.0)	547 (9.0)	627 (1.5)
Switzerland	350 (3.8)	430 (3.5)	484 (3.2)	538 (3.1)	617 (4.3)
Thailand	379 (2.6)	448 (3.3)	492 (3.7)	542 (3.0)	605 (3.9)
United States	337 (9.5)	438 (10.7)	507 (7.3)	582 (6.8)	681 (7.2)

*Seventh grade in most countries; see Table 2 for more information about the grades tested in each country.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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Table E.3

Standard Deviations of Achievement in the Sciences
Upper Grade (Eighth Grade*)

Country	Overall		Boys		Girls	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	545 (3.9)	106	550 (5.2)	110	540 (4.1)	103
Austria	558 (3.7)	98	566 (4.0)	97	549 (4.6)	98
Belgium (Fl)	550 (4.2)	81	558 (6.0)	82	543 (5.8)	79
Belgium (Fr)	471 (2.8)	86	479 (4.8)	89	463 (2.9)	81
Bulgaria	565 (5.3)	111	– –	–	– –	–
Canada	531 (2.6)	93	537 (3.1)	95	525 (3.7)	89
Colombia	411 (4.1)	76	418 (7.3)	79	405 (4.6)	71
Cyprus	463 (1.9)	89	461 (2.2)	93	465 (2.7)	83
Czech Republic	574 (4.3)	87	586 (4.2)	87	562 (5.8)	85
Denmark	478 (3.1)	88	494 (3.6)	90	463 (3.9)	83
England	552 (3.3)	106	562 (5.6)	108	542 (4.2)	102
France	498 (2.5)	77	506 (2.7)	76	490 (3.3)	77
Germany	531 (4.8)	101	542 (5.9)	101	524 (4.9)	99
Greece	497 (2.2)	85	505 (2.6)	85	489 (3.1)	84
Hong Kong	522 (4.7)	89	535 (5.5)	90	507 (5.1)	86
Hungary	554 (2.8)	90	563 (3.1)	89	545 (3.4)	90
Iceland	494 (4.0)	79	501 (5.1)	83	486 (4.6)	74
Iran, Islamic Rep.	470 (2.4)	73	477 (3.8)	76	461 (3.2)	67
Ireland	538 (4.5)	96	544 (6.6)	99	532 (5.2)	92
Israel	524 (5.7)	104	545 (6.4)	103	512 (6.1)	98
Japan	571 (1.6)	90	579 (2.4)	93	562 (2.0)	86
Korea	565 (1.9)	94	576 (2.7)	95	551 (2.3)	91
Kuwait	430 (3.7)	74	– –	–	– –	–
Latvia (LSS)	485 (2.7)	81	492 (3.3)	82	478 (3.2)	79
Lithuania	476 (3.4)	81	484 (3.8)	81	470 (4.0)	81
Netherlands	560 (5.0)	85	570 (6.4)	85	550 (4.9)	83
New Zealand	525 (4.4)	100	538 (5.4)	103	512 (5.2)	95
Norway	527 (1.9)	87	534 (3.2)	91	520 (2.0)	83
Portugal	480 (2.3)	74	490 (2.8)	73	468 (2.7)	73
Romania	486 (4.7)	102	492 (5.3)	104	480 (5.0)	99
Russian Federation	538 (4.0)	95	544 (4.9)	97	533 (3.7)	93
Scotland	517 (5.1)	100	527 (6.4)	102	507 (4.7)	96
Singapore	607 (5.5)	95	612 (6.7)	95	603 (7.0)	95
Slovak Republic	544 (3.2)	92	552 (3.5)	92	537 (3.9)	92
Slovenia	560 (2.5)	88	573 (3.2)	89	548 (3.2)	85
South Africa	326 (6.6)	99	337 (9.5)	102	315 (6.0)	94
Spain	517 (1.7)	78	526 (2.1)	77	508 (2.3)	77
Sweden	535 (3.0)	90	543 (3.4)	91	528 (3.4)	89
Switzerland	522 (2.5)	91	529 (3.2)	94	514 (3.0)	87
Thailand	525 (3.7)	72	524 (3.9)	72	526 (4.3)	72
United States	534 (4.7)	106	539 (4.9)	110	530 (5.2)	101

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
A dash (–) indicates data are not available.
( ) Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table E.4

Standard Deviations of Achievement in the Sciences Lower Grade (Seventh Grade*)

Country	Overall Mean	Overall Standard Deviation	Boys Mean	Boys Standard Deviation	Girls Mean	Girls Standard Deviation
Australia	504 (3.6)	103	507 (5.2)	107	502 (4.0)	98
Austria	519 (3.1)	94	522 (4.3)	98	516 (4.1)	90
Belgium (Fl)	529 (2.6)	73	536 (3.3)	75	521 (3.1)	71
Belgium (Fr)	442 (3.0)	79	453 (3.6)	78	432 (3.5)	78
Bulgaria	531 (5.4)	103	– –	–	– –	–
Canada	499 (2.3)	90	505 (2.9)	94	493 (2.5)	84
Colombia	387 (3.2)	72	396 (3.8)	74	378 (4.4)	69
Cyprus	420 (1.8)	87	420 (2.8)	91	420 (2.6)	82
Czech Republic	533 (3.3)	82	543 (3.2)	82	523 (4.1)	80
Denmark	439 (2.1)	86	452 (3.0)	89	427 (2.8)	83
England	512 (3.5)	101	522 (5.6)	103	500 (4.6)	97
France	451 (2.6)	74	461 (3.1)	76	443 (3.0)	72
Germany	499 (4.1)	96	505 (4.9)	97	495 (4.5)	93
Greece	449 (2.6)	87	452 (3.2)	90	446 (2.8)	85
Hong Kong	495 (5.5)	86	503 (6.6)	88	485 (5.8)	83
Hungary	518 (3.2)	91	525 (3.9)	94	510 (3.4)	89
Iceland	462 (2.8)	75	468 (4.4)	77	456 (2.4)	73
Iran, Islamic Rep.	436 (2.6)	72	443 (2.9)	75	428 (4.1)	66
Ireland	495 (3.5)	91	504 (4.6)	91	487 (4.5)	90
Israel	– –	–	– –	–	– –	–
Japan	531 (1.9)	86	536 (2.6)	89	526 (1.9)	83
Korea	535 (2.1)	92	545 (2.8)	92	521 (3.2)	90
Kuwait	– –	–	– –	–	– –	–
Latvia (LSS)	435 (2.7)	78	440 (3.6)	81	430 (3.0)	74
Lithuania	403 (3.4)	79	405 (3.5)	81	401 (4.2)	77
Netherlands	517 (3.6)	79	523 (4.0)	80	512 (4.4)	78
New Zealand	481 (3.4)	97	489 (4.3)	100	472 (3.7)	92
Norway	483 (2.9)	85	489 (3.6)	88	477 (3.6)	81
Portugal	428 (2.1)	71	436 (2.4)	74	420 (2.4)	68
Romania	452 (4.4)	100	456 (4.7)	101	448 (4.9)	99
Russian Federation	484 (4.2)	94	493 (5.3)	99	475 (3.8)	89
Scotland	468 (3.8)	94	477 (4.4)	97	459 (4.1)	90
Singapore	545 (6.6)	100	548 (7.9)	102	541 (8.2)	98
Slovak Republic	510 (3.0)	85	520 (4.0)	86	499 (3.1)	82
Slovenia	530 (2.4)	86	539 (3.0)	86	521 (2.8)	85
South Africa	317 (5.3)	92	324 (6.4)	93	312 (5.2)	91
Spain	477 (2.1)	80	487 (2.9)	82	467 (2.3)	76
Sweden	488 (2.6)	84	493 (2.9)	87	484 (3.3)	81
Switzerland	484 (2.5)	82	492 (2.9)	83	475 (2.9)	80
Thailand	493 (3.0)	69	495 (3.3)	71	492 (3.5)	68
United States	508 (5.5)	105	514 (6.3)	109	502 (5.8)	100

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.
A dash (–) indicates data are not available. Israel and Kuwait did not test the lower grade.
( ) Standard errors appear in parentheses.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994–95.

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Appendix F

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MANAGEMENT AND OPERATIONS

Since 1993, TIMSS has been directed by the International Study Center at Boston College in the United States. Prior to this, the study was coordinated by the International Coordinating Center at the University of British Columbia in Canada. Although the study was directed centrally by the International Study Center and its staff members implemented various parts of TIMSS, important activities also were carried out in centers around the world. The data were processed centrally by the IEA Data Processing Center in Hamburg, Germany. Statistics Canada was responsible for collecting and evaluating the sampling documentation from each country and for calculating the sampling weights. The Australian Council for Educational Research conducted the scaling of the achievement data.

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NATIONAL RESEARCH COORDINATORS

The TIMSS National Research Coordinators and their staff had the enormous task of implementing the TIMSS design in their countries. This required obtaining funding for the project; participating in the development of the instruments and procedures; conducting field tests; participating in and conducting training sessions; translating the instruments and procedural manuals into the local language; selecting the sample of schools and students; working with the schools to arrange for the testing; arranging for data collection, coding, and data entry; preparing the data files for submission to the IEA Data Processing Center; contributing to the development of the international reports; and preparing national reports. The way in which the national centers operated and the resources that were available varied considerably across the TIMSS countries. In some countries, the tasks were conducted centrally, while in others, various components were subcontracted to other organizations. In some countries, resources were more than adequate, while in others, the national centers were operating with limited resources. Of course, across the life of the project, some NRCs have changed. This list attempts to include all past NRCs who served for a significant period of time as well as all the present NRCs. All of the TIMSS National Research Coordinators and their staff members are to be commended for their professionalism and their dedication in conducting all aspects of TIMSS.

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The International Study Center was supported in its work by several advisory committees. The International Steering Committee provided guidance to the International Study Director on policy issues and general direction of the study. The TIMSS Technical Advisory Committee provided guidance on issues related to design, sampling, instrument construction, analysis, and reporting, ensuring that the TIMSS methodologies and procedures were technically sound. The Subject Matter Advisory Committee ensured that current thinking in mathematics and science education were addressed by TIMSS, and was instrumental in the development of the TIMSS tests. The Free-Response Item Coding Committee developed the coding rubrics for the free-response items. The Performance Assessment Committee worked with the Performance Assessment Coordinator to develop the TIMSS performance assessment. The Quality Assurance Committee helped to develop the quality assurance program.

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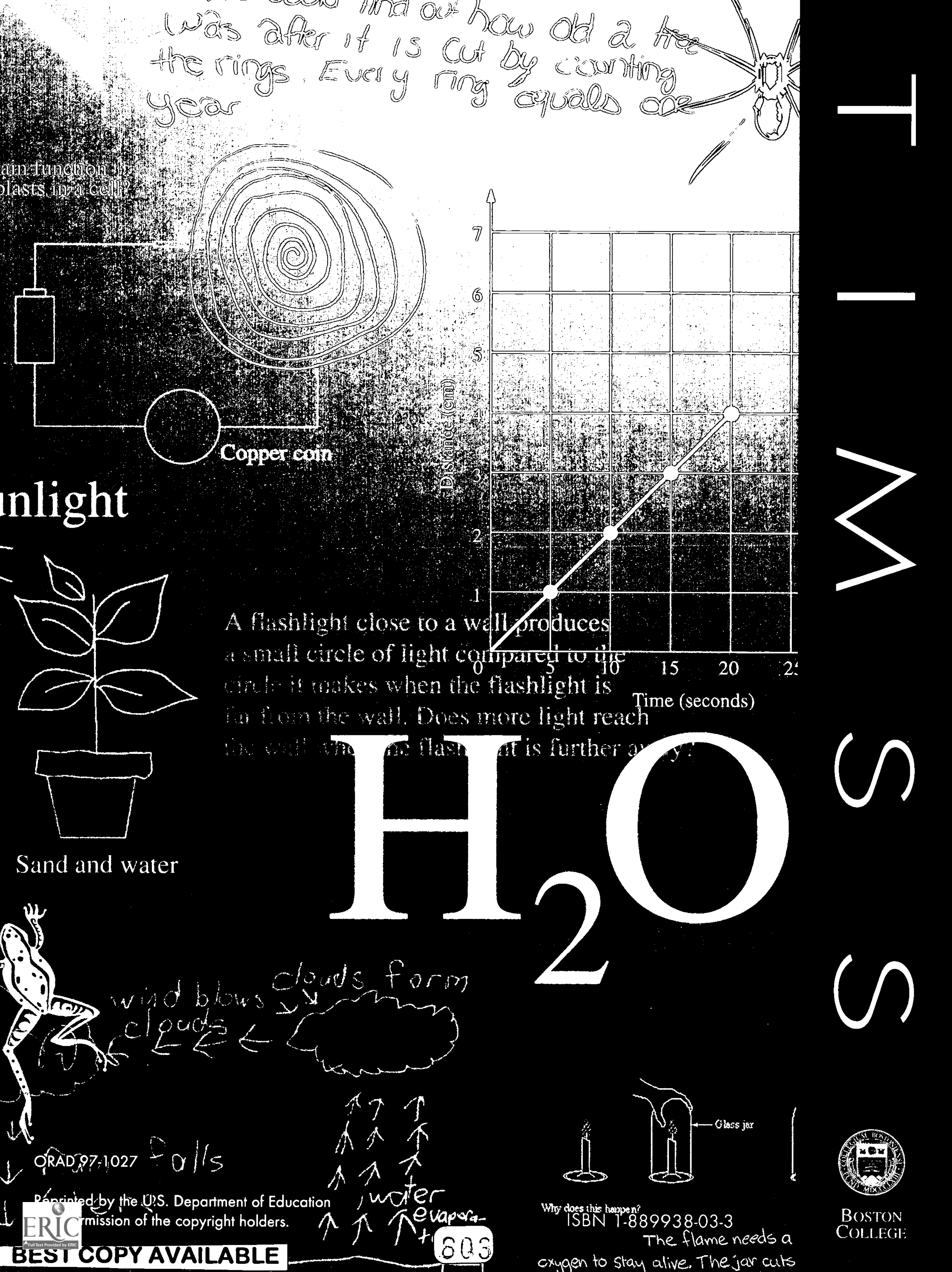

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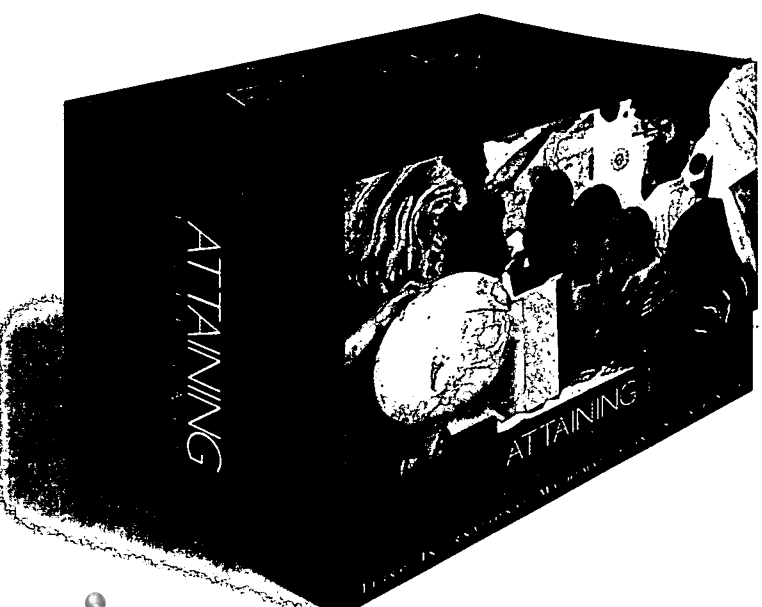

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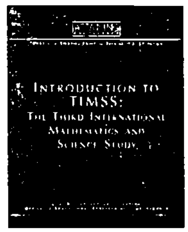

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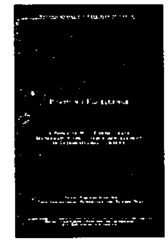

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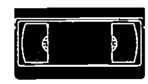

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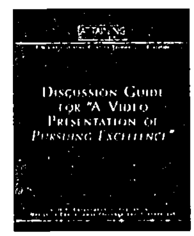

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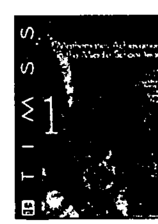

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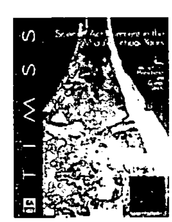

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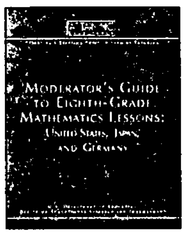

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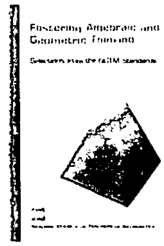

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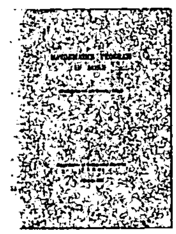

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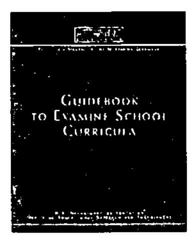

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TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and the National Science Foundation. The study tested the

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TIMSS AS A STARTING POINT TO EXAMINE TEACHING

MODERATOR'S GUIDE TO EIGHTH-GRADE MATHEMATICS LESSONS: UNITED STATES, JAPAN, AND GERMANY

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INTRODUCTION TO THE *MODERATOR'S GUIDE*

Overview of the TIMSS Project

The 1995-1996 Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive international study of schools ever conducted. The study tested a half-million students from 41 nations in 30 languages at three different education levels (fourth, eighth, and twelfth grades) to compare their achievement in mathematics and science. The study also involved analyses of students, teachers, schools, curricula, instruction, and policy in order to understand the educational context in which teaching and learning take place.

Additionally, TIMSS included an extensive videotape survey of eighth-grade mathematics lessons in the United States, Japan, and Germany. The TIMSS Videotape Classroom Study is the first attempt to collect videotaped observations of classroom instruction from nationally representative samples of schools and classes. The purpose of gathering this information was to understand better the processes of classroom instruction in different cultures in order to improve student learning in our schools. The primary aim was to show teachers (and others) some of the different possibilities for structuring and presenting lessons so they can look at their own teaching with the fresh perspective provided by an international lens. This module was designed to help teachers think about why they teach as they do, what thinking lies behind the choices they make, what goals they emphasize through a lesson, and how they instruct and interact with students.

The purpose of the TIMSS Videotape Classroom Study is not to prescribe any single way to teach or to learn. Nor does TIMSS suggest that U.S. teachers should duplicate either Japanese or German methods. Teaching in the United States, Japan, and Germany has evolved from different goals and cultures, yet educators in one country can be stimulated to reflect on their own behavior by observing their counterparts in other countries.

Use of the *Moderator's Guide*

This teaching module, with its videotape of lessons from U.S., Japanese, and German classrooms, is designed to help you, the moderator, facilitate discussions among educators. The TIMSS Videotape Classroom Study offers resources that can be useful in improving U.S. education for all students, but the effective use of these resources requires systematic planning. Hence, as the moderator, you should read the *Moderator's Guide* and view the videotape prior to facilitating a discussion. The guide will help you to make appropriate decisions about your own sessions and suggest things to consider as you plan for and facilitate the discussion of the TIMSS videotape, *Eighth-Grade Mathematics Lessons: United States, Japan, and Germany.* The guide is intended to be flexible in that it can be modified and used repeatedly. **You are permitted to reproduce any of the pages in this guide for use in your discussions.**

Goals for Sessions Based on the *Moderator's Guide*

Viewing and discussing the videotaped lessons offers us an opportunity to:

- talk together about teaching in the United States, Japan, and Germany.
- talk together about a shared example of teaching that is not our own and not our colleagues'.
- develop a common language for discussing teaching.
- develop new norms for teaching.
- discuss the elements of teaching that make mathematically strong lessons.
- learn about teaching, learning, and children from watching and talking about instances of practice.
- learn about ourselves and others while learning other countries' ways of thinking about mathematics teaching and learning.

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Development of the Videotape

The teachers in the accompanying videotape volunteered to participate and agreed to public distribution of the videotape. The six lessons in this production were not among the lessons actually taped as part of the TIMSS study, because those teachers were promised that their videotapes would be kept confidential. Nevertheless, the teachers and lessons in the accompanying videotape are representative of those in the actual study. The teachers shown are ordinary teachers, working within the constraints of their various systems. The purpose of the videotape is not to present extraordinary teaching for U.S. teachers to imitate. Instead, it is intended to help viewers discuss how teaching may relate to student learning.

Organization of the *Moderator's Guide*

- **Preparation for Sessions to Discuss the TIMSS Videotape—*Eighth-Grade Mathematics Lessons: United States, Japan, and Germany.*** This section provides guidelines for using the videotape to facilitate group discussions and suggests how to prepare for those discussions, including possible focus areas and agendas.
- **The Six Lessons: A Discussion Guide.** This section provides a series of descriptions, with pertinent sidebars, of the U.S., Japanese, and German geometry and algebra lessons that appear on the videotape. The descriptions include tips to help you facilitate the discussion sessions.
- **Research Methods and Findings of the TIMSS Videotape Classroom Study.** This section provides further information on the TIMSS Videotape Classroom Study, as well as detailed explanations of the methodology and the results.
- **Background on Education in the United States, Japan, and Germany.** This section briefly describes education, schooling, and curricula in each of the three countries.
- **Frequently Asked Questions and Answers.** This section provides information about the TIMSS study that may be useful in dealing with discussion participants' questions.

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- **Handout/Transparency Masters.** This section provides master copies for reproduction of pre- and postdiscussion participant questions and general questions for participants to keep in mind while viewing the lessons. They can be duplicated for use by participants or photocopied onto transparencies.
- **Lesson Tables.** This section contains tables that provide a graphic overview of the complete subject matter and the instructional format of each of the six lessons.
- **Lesson Transcripts.** This section contains transcripts of the videotaped portions of the six lessons.

Additional discussion resources included as part of the teaching module: The Japanese standards *Mathematics Program in Japan (Kindergarten to Upper Secondary School)* and *Fostering Algebraic and Geometric Thinking: Selected Standards from the NCTM Standards Documents.*

PREPARATION FOR SESSIONS TO DISCUSS THE TIMSS VIDEOTAPE—*EIGHTH-GRADE MATHEMATICS LESSONS: UNITED STATES, JAPAN, AND GERMANY*

In preparing to facilitate the discussion of the TIMSS videotape *Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*, you will want to study this *Moderator's Guide* carefully and view the videotape once or twice. Then, think carefully about how to conduct your viewing and discussion session. For help in preparing your session, this guide includes some suggestions based on field tests in which a variety of audiences viewed the videotape.

In addition, you also will find it helpful to have the overview module to this Resource Kit, *Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education.* Two other modules you may want to refer to are *TIMSS as a Starting Point to Examine Student Achievement* and *TIMSS as a Starting Point to Examine Curricula.*

SESSION SIZE

The most successful sessions occur with small groups of up to 20 people, although the materials can also be successfully used with groups of as many as 100. The larger the group, the more time needed. For example, larger groups may need time to divide into small groups of four to six people to discuss key issues around teaching and learning and then reconvene and share their thoughts with the larger group. Also, large groups may need multiple TV monitors or a screen large enough for all participants to view it.

PARTICIPANT MIX

When preparing for a viewing of the videotape, think about the audience's knowledge of TIMSS in general. For example: Do participants have knowledge of what TIMSS is? What do they know about the findings other than the comparison of scores they may have heard about through the media?

Even if the participants already have some information about TIMSS, the study is so large and complex that you should discuss it before showing the videotape. The overheads provided in the booklet, *Introduction to TIMSS:*

The Third International Mathematics and Science Study, provided in this Resource Kit, will help you with this introduction. Another option is to use two sessions, one to focus on TIMSS as a whole and another to focus on the teaching module.

Think about who your participants are and where they come from. This will help you tailor the discussion. Are they elementary teachers, secondary math teachers, principals, or some other group? An understanding of each group, and the lens through which they are likely to view and discuss the videotape, will help you anticipate the issues that can emerge during the discussion.

For example, principals have a tendency to focus on general issues around teaching and learning and the system structures that support or inhibit teachers' efforts to improve practices. Most principals are not mathematicians, but they may support improvements in teaching practices that help students experience mathematics differently from the way they themselves did as students. Principals may feel that they are learning some mathematics from viewing the videotape. This can also be the case with non-math teachers. Tapping into non-math teachers' knowledge about teaching and learning in other subject areas enables them to connect their experiences to the discussion of mathematics teaching and learning. Secondary mathematics teachers are more inclined to focus on a lesson's mathematical content and on the cultural reasons for differences in teaching practices. Be prepared for the possibility that some participants may become defensive when viewing lessons from other countries.

Order of the Lessons

The order in which the lessons appear on the tape is the result of careful field testing. Geometry lessons are shown first, from the United States, Japan, then Germany, followed by algebra lessons from these countries. However, as the moderator, you may choose to change the order, as other orders may be more effective in your situation.

The videotape is designed so that discussion leaders will show the U.S. lesson first. This reduces the defensiveness that sometimes occurs if participants have seen the Japanese lessons first and feel the need to defend U.S. teachers.

An alternative, however, is to show the Japanese lesson first with the idea that, in order to look at U.S. teaching and learning from a fresh perspective, participants need first to experience looking at a different style of teaching and learning. Viewing the Japanese lesson first can help audiences begin to draw comparisons immediately when the U.S. lesson is shown.

Focus Areas for the Session

General Focus

First, offer guidance to participants about how to view the lessons overall. The general guidelines and questions in the box below will help you set the initial focus for the participants.

General Suggestions for Viewing the Lesson

Stay focused on the lesson itself: What do you notice? What do you hear? What inferences do you find yourself making and why? Look for patterns that provide clues to how and what the student/teacher was thinking.

Draw on your experience with teachers and students, and with teaching and learning, but also try to look beyond your assumptions and experiences to see with fresh eyes.

- What do you think is the teacher's goal? What does he/she seem to want students to learn? What do you think they are learning?
- What does the teacher do? Are there key moves or moments in the lesson? Are there crucial missed opportunities?
- Why do you see this lesson in this way? What does this tell you about what is important to you? Look for patterns in your thinking.
- What questions about teaching and learning did viewing the videotape raise for you?
- Are there things you would like to try in your classroom as a result of viewing the lessons? How would you need to prepare yourself and your students to try these things?

Specific Focus

Following presentation of the general guidelines, choose a specific focus area from the initial session. Focus areas to choose from include the following:

1. Mathematics instruction;
2. Communication between teacher and students; and
3. Teacher beliefs about mathematics, teaching, and learning.

The focus may dictate the lessons you need to show, the stage to set for viewing the tape, the order in which to show the lessons, and the questions to raise for discussion. Each focus area is discussed below, along with suggestions for specific questions to ask participants.

1. Mathematics Instruction

The first, and perhaps most important, focus area for the session may be the teaching methods used in the taped lessons and the learning that students experience. When leading a discussion on the teaching and learning of mathematics, try to help participants focus on the analysis of teaching and learning, rather than on what they like or dislike about a particular teacher. As the discussion unfolds, focus on key questions that can be raised again and again.

Questions About Mathematics Instruction

- What is the mathematics of the lesson?
- What seems to be the teacher's mathematical goal?
- How does the lesson flow?
- Are there logical connections between the parts of the lesson?

If responses focus on topics or ideas, probe for mathematical process goals, and vice versa, for example:

You've mentioned a topic. Are there others? Would you say there are also goals that have more to do with mathematical reasoning or thinking? **or...**

You've mentioned mathematical reasoning. Would you say that there are also goals that focus on particular mathematical topics? What do the teacher's goals seem to be? What do you think this teacher wants students to learn? What kinds of things do they seem to be learning? What evidence do you have for this?

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If the discussion moves in other directions, such as cultural or organizational issues, the key questions shown in the box below can pull the discussion back into focus. It is helpful to display the questions before playing the videotape so participants can use them in viewing and discussing the lessons. An overhead of the questions appears in the handout section. Consider making copies for participants for reference while viewing and discussing the lessons.

2. Communication Between Teacher and Students

Another key focus area for the session's participants is the communication between the teacher and the students during the taped lessons. In analyzing the communication, you may find it helpful to look at the roles of the teacher and students with regard to the mathematics discussed in each lesson. Again, the point is not to focus on what participants might judge as good or bad, but on what can be inferred about student learning from specific evidence in the videotaped lessons.

Questions About Communications Between Teachers and Students

- What does the teacher do to orchestrate discussion in the lesson? What are the questions posed to students? When and how are they posed? How do the questions elicit mathematical thinking among the students?
- What does the teacher do to use students' ideas in the discussion? Are most students involved? How are students' ideas used?
- What decisions does the teacher appear to make in regard to students' ideas or discussion? Here, you can probe for more detail by asking:
  Do there appear to be ideas that the teacher is pursuing? Are there times when the teacher decides to provide more information, clarify an issue, model a strategy, or let students struggle? What do you think that says about the teacher's goal?
- What do the students do in the lesson discussion? What do their verbal and nonverbal communication suggest about their mathematical understanding?

3. Teacher Beliefs About Mathematics, Teaching, and Learning

A third focus area for discussion is what the teacher seems to believe about mathematics, teaching, and learning. The goal is to understand what the teacher values and believes and how this seems to influence his or her teaching of mathematics and, in turn, student learning. Such a focus can help participants consider their own perspectives more explicitly.

Questions About Teachers' Beliefs About Mathematics, Teaching, and Learning

- What does this teacher seem to believe about mathematics? About the way students learn? About the role of the teacher?
- What specific evidence can you find that indicates the teacher's patterns of thinking? His or her apparent theories of teaching and learning?
- What role do you think culture plays in teacher beliefs about teaching and learning?

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LENGTH OF SESSION AND SAMPLE AGENDAS

It is strongly recommended that you plan at least a three-hour initial session. Experience shows that anything under three hours provides insufficient time for discussion, and even with three hours, you will likely have time to show only two lessons. Because the lessons provoke a lot of thought and discussion—particularly, as demonstrated by field tests, the U.S. and Japanese lessons on geometry—you may want to add three more hours, for a total of six, to show all the lessons. In field tests, for example, it took up to four hours to view and discuss just the geometry and algebra lessons of the United States and Japan. Alternatively, you may want to schedule a second session rather than trying to achieve everything in one lengthy session. For example, you might choose to view the German lessons in the second session, after participants have had a chance to digest and learn from the experience of the first session. Each of the six lessons runs approximately 15 minutes.

To help you in planning the sessions, two sample agendas follow, one for a six-hour session and one for a three-hour session.

Sample Six-Hour Agenda

(Include two 15-minute breaks and a 45-minute lunch)

(20 minutes) *Introduction:* Have participants answer the prediscussion questions as they enter (see the Handout/Transparency Masters section). Explain the TIMSS study and the TIMSS Classroom Videotape Study. Use overheads summarizing TIMSS (see handouts in the accompanying booklet, *Introduction to TIMSS: The Third International Mathematics and Science Study*). Consider providing additional information on the study's findings contained in "Research Methods and Findings of the TIMSS Videotape Classroom Study" in this *Moderator's Guide.*

(15 minutes) *Set the stage:* Before viewing the videotape, set the stage by saying, "As you watch each lesson, try not to evaluate or make judgments about whether the instruction is good or bad. Instead, try to focus on what is happening in the lesson and the teaching and learning that take place." This will keep the discussion grounded in the events on the videotape and will provide a place to return to should the discussion become evaluative. Raise the key questions and let participants choose which ones interest them as a framework for viewing the lessons.

(10 minutes) *Distribute materials:* Hand out lesson scripts, lesson tables, and focus questions to each participant for use during the viewing and discussion of the videotape.

(15 minutes) *View the videotape introduction:* Use the section "Research Methods and Findings of the TIMSS Videotape Classroom Study" in this document to clarify any questions or issues raised in relation to the study and its methodology.

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(90 minutes) *View geometry lessons*: View the U.S. lesson and organize participants in small discussion groups using the focus questions. Then, have the small groups share the main points of their discussions with the larger group. View the Japanese lesson, then discuss it, again using the small-group format with a large-group follow-up discussion. If time permits, show the German lesson.

(90 minutes) *View algebra lessons*: Follow the same procedure as with the geometry lessons.

(45 minutes) *Across all lessons:* Go back to the original focus areas. Ask small groups to look for similarities between the U.S. geometry and algebra lessons. Then ask them to think about similarities between the Japanese geometry and algebra lessons. Have the small groups share key points with the whole group. Relate the groups' thinking to the findings of the TIMSS Classroom Videotape Study wherever possible. Finally, ask the participants to answer the postdiscussion questions (see the Handout/Transparency Masters section).

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Sample Three-Hour Agenda

(Include a 10-minute break)

(20 minutes) *Introduction:* Have participants answer the prediscussion questions as they enter (see the Handout/Transparency Masters section). Explain the TIMSS study and the TIMSS Classroom Videotape Study. Use overheads summarizing TIMSS (see handouts in the accompanying booklet, *Introduction to TIMSS: The Third International Mathematics and Science Study*). Consider providing additional information on the study's findings contained in "Research Methods and Findings of the TIMSS Videotape Classroom Study" in this *Moderator's Guide.*

(15 minutes) *Set the stage:* Before viewing the videotape, set the stage by saying, "As you watch each lesson, try not to evaluate or make judgments about whether the instruction is good or bad. Instead, try to focus on what is happening in the lesson and the teaching and learning that take place." This will keep the discussion grounded in the events on the videotape and will provide a place to return to should the discussion become evaluative. Raise the key questions and let participants choose which ones interest them as a framework for viewing the lessons.

(10 minutes) *Distribute materials:* Hand out lesson scripts, lesson tables, and focus questions to each participant for use during the viewing and discussion of the videotape.

(15 minutes) *View the videotape introduction:* Use the section "Research Methods and Findings of the TIMSS Classroom Videotape Study" in this document to clarify any questions or issues raised in relation to the study and its methodology.

(80 minutes) *View geometry lessons*: View the U.S. lesson and have small groups discuss the lessons with the help of the focus questions. Then, have the small groups share the main points of their discussion with the larger group. View the Japanese lesson then discuss it using the same procedures. If time permits, show the German lesson.

(30 minutes) *Across both lessons:* Go back to the original focus area. Ask small groups to look for similarities and differences between the two lessons and then to share the main points of their discussion with the whole group. Relate the groups' thinking to the findings of the TIMSS Classroom Videotape Study wherever possible. Ask the participants to answer the postdiscussion questions (see the Handout/Transparency Masters section).

Recommendations to the Moderator

- Don't show the algebra lessons by themselves. They don't stimulate as much discussion as the geometry lessons and can result in defensiveness, depending on the audience.
- Make sure to preserve discussion time; don't cut this down!
- Allow an extra hour for discussion for each pair of lessons that you show.

Follow-Up Sessions

After the first viewing and discussion of the taped lessons, some participants might incorrectly feel that they have completed their work with these materials. You should encourage them to regard the first viewing as only the beginning of an extended journey into examining teaching practices and offer them additional opportunities to view and discuss the videotaped lessons or related issues. Follow-up sessions will allow participants to explore certain topics in greater depth, to reflect on their own practices, and to discuss their considered reflections and observations with colleagues. In addition, these sessions are opportunities to introduce new discussion themes related to the initial session. You may wish to consider the following themes:

1. Examining other focus areas

Use another one of the specific focus areas suggested above that was not used in your first session. For example, "teachers' beliefs about mathematics teaching and learning" is an especially useful focus area in the second or third session for those whose first session focused on mathematics instruction.

2. Connecting the six lessons to the findings of the TIMSS videotape study

Familiarize participants with the findings of the TIMSS Classroom Videotape Study contained in this *Moderator's Guide.* Encourage discussion of whether and how these particular lessons reflect specific findings of the larger study.

3. Examining the mathematical content

Exploring the mathematics of certain lessons, such as the Japanese geometry lesson, is an option for a two-hour session. Concentrating on mathematical content and goals can spur examination of local standards and curricula.

For example, you may want to look at the phrasing and emphasis of the local standards. By examining the content sequence of the local curriculum, you can see whether or not the repeated topics would add a new perspective or help deepen understanding.

Questions to ask might also include the following: Is this important mathematics? How does this mathematical concept develop in later grades? What is the value of understanding this particular mathematical concept?

4. Examining the lessons through the *NCTM Standards*

You might choose to examine the lessons using the analytic framework from the National Council of Teachers of Mathematics' (NCTM) *Professional Standards for Teaching Mathematics,* exploring specific evidence of NCTM's recommendations. (See *Fostering Algebraic and Geometric Thinking: Selected Standards from the NCTM Standards* provided in this module.)

5. Examining the Japanese standards

You might arrange a session to study where the Japanese mathematics lesson was situated in the curriculum. You can examine the primary grade standards to obtain an idea of the experience students have coming into the eighth grade. Another option is to compare the Japanese standards to the NCTM standards, looking for similarities and differences. [See *Mathematics Program in Japan (Kindergarten to Upper Secondary School)* provided in this module.]

6. Viewing the same videotaped lessons again to focus in greater detail

You might plan a session so that participants focus in detail on the types of questions the teachers raise or critical moves the teachers make in each lesson. Participants may look for critical opportunities missed by the teacher during the lesson and discuss these in detail, brainstorming about what the teacher could do differently and why.

7. Exploring the same lesson taught differently

Teachers might agree to try out a lesson similar to one on the videotape in their own classrooms and then return to share the results in detail, using the videotape for reference and comparison.

8. Exploring interesting practices

As a result of the first viewing of the videotape and the first discussion session, participants may try different practices that intrigue them. These might include the following: using a variety of student solutions; posing only one or two problems; posing a thought-provoking problem at the beginning of a lesson; working to develop concepts; and discussing and sharing ideas with the whole class, with teacher-facilitated summaries at the end of the lesson. Participants may then share with others what they did and how it worked. Remember that new practices might not work the first time without proper preparation by teachers and students.

Such experimentation might lead to the formation of an ongoing study group for examining teaching practices. If a dialogue is sustained beyond the first session, it will likely yield greater results in further refining teaching practices.

THE SIX LESSONS: A DISCUSSION GUIDE

The accompanying videotape, *Eighth-Grade Mathematics Lessons: United States, Japan, and Germany*, contains six lessons, one in geometry and one in algebra from each of the three countries. The lessons on the videotape are different from, but representative of, those in the TIMSS Videotape Classroom Study. The lessons for the study were filmed with the understanding that they would be kept confidential, while the ones on the videotape in this Resource Kit were filmed separately with the understanding that they would be distributed publicly. However, researchers used the same procedures to analyze these six lessons as they did for those in the TIMSS Videotape Classroom Study and chose lessons that were similar to those they observed in the actual study. Hence, the accompanying videotape accurately illustrates the findings of the TIMSS Videotape Classroom Study.

This section of the module describes the sections of each lesson shown on the videotape. Sidebars provide mathematicians' and students' perspectives on the lessons, the responses of the videotaped teachers to the TIMSS questionnaire concerning their lesson goals, tips from experienced moderators, and common questions and comments you may need to deal with after participants view the videotape.

Remember, these lessons are intended to represent typical teaching in these countries. They are not ideal lessons, nor are they intended to prescribe what teachers should or should not do.

Mathematician's Perspective

This lesson is dominated by about 65 straightforward applications of the definitions and most elementary properties of vertical, supplementary, complementary, right, and straight angles and congruent triangles. The formula giving the sum of the angles in an n-gon is stated and applied for small values of n. The lesson concludes with a review of the definitions and properties mentioned along with the definitions of equilateral, isosceles, and scalene triangles (not shown in this videotape).

U.S. Geometry Lesson: Angles

In this lesson, students practice using what they know about vertical, complementary, and supplementary angles to calculate the sizes of various angles. The teacher concludes by presenting the formula for finding the sum of the interior angles of any polygon.

Part 1: Presenting and Checking Warm-Up Problems

The teacher begins by presenting four diagrams, all drawn on the chalkboard. Each contains intersecting lines and rays that create vertical and supplementary angles. Students are asked to find the measures for ten angles. The teacher helps find four of the angles by asking questions and providing information. Then he asks students to find the rest. After about 40 seconds, the teacher works through the

Moderator Questions

- What aspects of angles is this lesson about?
- What's the place of vocabulary? How do we teach mathematical terms? How do students learn them?
- Is this a geometry lesson? What makes it a geometry lesson?
- What do students appear to be learning?
- How do you deal with arithmetic in the eighth grade?
- What seems to be this teacher's view of teaching mathematics?
- What's the role of practice?
- How would you teach this differently?
- What does the students' perspective tell us about what we in the United States think mathematics, teaching, and learning are about?
- Do you agree/disagree with the mathematician's perspective? Why, or why not?

remaining problems in a similar way, by eliciting responses from students using questions such as "If this angle is a right angle and this is 30 degrees, what does F have to be? And what's left for angle E? They all have to add up to...?" The warm-up activity lasts about five minutes.

Part 2: Checking Homework

The teacher asks students to take out the worksheet that was assigned earlier in the week for homework. The worksheet, "Types of Angles," includes definitions of terms (such as "supplementary"), sample problems with solutions, and about 40 problems for students to solve. The teacher checks students' answers through a question-and-answer format: "The complement of an angle of 84, Lindsay, would be.... [16] Are you sure about your arithmetic on that one? [Six?] Six. Six degrees. Albert, number four." Moving through the homework in this way continues for about ten minutes.

U.S. Eighth-Graders' Perspective

After viewing U.S. and Japanese lessons, U.S. students who participated in the field testing of this module's materials were asked which class they would choose to learn mathematics in, and why? They said that they would like to be in the U.S. class because "the teacher explained well and students were learning." When asked to give specific evidence of "explaining well," some students replied that "the teacher started sentences for the students to help them, and he went step by step by step."

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the subject matter content of this lesson: geometric congruence and similarity (from a list of mathematical topics). He reported that the material was mostly new. He wanted students to learn angle relation (vertical, supplementary, and complementary) from this lesson. He indicated that this class contains students of mixed abilities. He reported that this lesson was "very similar to the way I always teach."

Part 3: Assigning Seatwork

The teacher distributes a worksheet, "Types of Angles (Continued)," that contains two sample problems with solutions and 15 problems that ask for measures of angles shown in drawings. The teacher introduces the worksheet by working through several problems with the students, asking questions such as, "If angle 3 is 120 degrees and angle 3 and angle 1 are vertical, what must angle 1 be equal to?" While the students work individually on the rest of the problems, the teacher assists individual students.

Part 4: Providing Extra Help on Challenging Problems

While assisting students on the worksheet problems, the teacher receives many questions on problem 37 (Find the measure of two angles that are equal and supplementary) and problem 38 (Write an equation that represents the sentence: The product of 12 and a number is 192). He decides to work these problems with the class. For problem 37, he says, "Two angles are supplementary. Therefore, they must add up to 180 degrees. But they are equal, so let's call one QRS and the other SRT (he draws a figure on the chalkboard). Each one of them has to be...?" After both problems have been answered and discussed, the students return to their worksheets.

Part 5: Checking More Homework and Introducing a New Formula

After the students finish the worksheet, the teacher asks them to get "the worksheet we did on Friday after the quiz." This worksheet has two problems. The first contains a map of two streets intersecting at a 45-degree angle with a triangular-shaped piece of land between the streets. A boundary line divides the piece into two parking lots. The task includes finding the measure of the angle formed by the property line and First Street and suggesting a more equal way to divide the lots. The teacher elicits the answers to these questions from the students, helping when the students are stuck. The second problem involves finding the sum of the interior angles for a six-sided figure. The teacher asks students for the answers they found using their protractors. The teacher then presents a formula and asks students to try it.

Part 6: Previewing the Upcoming Schedule

The teacher concludes the lesson by announcing the topic for the next day and informing students of the dates for the next quiz and the next exam.

Moderator's Tips

- Sometimes it is hard to get the conversation to go beyond the surface level and into the specifics of analyzing practice. Use questions to help push the conversation into deeper levels.
- Sometimes the conversation can become focused on good or bad teaching. Use questions, like those on the next page, to help get the discussion back into focus.
- You may want to wait to share the teacher's goal for the lesson (as shown in the teacher's response to the questionnaire), until the participants have shared their own interpretations of the teacher's mathematical goal(s).

Common Questions/Comments

- This is a vocabulary and subtraction lesson.
- There appears to be little more than recall required of students.
- The students were spoon-fed the information.
- This isn't how I teach; this can't be typical.
- Some things need to be taught this way; I don't think he always teaches this way.
- He didn't help students with the arithmetic errors.
- The teacher is working so hard!
- Q: Is this one period?
  A: Yes.
- I wonder if he considers this "teaching the basics."

Mathematician's Perspective

There are three applications (of increasing complexity) of the general principle that any two triangles with the same base and a vertex on the same line parallel to that base have the same area. The first application is to replace two straight-line segments forming the boundary between two land regions with one line segment so that the areas of the two regions are unchanged. The second is to find a triangle whose area is the same as that of a given quadrilateral. The final application is to find a triangle whose area is the same as that of a given pentagon. (Note the progression in abstraction and complexity, even though all three applications rely on the same fundamental geometric principle.)

Japanese Geometry Lesson: Areas of Triangles

In this lesson, students apply a concept to solve a problem involving the areas of irregularly shaped quadrilaterals. After working the problem on their own, students share their solution methods with the class.

Part 1: Linking Yesterday's Lesson to Today's Topic

The class begins with a ritual bowing by the students, as in almost all Japanese classrooms. The teacher begins the lesson by asking, "Do you remember what we did last period?" Then he walks to the front of the classroom where a TV monitor is connected to a computer, and he uses it to show a triangle between two parallel lines. A student replies that they studied how to obtain the area of a triangle constructed between parallel lines. As the teacher shows various triangles that can be formed by moving the top vertex along a line parallel to the base, he reminds the students that the areas of these triangles are the same because the base and the height are always the same. The teacher says they will use this result as "the foundation today."

Moderator Questions

- What aspects of triangles is this lesson about? Is this important mathematics?
- How many methods are there for solving the original problem? What are they?
- What are students doing? What mathematical reasoning is taking place?
- What seem to be the teacher's views of teaching, learning, and mathematics?
- What are the similarities to the U.S. lesson? The differences?

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Part 2: Posing the Problem

The teacher draws a figure on the board representing two pieces of land, each piece owned by a student in the class. The boundary is a line bent in the middle. The owners would like to make the boundary straight without changing the areas of the two pieces of land. The teacher asks where he should draw the boundary. After a brief question-and-answer session to clarify the problem, and several predictions by the students, the teacher asks the students to work on the problem, "First of all, please think about it individually for three minutes."

Part 3: Working on the Problem

The students work individually on the problem while the teacher observes and assists them. The students' task is to develop a method to solve the problem, so the teacher gives hints to the students instead of showing them what to do. For example, the teacher asks one student, "Is there a method that uses the area of triangles?" and says to another student, "The question is... that there are parallel lines somewhere." After three minutes, the teacher suggests that students may want to work together. He adds, "And for now I have placed some hint cards up here so people who want to can refer to them." He tells the students they can think about the problem themselves, with a friend, or discuss it with the assistant teacher.

U.S. Eighth-Graders' Perspective

U.S. students who participated in the field testing said that they were surprised that the teacher laughed and the students laughed too. They thought the Japanese class would be very strict, with no talking allowed. They were intrigued by the teacher's relation with the students. "He seemed to like them!" But, students thought he did not explain as well as the teacher who presented the U.S. lesson on angles.

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the content of this lesson: perimeter, area, and volume, basics of one- and two-dimensional geometry, geometric transformations and symmetry, problem-solving strategies, and "other" mathematics content. He reported that the material was half review/half new. This is a class of mixed abilities. He reported that this lesson was "similar to the way I always teach." He described this lesson as very typical of the lessons he normally teaches.

Part 4: Students Presenting Solutions

For about ten minutes, the students discuss the problem with each other, the teacher, or the assistant teacher. The teacher asks two students to draw their solutions on the chalkboard while the other students finish their discussions. The teacher then asks all the students to return to their seats and attend to the students' presentations. While a series of students explain their solutions, the rest of the students and the teacher ask questions and request clarifications. The solutions involve drawing parallel line segments, one connecting the two endpoints of the boundary and the other parallel to the first. By moving the vertex along the parallel line segment, a new straight boundary can be formed that retains the same areas.

Part 5: Reviewing Students' Methods and Posing Another Problem

The teacher reviews and clarifies the students' methods and asks how many students used each method. Then the teacher presents a follow-up problem, which is to change a quadrilateral into a triangle without changing the area. The teacher puts a figure on the board and says, "Without changing the area, please take the quadrilateral and make it into a triangle. Please think for three minutes and try doing it your own way." The students work on the problem at their desks, and the teacher assists students as necessary. After about three minutes, the teacher again tells them to discuss their solutions with one another.

Part 6: Summarizing the Results

During the students' seatwork, the teacher encourages students to find as many solutions as possible. He draws ten quadrilaterals on the chalkboard and asks students to show their solutions on the figures. After about 20 minutes, he briefly reviews the solutions and asks which students found each solution. All of the methods involve drawing a diagonal that divides the quadrilateral into two triangles, then drawing a line parallel to the first through the opposite vertex of one of the triangles, and then changing the shape of that triangle by moving the vertex along the parallel line until the entire figure is a triangle. The teacher ends the lesson by suggesting that, for homework, the students try to change other polygons, such as pentagons, into triangles with equal areas.

Moderator's Tips

- Before having the participants view this lesson, tell them that in the previous lesson the students explored the areas of triangles constructed between two parallel lines.
- Refer to the lesson script before the group views the lesson. The script gives more information about this lesson than does the videotape.
- The geometry problem posed in part two often intrigues participants. You may want to stop the videotape at that point and explore the problem. Alternatively, you may elect to defer the discussion about the actual mathematics to later.
- You may want to wait to share the teacher's goal for the lesson, as shown in his response to the teacher questionnaire, until the participants have shared their own interpretations of the teacher's mathematical goal(s).
- Sometimes it is hard to get the conversation to go beyond the surface level and into the specifics of analyzing practice. Use questions to help push the conversation into deeper levels.
- Sometimes defensiveness and cultural stereotypes emerge after viewing this lesson. Use focus questions to help get the discussion back on track. You may have to respond by re-posing the original focus question.
- Point out that while walking around the classroom, Japanese teachers typically note student methods and choose which students will be asked to share their methods on the blackboard. The teacher is looking for the strategies he expects will emerge from this problem and is developing a plan as to how to use them in his summary of the lesson.

Common Questions/Comments

- Q: Is this a high-level class?
  A: There is no tracking of Japanese students through the ninth grade. All students receive the same standard curriculum.
- Q: Isn't the student population homogeneous in Japan? Japan doesn't have the same diversity we do.
  A: There is variability of mathematical knowledge and there is social diversity. In fact, Japanese teachers cite differences in students' ability as a challenge that limits their teaching more than any other factor.
- Q: Don't the Japanese have higher IQ's than other cultures?
  A: There has been a great deal of research proving that this is not the case.
- Q: Who is the second teacher in the room?
  A: During the videotaping, many Japanese principals stayed in the room. Also, because of the extensive internship involved in becoming teachers, it is not uncommon to have an intern in the room.
- Q: Do most Japanese students wear uniforms?
  A: Almost all middle schools require them.
- Q: How are students assessed in Japan?
  A: The teachers at each school get together by grade level and develop exams to assess student understanding and to make instructional decisions. Students who want to enter high schools or universities must pass exams.
- Q: How long is this class period? Do Japanese teachers have more time than do U.S. teachers to teach lessons?
  A: Class periods average between 45-50 minutes, the same as in the United States.
- Q: When does the teacher take roll?
  A: A student monitor takes roll before the teacher arrives.
- Q: Don't Japanese classrooms experience interruptions?
  A: No, classes in Japan are rarely interrupted by outside agents such as loudspeakers or visitors.
- Q: Are computers common in Japanese schools?
  A: Virtually all junior high schools have computers, but the level of computer use varies from school to school.
- Q: What does "Onegaishimasu" mean?
  A: It means, "Please (teach us.)" Virtually all Japanese lessons and classes begin with this standard greeting and bow.

Mathematician's Perspective

Students share answers to homework problems using the formulas for the volume and mass of a rectangular solid to find the mass of three solids. A related, but still significantly different, problem is given to find the height when the length, width, specific gravity, and mass are known. Students confusing units while solving the problem leads the class to a discussion of dimension analysis. Ultimately, they draw a conclusion that the formula for mass can be used to find any one variable if all the others are known. Several applications of this conclusion are presented as additional problems.

Moderator Questions

- What seems to be the mathematical focus of the lesson?
- What are students doing? What is happening to enable the students to reason mathematically?
- How is this lesson similar to the U.S. angles lesson and the Japanese lesson on areas of triangles? How is it different?
- How does this teacher seem to view mathematics, teaching, and learning? What specifics can you give?

German Geometry Lesson: Volume and Density

In this lesson, after reviewing homework, the students and teacher work through several problems involving the relation between volume and density.

Part 1: Sharing Homework

The lesson begins with the teacher asking a student to present her homework results. The student uses an overhead projector to explain what she did. There are three problems. One of them is, "A rectangular bowl of glass with a width of 14.6 cm and a length of 8.4 cm is filled with 17 mm of quicksilver (density 13.6 g/cm^3). What is the mass of the quicksilver?" After the student explains her solutions, the teacher leads the class in a discussion of the results. The teacher says, "Who confirms this result?" and "Does anybody else have any other suggestions for an alternative?" When mistakes are noted, the presenter makes corrections on the transparency. Reviewing the homework in this way continues for about 10 minutes.

Part 2: Revisiting Previous Materials

The teacher asks, "Yesterday, you put together what you know about calculation. Who can remember what we said?" The students say, when nominated, that they can calculate the surface, volume, and mass of a rectangular solid. The teacher asks for the formulas, and the students provide them. The teacher says that they will develop a fourth calculation during today's lesson.

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Part 3: Posing a Problem

The teacher presents a problem using the overhead projector. The problem reads, "An iron sheet with a length of 0.5 m and a width of 20 cm weighs 3.9 kg. Calculate the height (thickness) of the sheet ($7.8 g/cm^3$)." The teacher leads a brief discussion of the problem, reminding students to think about "our three-step [method]: given, wanted, and calculation path."

Part 4: Working on the Problem Together

The teacher asks for a volunteer to work the problem on the chalkboard. The volunteer begins working the problem by recording the given information. The teacher monitors the ensuing 20-minute discussion on how to solve the problem. The student at the board tries to solve the problem while taking suggestions and corrections from the other students. One student says, "I would convert that into centimeters." The volunteer responds, "I wouldn't." The teacher says, "Would you give him a reason," and the student says, "Well, then the numbers are a little bigger and the density would be easier to calculate." During this activity, several other students take their turn at the board. The activity concludes when the students agree on the answer.

Moderator's Tips

You may want to wait to share the teacher's goal for the lesson, as shown in her response to the teacher questionnaire, until the participants have shared their own interpretations of the teacher's mathematical goal(s).

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the content of this lesson: common and decimal fractions, estimation and number sense, measurement units and processes, perimeter, area, volume, equations, inequalities, and formulas. She reported that the material was half review/half new. This is a class of average abilities. On the questionnaire, she reported that this lesson was "similar to the way I always teach." She described this lesson as mostly typical of the lessons she normally teaches.

Common Questions/Comments

- The problems are real but the focus is on the procedures, not the concepts.
- The students didn't practice many problems.
- Q: What is rho?
  A: Density.
- Q: Do German classes have tracking or ability groups?
  A: Yes. In Germany, students are usually separated into three tracks after the fourth grade, and each track attends a different school. All students receive a similar curriculum, but it is taught at a different level of complexity.

Part 5: Summarizing the Result

Following the completion of the problem-solving activity, the teacher says, "Is anyone able to say what we just did, what you learned?" Students volunteer that they learned to calculate the length, width, and height of a rectangular solid. The teacher fills in the statement of this calculation into the table she reviewed at the beginning of the lesson.

Part 6: Assigning Seatwork

The teacher offers three types of problems that differ in their level of difficulty and asks students to choose those they would like to do. She reminds them of an important point about units that they had discussed previously and then lets them choose the problems and begin working individually. During part of this work time, the teacher meets with four students at the board who are having difficulties with the earlier problem. The class ends while students are working, and the teacher suggests that they save their unfinished problems until class tomorrow and work at home on their home exercise book.

Mathematician's Perspective

Four warm-up activities begin the lesson. Two require finding integer solutions to equalities involving exponential expressions. One requires finding a volume of a box whose sides turn out to have integer length. The last is to evaluate the quotient of two monomials. The focus of the lesson is announced to be least common denominators. Two examples of adding two rational expressions are discussed. In the first, the denominator of the first fraction is a linear factor of the quadratic denominator of the second fraction. In the second example, the two fractions have the same denominator, which is linear. The lesson concludes with students working on homework exercises, all of which seek least common denominators for two or three given denominators—the fractions are not given—that may be integers, monomials, or linear or quadratic polynomials.

U.S. Algebra Lesson: Complex Algebraic Expressions

In this lesson, after some warm-up problems, the teacher presents the problem $1/(x - 7) + 1/(x^2 - 49)$ and asks students to find the least common denominator. After explaining the correct way to solve the problem, the teacher assigns multiple tasks for seatwork, and students work on their own for the rest of the lesson.

Part 1: Presenting and Checking Warm-Up Problems

The teacher asks students to solve "warm-up" problems displayed on the overhead projector. The problems include finding the largest integer n for which $2 > n!$ and finding the number of cubic inches in the volume of a rectangular solid if the side, front, and bottom faces have areas of 12, eight, and six square inches, respectively. Students work on their own, during which time the teacher moves around the classroom helping students. After 13 minutes, the teacher reconvenes the class to share the solutions. The teacher asks students for the answers, which she records on the transparency. For the last problem, she asks, "How did you get it?" and the student describes the process.

Moderator Questions

- What appears to be the mathematical focus of this lesson?
- What do you think students are learning? Give examples of apparent mathematical learning.
- What is the purpose of review? How does it help student learning? What is review?
- How might this lesson be taught differently? How does this teacher use the overhead projector?
- When the teacher was walking around the room, how many students appeared to understand? How was student understanding used to make instructional decisions?
- How is this lesson like the U.S. angles lesson? What patterns emerge in both lessons? What can that tell us about U.S. views on teaching, learning, and mathematics?
- Do you think this teacher is teaching according to the recommendations of the NCTM standards? What did you see that makes you think that?

Part 2: Presenting and Discussing Problems

The teacher presents the problem $1/(x-7) + 1/(x^2-49)$ on the overhead projector and says to the students, "Yesterday we worked on least common denominators. Try this problem." While the teacher passes out the homework worksheets, the students work on this problem. After about one minute, the teacher asks for the solution. Some students have difficulty, so the teacher explains each step. She then continues the lesson by presenting a second problem, $[5/(x+6)] - [(2-x)/(x+6)]$, and warns students that "this one looks easier but there is a trick to it." Students work on the problem for about one and a half minutes. During this time, the teacher moves from desk to desk, checking students' work.

U.S. Eighth-Graders' Perspective

After viewing both U.S. and Japanese lessons, U.S. algebra students said that they would rather be in this classroom because it felt more like their classroom. They said that the way things were in this classroom was what they were used to seeing. Non-algebra students said that this was obviously a "smart" class. When asked if they understood the lesson, they answered, "No." However, they pointed out that they had not had this math, and said they thought the students in the class did understand. They thought this was the "hardest math" because of all the Xs.

Moderator's Tips

You may want to wait to share the teacher's goal for the lesson, as shown in the teacher questionnaire, until the participants have shared their own interpretations of the teacher's mathematical goal(s).

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the content of this lesson: problem-solving strategies (draw a picture, make a simpler problem, and guess and check), and adding and multiplying algebraic fractions with like and unlike denominators. She reported that the material was mostly new. This is a class of high-ability students. On the questionnaire, she reported that this lesson was "very similar to the way I always teach." She described this lesson as very typical of the lessons she usually teaches.

When the teacher announces the answer, some students ask for an explanation. The teacher provides a brief explanation by asking students to complete several steps leading to the answer.

Part 3: Assigning Multiple Tasks for Seatwork

The teacher says, "For the remainder of the period there are about five things that I would like you to work on in the following order." These include finishing a test, correcting the previous day's homework, and finishing a worksheet for which a graphing calculator is needed. When these tasks are completed, students are to work on the next day's homework. The homework requires students to find the least common denominator (LCD) of rational expressions. Exercises include finding the LCD of 4x and 8x; 3x-6 and 12x-24; and 12, 18, and 30. Students work on these assignments individually as the teacher circulates to assist them. The seatwork activity lasts about 12 minutes. The lesson ends with this activity.

Common Questions/Comments

- This must be an algebra class.
- People might think this is "reform" because students are seated in groups and using calculators.
- I can't figure out the mathematical focus of this lesson.
- This must be a review day.
- The lesson seemed disconnected, disjointed, and focused on procedural learning. I couldn't find the concept.
- The students are obviously learning because this is an advanced class.
- Why did the teacher tell a student to look at the overhead when she was writing? What does that accomplish?
- The teacher did what I have often done: Find one student who gets the answer I'm looking for, and then move on in the lesson in an effort to cover the material.

Mathematician's Perspective

The teacher presents algebraic solutions to six linear inequalities. Three similar word problems that can be answered by solving linear inequalities are presented. In all the applications, an added feature is that the solution sought is the largest integer satisfying the inequality. They originally solve the first in two other ways, but then they discuss how setting up an inequality facilitates finding the answer. The solutions for the other two begin by carefully using tables to set up the inequalities and conclude by using the tables to develop careful algebraic solutions.

Japanese Algebra Lesson: Algebraic Inequalities

In this lesson, after briefly checking homework, the teacher poses a problem that can be solved by creating and solving an algebraic inequality. Students work on the problem, then share their solutions with the class. The teacher then poses some follow-up problems.

Part 1: Sharing Homework

The teacher asks six students to write the solutions for six of the homework problems on the chalkboard. The problems involve solving inequalities, such as $6x - 4 < 4x + 10$. While they are working, the teacher checks whether the students have completed their homework. The class spends about seven minutes answering the problems, explaining methods, and checking correctness of solutions.

Part 2: Posing the Problem

The teacher introduces the main problem for the day by saying, "I will have everyone use their heads and think a little, okay? Until now,

Moderator Questions

- What seems to be the mathematical focus of this lesson?
- Do you agree or disagree with the mathematician's perspective? Why or why not?
- What issues are raised for you with the students' perspectives? What does this say about our educational system?
- How was this lesson similar/different from the Japanese geometry lesson? What patterns emerge as clues for how Japanese teachers view teaching, learning, and mathematics?
- How is this lesson similar/different from the U.S. lesson? What are the differences in the way we think about mathematics, teaching, and learning and the way the Japanese teacher thinks about teaching and learning?
- Would you teach this topic differently?

we've just done calculation practice, but today you will have to use your heads a little." The teacher then displays a poster with the problem: There are two different types of cakes, one costing 230 yen and the other, 200 yen. You want to buy 10 cakes, but you don't want to pay more than 2,100 yen. How many of each type should you buy? The cakes costing 230 yen "look more delicious." The teacher clarifies the problem by restating it in several ways and then asks the students to work individually on the problem for about three minutes, using whatever methods they would like.

Part 3: Students Presenting Solution Methods

After about six minutes during which the teacher observes and assists students as they work individually, the teacher asks a student to share her solution method. The student reports that she computed the cost for ten 230-yen cakes and that the total was too much. She reduced the number of 230-yen cakes by one and computed again. She says she had planned to continue this process but ran out of time. Other students, who used the same method, build on her explanation and report that the solution is three 230-yen cakes and seven 200-yen cakes.

Part 4: Teacher and Students Presenting Alternative Solution Methods

The teacher introduces another method by saying, "I've thought about it too, so... what do you think about this way

U.S. Eighth-Graders' Perspective

When U.S. students viewed this Japanese lesson, they often said that the mathematics seemed simple to them. When pushed for specifics, they said they had done "cake" problems in elementary school. They were bothered by the fact that the teacher "made" a student get up and share when she didn't understand; they thought that was "mean." When asked if the student seemed uncomfortable, they answered, "No." Many also thought that the teacher talked too much and too fast and didn't explain well. The U.S. algebra students viewing this lesson said that this appeared to be a lower level class because the mathematics was easy, the classroom was messy, and there was no computer in the room.

of thinking?" He then describes a method of subtracting the savings of a cheaper cake (30 yen) from the amount needed to buy all delicious cakes (2,300 yen). One would need to subtract seven times to get below the 2,100 yen, so one could buy only three delicious cakes. Not all students understand his explanation so he asks another student, whom he knows has used an algebraic inequality, to explain. The student verbally describes the inequality $230x + 200(10-x) < 2{,}100$. After the student's presentation, the teacher challenges students to provide explanations that others can understand.

Part 5: Teacher Elaborating on a Student's Method

The teacher indicates that the last student's presentation on using algebraic inequalities captured his goal for the lesson. He says he would like to review the method carefully so others will understand: "To tell you the truth, I was going to set up today what Rika set up, but I wanted you all to come up with a number of ways to [solve] it. So we are going to try to do the problem using an inequality equation." He then spends about seven minutes leading the students step by step through the method. At the end of this discussion, he notes the advantages of using this method over the trial-and-error methods presented earlier in the lesson: "The answer will come out quickly... you don't need to figure out each number one by one."

Moderator's Tips

Point out that teachers in Japan often view student mistakes as valuable learning opportunities, which can further understanding for the individual student and the class as a whole. Allow participants to share their own interpretations of the teacher's mathematical goals before discussing them with the whole group.

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the subject matter content of this lesson: equations, inequalities and formulas, and problem-solving strategies. He reported that the material was half review/half new. This is a class of mixed abilities. On the questionnaire, he reported that this lesson was "similar to the way I always teach." He described this lesson as mostly typical of the lessons he normally teaches.

Part 6: Posing and Solving Follow-Up Problems

The teacher presents two similar problems and asks the students to use the method just discussed to solve these problems. Here is one problem: "You want to buy 20 apples and tangerines all together for less than 2,000 yen. Apples are 120 yen each and tangerines are 70 yen each. Up to how many apples can you buy?" He reminds the students about the advantages of using this method and then gives the students about 12 minutes to work on the problems. As he assists students, he asks two of them to write their methods on the chalkboard.

The teacher completes this part of the lesson by talking through the students' work displayed on the board.

Part 7: Summarizing the Lesson Objective

The teacher summarizes the major point of the lesson: "What we talked about today was solutions using inequality equations. That is, when you work out problems, instead of counting things one by one and finding the number, it's usually easier if you set up an inequality equation and find the answer." Then the teacher distributes another worksheet for homework.

Common Questions/Comments

- Q: What is a 200-yen cake?
  A: Yen is the unit of currency in Japan.
- I was shocked to see paint chipping off the wall! It made me feel better about where I teach.
- There was a window washer outside washing windows, and none of the students looked at him!
- It seems this might be a school in a lower socioeconomic area. The students are wearing different uniforms, and the classroom looks less kept up.
- The students weren't actively involved but seemed comfortable sharing their strategies when they didn't understand.
- The teacher shared "his" method of solving inequalities, and "there were only two problems the *whole* period."
- Q: Is this an algebra class? Is this a class of lower abilities than the geometry class?
  A: No, students are not separated by ability in Japan until the tenth grade. All eighth graders have this curriculum.

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Mathematician's Perspective

Five quick warm-up activities begin the lesson. Three involve numeric or symbolic exponentiation, another is a percentage calculation, and the last is the computation of the difference of two rational numbers. A quick review of three methods of solving systems of two linear equations follows; all examples given in the review have integer coefficients. The central problem of the lesson is to solve a system of two equations with two unknowns; rational forms are in both equations, but each is reducible to a linear equation with integer coefficients. After the class solves this system, the teacher describes the general method of solving such equations. The lesson concludes with three problems similar to its central problem.

German Algebra Lesson: Systems of Equations

In this lesson, after some brief warm-up problems, the students and teacher work collaboratively on solving a complex system of equations: $(2y-5)/9=5(x-1)/6-5y$ and $(3x+1)/12=(8/3)(y-2)+33x/2$.

Part 1: Presenting Warm-Up Problems

The lesson begins with two minutes of quickly paced warm-up exercises. The teacher asks six questions, including "Eight to the third power?" "Twelve percent of 120?" and "Five factorial?" Students answer orally, and the teacher confirms the response or asks if others agree.

Part 2: Reviewing Previous Material

After the warm-up activity, the teacher asks, "What have we done lately?" After a student replies that they have studied "equations with two variables," the teacher encourages students to describe the solution methods they have learned. Students respond by identifying the methods of "equating," "substituting," and "adding." The teacher asks them to give examples of how such

Moderator Questions

- What seems to be the mathematical focus of this lesson?
- What did students seem to be learning? Give specific examples of learning.
- What are the similarities/differences compared to the U.S. and Japanese algebra lessons?
- Given the similar student performances of German and U.S. students, what are the similarities in the apparent views of mathematics teaching and learning?

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methods work. With some prodding, students generate a system of equations and illustrate the method while the teacher records their verbal descriptions on the chalkboard. They work on three examples of systems of equations during this review activity, which lasts about seven minutes.

Part 3: Posing and Working on the Problem

The teacher writes the following system of equations on the chalkboard: $(2y-5)/9=5(x-1)/6-5y$ and $(3x+1)/12=(8/3)(y-2)+33x/2$. After giving students a minute to think about the problem, he asks for students to volunteer suggestions on how to proceed. Students take turns coming to the board to work on the problem, taking questions and advice from their peers and the teacher. After about ten minutes working together in this way, the teacher asks students to record the partial result in their notebooks and continue solving the problem. He gives them about five minutes to find the solution.

Moderator's Tips

Wait to share the teacher's goal for the lesson (as shown in the teacher's response to the questionnaire), until the participants have shared their own interpretations of the teacher's mathematical goal(s).

Teacher Questionnaire

On the questionnaire, the teacher checked the following as the subjects of this lesson: equations, inequalities and formulas, and problem-solving strategies. He reported that the material was half review/half new. This is a class of average ability. On the questionnaire, he reported that this lesson was "similar to the way I always teach" and that the lesson was mostly typical of the lessons he normally teaches.

Part 4: Sharing the Result

The teacher asks students to describe the methods they used to finish the problem. One student suggests the method of addition, and the teacher asks her to show her work on the chalkboard. She works at the board to complete the problem with help from the teacher and the other students. She occasionally asks questions of the teacher, and debates points with her peers. She finishes the problem in about six minutes.

Part 5: Summarizing the Objective and Assigning Seatwork

When the student completes the problem and returns to her seat, the teacher asks the students to summarize what they learned about solving "complicated problems" similar to this one. The teacher says that the main thing is to think about what method will be best to use for different types of systems. He then assigns a problem from the exercise book. For about seven minutes the students work independently. The teacher monitors their work and occasionally assists students until the lesson ends.

Common Questions/Comments

- I was amazed at the mental mathematics!
- There weren't any books.
- Q: It's interesting how the desks are set up; is that typical?
  A: Yes, it is common to find desks arranged in this order in German eighth-grade classrooms.
- There were no practice problems during class time.
- Like the U.S. lessons, this German lesson focused on using procedures to solve problems as opposed to conceptually understanding the origin of the methods.
- I was shocked to see the teacher stick his tongue out at the students!

RESEARCH METHODS AND FINDINGS OF THE TIMSS VIDEOTAPE CLASSROOM STUDY

This section describes the methodology used by the researchers in conducting the TIMSS Videotape Classroom Study, as well as the goals and findings. The information here will help you be more informed about the study so that you can better facilitate the discussion sessions, both anticipating and reacting to participants' questions and comments.

Introduction to TIMSS Videotape Classroom Study

The Third International Mathematics and Science Study (TIMSS) included a videotape survey of eighth-grade mathematics lessons in the United States, Japan, and Germany. Funded by the U.S. Department of Education's National Center for Education Statistics and the National Science Foundation, the TIMSS Videotape Classroom Study is the first attempt to collect videotaped records of classroom instruction from nationally representative samples of teachers. The purpose of gathering this information was to build a better understanding of the processes of classroom instruction in different cultures in order to contribute to efforts to improve student learning in schools.

The TIMSS Videotape Classroom Study was conducted in 231 classrooms in the United States, Japan, and Germany. Innovative multimedia database technology helped to facilitate the management and analysis of the videotapes.

The videotape study had four goals:

1. Provide a rich source of information regarding what takes place in eighth-grade mathematics classes in the three countries.
2. Develop objective observational measures of classroom instruction to serve as quantitative indicators, at the national level, of teaching practices in the three countries.

3. Compare actual mathematics teaching methods in the United States and the other countries with those recommended in current reform documents and with teachers' perceptions of those recommendations.
4. Assess the feasibility of applying videotape methodology in future wider scale national and international surveys of instructional practices.

Research Methods Used

The study sample included 231 eighth-grade mathematics classrooms: 81 in the United States, 50 in Japan, and 100 in Germany. The sample was designed to be representative of eighth-grade classrooms in the three countries. The findings are representative of the instruction received by eighth-grade students in each country.

Researchers videotaped one lesson in each classroom during the school year. Tapes were encoded, stored digitally on CD-ROM, and accessed and analyzed using multimedia database software developed specifically for this project. Teams of coders who are native speakers of the three languages transcribed and then analyzed all lessons. Analyses focused on the content and organization of the lessons as well as on the instructional practices that teachers used during the lessons.

TIMSS was based on randomly chosen, nationally representative samples of eighth-grade students in each country. The TIMSS Videotape Classroom Study sample was designed to be a random subsample of approximately half of the TIMSS classrooms in the United States, Japan, and Germany.

Sampling was conducted in two stages. Researchers first sampled schools, then classrooms within schools. The exact procedures used varied by country, but in each case procedures were expected to yield a sample representative of the instruction received by eighth-grade mathematics students in each nation.

A project coordinator initially contacted the teachers in each country to explain the study's goals and schedule the date and time for videotaping. Because teachers knew when the taping would occur, there was a possibility that they might attempt to prepare in some special way. To mitigate any bias caused by the teachers' preparations, researchers gave the teachers in each country a common set of instructions and told them that the goal was to see what typically happens in the mathematics classrooms of their country. The researchers indicated that they wanted to see what the teachers would do were they not being videotaped.

Researchers collected two kinds of data in the TIMSS Videotape Classroom Study: videotaped lessons and questionnaire responses. They also collected supplementary materials (e.g., copies of textbook pages or worksheets) deemed helpful for understanding the lesson. Each classroom was videotaped once, on a date convenient for the teacher. One complete lesson—as defined by the teacher—was videotaped in each classroom. A primary purpose of the questionnaire was to obtain teachers' judgments of how typical the videotaped lesson was compared to what observers would normally see in their classroom.

Teachers and students who appeared in the TIMSS Videotape Classroom Study were guaranteed confidentiality; videotapes of their classrooms can be studied only by researchers who have applied for and received a license from NCES. In addition, TIMSS collected five "public use" tapes in each country as examples to help communicate the results of the study. Teachers and students who appear in the public-use tapes were not part of the main study but agreed to be taped and to have their lessons made available for public viewing. From these five tapes, two lessons from each country were chosen for inclusion in the videotape accompanying this module.

The success of any videotape study hinges on the quality, informativeness, and comparability of the tapes collected. What is captured on a videotape is determined by not only what transpires in the classroom but also the way the camera is used. Therefore, researchers constructed standardized procedures for camera use and trained videographers in the application of these procedures. Only one camera was used to tape each lesson, and it was usually focused on the teacher.

Coding and Evaluating

Researchers conducted a field test with nine classrooms in each country before data collection. They used these field-test tapes, in part, as a basis for developing event codes.

Once the tapes were collected, they were sent to the project headquarters at The University of California, Los Angeles (UCLA), for transcription, coding, and analysis. The first step in this process was to digitize the videotape and store it in a multimedia database, together with scanned images of supplementary materials. Digital videotape offers several advantages over standard videotape for use in studies. The resulting files are far more durable and lasting, and they will not degrade with the repeated playing or replaying of segments that is required for thorough analysis. Digital video also enables random, instantaneous access to any location on the videotape, a feature that makes possible far more sophisticated analyses.

The videotapes were then transcribed, and the transcripts were linked by time codes to the videotape. German and Japanese transcripts were translated into English. Transcription of videotapes is essential for coding and analysis. Without a transcript, coders have difficulty hearing, much less interpreting, the complex stream of events that flow past in a classroom lesson.

Using the software developed for this project, coders had instant access to the videotape as they worked with the linked transcript, making it easy to retrieve the context needed for interpreting the transcript. All event codes were marked, stored, and linked to a time code on the videotape, all within the same database.

Objectives of coding

In deciding what to code, researchers had to keep two goals in mind: They wanted to code aspects of instruction that relate to current definitions of instructional quality, and they wanted the codes to provide a valid picture of instruction in three cultures.

To achieve the first goal, they sought ideas about what to code from the research literature on the teaching and learning of mathematics, and from reform documents—such as the National Council of Teachers of Mathematics' *Professional Standards for Teaching Mathematics*—that make recommendations about how mathematics ought to be taught. Researchers wanted to code both the structural aspects of instruction, that is, those things that the teacher most likely planned ahead of time, and the real-time aspects of instruction, that is, the processes that unfold as the lesson progresses.

The second goal was an accurate portrayal of instruction in the United States, Japan, and Germany. Toward this end, researchers took care to make sure that their descriptions of classrooms in each country made sense from within those cultures and not just from the U.S. point of view. They wanted to be sure that, if different cultural scripts underlie instruction in each country, this study would have a way to discover these scripts. For this reason, they sought coding ideas from the videotapes themselves.

Process of coding

In a field test in May 1994, researchers collected nine tapes from each country. A team of six code developers—two from the United States, two from Japan, and two from Germany—spent the summer watching and discussing the contents of the tapes in order to develop an understanding of how teachers construct and implement lessons in each country.

The process was a straightforward one: They watched a tape, discussed it, and then watched another. As they worked their way through the 27 tapes, they generated hypotheses about what the key cross-cultural differences might be. These hypotheses formed the basis of the codes, i.e., objective procedures that could be used to describe the videotapes quantitatively. The code developers also outlined hypotheses about general scripts that describe the overall process of a lesson, and they devised ways to validate these scripts against the videotape data.

In this way, they developed codes describing dimensions along which the lessons varied, including the type of mathematics studied, the ways in which lessons were organized, and the kind of thinking students were engaged in during the lesson. Great emphasis was placed on the development of codes that could be applied with high levels of inter-rater reliability.

Once the list of "what to code" was completed, a group of four code developers, all of whom had participated in the initial viewing and discussion of the 27 field-test tapes, developed the specific coding procedures. Two code developers were from the United States, one from Japan, and the other from Germany. Three developers—one from each country—were doctoral students in either psychology or education, all with classroom teaching experience. The fourth code developer, a doctoral student in applied linguistics from the United States, helped work through the technical issues involved in coding classroom discourse.

Some codes were used to indicate the frequency of events, others to indicate the duration of various kinds of activities. In all cases, great emphasis was placed on establishing the inter-rater reliability of the codes before putting them to use. Once codes were defined and coding procedures specified, the developers checked the reliability of the codes. Only after they reached at least 80 percent agreement among themselves on independent judgments of the same code did coding begin. Actual coding was completed by a separate group of coders trained by the developers in implementing the codes. Coding of the main study tapes did not begin until coders proved reliable with each other and with the code developers on at least 80 percent of their judgments.

Preliminary Findings of the TIMSS Videotape Classroom Study

In the analyses completed thus far, a number of cross-cultural differences have emerged. These findings can be grouped into five categories, each of which will be explored in some detail:

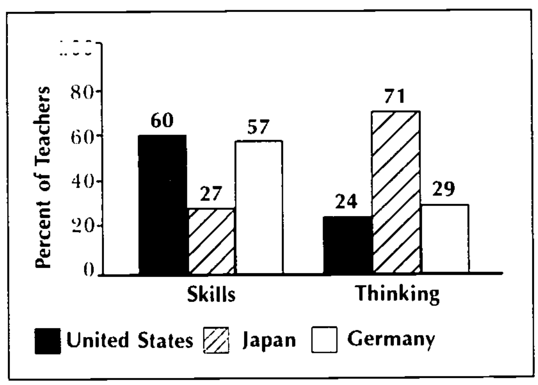
1. **Structure and Delivery of the Lessons**—U.S. and German teachers stress skill acquisition as the goal of instruction; Japanese teachers stress understanding.
2. **Type and Level of Mathematics Taught**—In both the level and richness of content, Japanese and German classrooms appear more advanced than U.S. classrooms.
3. **Student Thinking During the Lessons**—Japanese students appear to engage in different kinds of mathematical thinking during the lesson than U.S. or German students.
4. **Teachers' Views of Reform**—Most U.S. teachers report familiarity with reform recommendations; only a few apply the key points in their classrooms.
5. **Achievement in the Three Countries**—Japanese students scored significantly higher than U.S. students in both mathematics and science. U.S. and German students had similar scores in both mathematics and science.

1. Structure and Delivery of the Lessons

Exhibit 1 shows the percentage of teachers who gave responses in each of these two categories. Japanese teachers focused on thinking and understanding, while U.S. and German teachers focused on skills.

EXHIBIT 1:

PERCENTAGE OF TEACHERS WHO DESCRIBE THE GOAL OF THE VIDEOTAPED LESSON AS "SKILLS" VS. "THINKING"



Evaluating a classroom mathematics lesson is difficult unless we first know what the teacher is trying to accomplish in the lesson. On a questionnaire, researchers asked teachers whose lessons were videotaped to state what they wanted students to learn in that lesson. Most of the answers fell into one of two categories:

Skills—answers that focused on students being able to *do* something: perform a procedure or solve a specific type of problem.

Thinking—answers that focused on students being able to *understand* something about mathematical concepts or ideas.

These different goals lead Japanese teachers to construct lessons different from those of U.S. and German teachers.

A clear distinction exists between the way the lessons are put together by Japanese teachers, and the way they are put together by U.S. and German teachers. The different ways follow from different instructional goals, and they are probably based on different assumptions about the role of problem solving in the lesson, the way students learn, and the proper role of the teacher.

U.S. and German lessons tend to have two phases: an initial acquisition phase and a subsequent application phase. In the acquisition phase, the teacher demonstrates and/or explains how to solve an example problem. The explanation might be purely procedural (as most often happens in the United States), or it can include development of concepts (more often the case in Germany). Yet, the goal in both countries is to teach students a particular method for solving the example problem(s). In the application phase, students practice solving examples on their own while the teacher helps students who are experiencing difficulty.

Japanese lessons generally follow a different script. Problem solving comes first, followed by a time in which students first share the solution methods they have generated and then work jointly to develop explicit understandings of the underlying mathematical concepts. Whereas students in U.S. and German classrooms must follow their teachers through the solution of example problems, the Japanese students have a different job: to invent their own solutions and then reflect on those solutions in an attempt to increase understanding.

How Time Is Used in a Typical Lesson

UNITED STATES

50 min - 1 hr

- 10-15 min — **Warm-Up/Homework**: *Classwork: exercise on board, seatwork on exercise, or checking of homework*
- 10 min — **Main Activity**: *Usually starts with classwork terminology, problem solving, practice of model exercises*
- 20 min — **Seatwork**: *Apply terminology learned or practice model exercises*
- 5-10 min — **Homework done in class**: *Sometimes seatwork*

JAPAN

45 - 50 min

- 10-15 min — **Main Activity**: *Classwork: linking to previous activity, set up activity, introduction, pose a question or problem to solve*
- 10-15 min — **Seatwork**: *Use any method, problem solving*
- 10 min — **Classwork**: *Share solutions, collectively come to conclusion, elaborate from a particular method, pose new problem connected to main problem*
- 10 min — **Seatwork**: *Work on new problem*
- 10 min — **Classwork**: *Conclusions stated or sometimes share solutions, summing up at the beginning of the next lesson, assign homework*

GERMANY

45 min

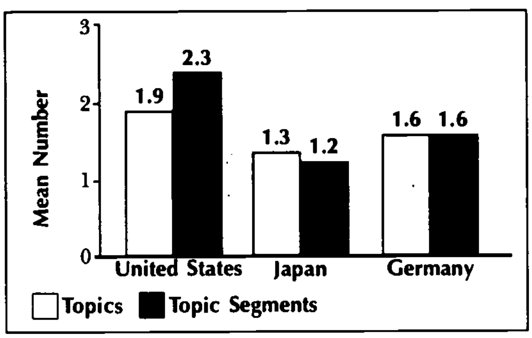
- 5 min — **Mental Activity**: *Classwork: mental calculations or two brief exercises*
- 30-35 min — **Main Activity**: *Classwork: teacher takes class through steps*
- 5-10 min — **Seatwork**: *(Sometimes)*

Coherence of the Lesson

In addition to these differences in goals and scripts, researchers also found differences in the coherence of lessons in the three countries. Students will be more successful in making sense of instruction that is more coherent. The greatest differences in coherence were apparent between U.S. lessons and Japanese lessons; researchers using several criteria found U.S. lessons to be less coherent than Japanese lessons.

EXHIBIT 2:

AVERAGE NUMBER OF TOPICS AND TOPIC SEGMENTS PER LESSON IN EACH COUNTRY



First, U.S. teachers switched from one topic to another within lessons more than Japanese teachers did. As shown in Exhibit 2, U.S. lessons contained significantly more topics and topic segments than did Japanese lessons.

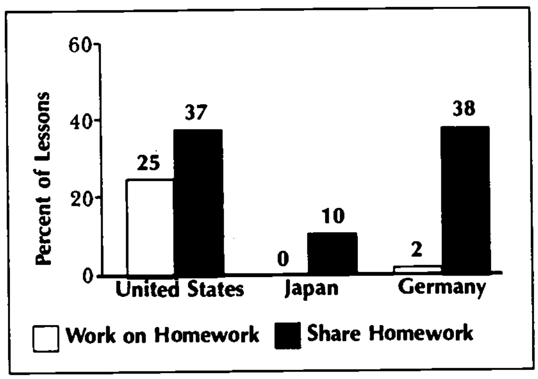
Second, the changes from topic to topic or from one segment to another in U.S. lessons often were not linked together by the teacher. Compared to U.S. and German teachers, Japanese teachers were significantly more likely to provide explicit links or connections between different parts of the same lesson.

Third, U.S. teachers devoted significantly more time during the lesson to irrelevant diversions than did German or Japanese teachers. U.S. lessons were more frequently interrupted by outside events, such as announcements or visitors. This was true for 28 percent of U.S. lessons, 13 percent of German lessons, and zero percent of Japanese lessons.

Homework During the Lesson

EXHIBIT 3:

PERCENTAGE OF LESSONS IN WHICH CLASS WORKED ON AND SHARED HOMEWORK



Another cross-national difference was in the role homework played in the lessons. If homework was attended to during the lesson, it could happen in two ways: The class might review and share the results of homework assigned during the previous lesson, or the students might be given time to work on their homework for the next day. Exhibit 3 shows the percentage of lessons in which students actually worked on or shared homework.

Japanese students never worked on the next day's homework during class and rarely shared homework results. Both U.S. and German students shared homework frequently, but only U.S. students spent time in class working on the next day's homework. When we calculate the total percentage of class time devoted to assigning, working on, or sharing homework, we get a similar result: Only 2 percent of lesson time in Japan involved homework in any way, compared with 8 percent in Germany and 11 percent in the United States.

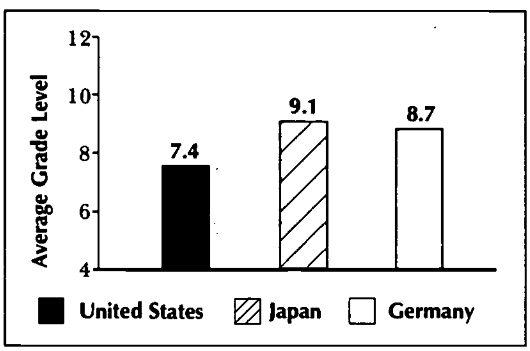
On the questionnaire, researchers asked teachers whether they had previously assigned homework that was due for that day. Whereas 55 percent of both U.S. and German teachers said that they had assigned such homework, only 14 percent of Japanese teachers reported assigning homework.

2. Type and Level of Mathematics Taught

It is not possible, a priori, to say that one mathematical topic is more complex than another. However, the TIMSS researchers could judge how advanced a topic is based on its placement in mathematics curricula around the world. The videotape study made use of the TIMSS curriculum analyses to estimate the average level of mathematical content in the videotaped lessons in each country.

EXHIBIT 4:

AVERAGE GRADE LEVEL OF CONTENT IN THE VIDEOTAPED LESSONS BY INTERNATIONAL STANDARDS

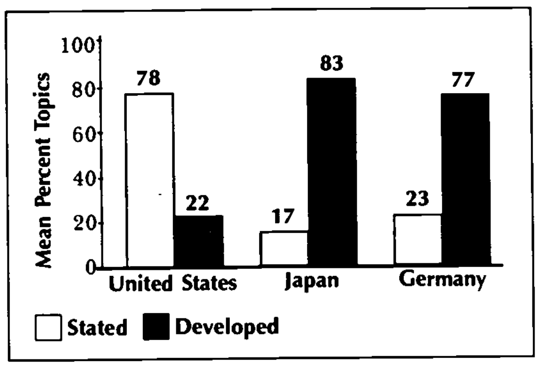


For the curriculum analysis, experts in the 41 TIMSS countries identified the grade levels at which various topics in the TIMSS framework were most emphasized in their country, so that researchers could determine the average grade level for each particular topic. Researchers coded the content of each lesson in the videotape study according to the same framework and compared the topics taught with the international average.

Exhibit 4 shows the average grade level of topics covered in the videotape sample. By international standards, the mathematical content of U.S. eighth-grade lessons was at a seventh-grade level on average, whereas German and Japanese lessons placed at the high eighth- or ninth-grade levels.

EXHIBIT 5

AVERAGE PERCENTAGE OF TOPICS IN EACH LESSON THAT CONTAINED CONCEPTS THAT WERE DEVELOPED VS. ONLY STATED



The nature of the content also differed across countries. For example, most mathematics lessons include some mixture of concepts and the application of those concepts to solving problems. How concepts are presented, however, varies across countries. Concepts might simply be stated, as in "the Pythagorean Theorem states that $a^2 + b^2 = c^2$," or they might be developed and derived over the course of the lesson. Exhibit 5 shows the percentage of topics in each lesson that contained concepts that were developed as opposed to only stated. More than three-fourths of German and Japanese teachers developed concepts when they included them in their lessons, compared with approximately one-fifth of the U.S. teachers.

As part of the videotape study, U.S. college mathematics professors evaluated the quality of mathematical content in a representative subsample of the videotaped lessons. They examined 30 lessons in each country, basing their judgments on a detailed written description of each lesson's content. Descriptions were altered to disguise the country of origin (deleting, for example, references to currency that might identify the country).

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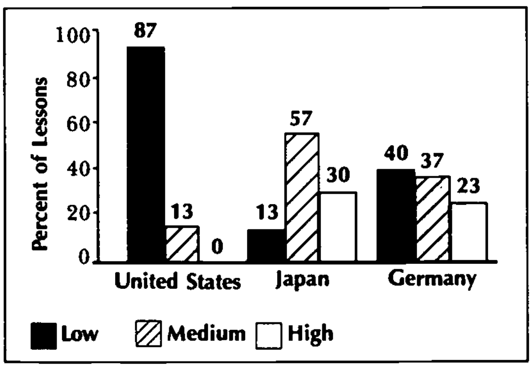
EXHIBIT 6:

PERCENTAGE OF LESSONS WITH CONTENT JUDGED TO BE OF LOW, MEDIUM, OR HIGH QUALITY

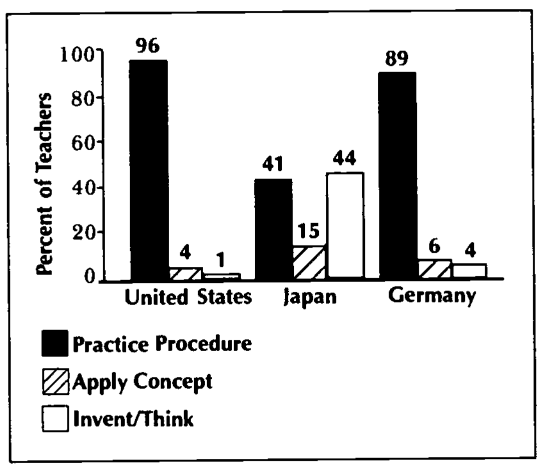


The professors completed several in-depth analyses, the simplest of which involved global judgments of the content quality of each lesson on a three-point scale (low, medium, high). The judgments are summarized in Exhibit 6. Whereas 30 percent of the Japanese lessons and 23 percent of the German lessons received the highest rating, none of the U.S. lessons did so. Eighty-seven percent of U.S. lessons received the lowest rating, compared with 13 percent of Japanese lessons and 40 percent of the German lessons.

3. Student Thinking During the Lessons

EXHIBIT 7:

Average Percentage of Seatwork Time in Each Country Spent Working on Three Kinds of Tasks



When researchers examined the kind of work students engaged in during the lesson, they found a strong resemblance between Germany and the United States, with the situation in Japan distinctly different. Three types of work were coded in the videotape study: Practicing Routine Procedures, Applying Concepts to Novel Situations, and Inventing New Solution Methods/Thinking.

Almost all students' seatwork time in the United States and Germany was spent in practicing routine procedures, compared with 41 percent in Japan. Japanese students spent nearly half their time inventing new solutions and engaging in conceptual thinking about mathematics.

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4. Teachers' Views of Reform

Considerable effort has been invested in the reform of mathematics teaching in the United States in recent years. Agreement exists among experts about what good instruction should include. The main goal of much of mathematics reform is to create classrooms in which students are challenged to think deeply about mathematics by discovering, understanding, and applying concepts in new situations. Numerous documents—including the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards* and the *Professional Standards for Teaching Mathematics*—encourage teachers to adopt new practices and point to some features of preferred instruction.

Although many of the current ideas stated in such documents are not defined in such a way that they could be directly coded, it is possible to view some of the indicators developed in the videotape study in conjunction with these current ideas. When the videotape data are viewed in this way, in some respects Japanese lessons come closer to implementing the spirit of current ideas advanced by U.S. reformers than do the U.S. lessons. Japanese students were asked to solve problems, generate alternative solution methods, and explain their thinking more often than were U.S. students. In contrast, there were other ways in which Japanese lessons departed from current U.S. reform recommendations. For example, eighth-grade Japanese lessons emphasized abstract, symbolic problems more than real-world hands-on problems and almost never required calculators. Thus, Japanese lessons follow a distinct pattern that cannot be labeled as either traditional or reform-minded in the U.S. sense.

U.S. teachers believe that they are implementing current reform ideas in their classrooms. When asked to evaluate their videotaped lesson, almost three-fourths of the U.S. teachers rated it as being reasonably in accord with current ideas about the teaching and learning of mathematics. They were more than twice as likely to respond this way than either Japanese or German teachers. Teachers who said that their videotaped lesson was in accord with current ideas about the teaching and learning of mathematics were asked to justify their responses. Although the range of responses to this question was great, the vast majority of U.S. teachers referred to surface features, such as the use of manipulatives or cooperative groups, rather than to the deeper characteristics of instruction, such as the depth of understanding developed by their students.

The study suggests that written reports on reform disseminated to teachers have little impact on practices in the classroom. One reason for this may be that teachers may not have widely shared understandings of what such terms as "problem solving" really mean, leading to idiosyncratic interpretations in the classroom. Videotaped examples of high-quality instruction, tied to descriptions of what quality instruction should look like, can help address this issue.

5. Achievement in the Three Countries

Japanese students were among the highest-scoring in the 41 TIMSS countries in eighth-grade mathematics. U.S. and German students scored below the international average. There was no statistically significant difference between the U.S. and German students' average scores.

BACKGROUND ON EDUCATION IN THE UNITED STATES, JAPAN, AND GERMANY

SCHOOL ORGANIZATION

United States

The U.S. school system is difficult to define because practices differ among the thousands of school districts in the country. Within-class grouping or individualization of instruction is common in elementary schools in reading and mathematics. In middle and high schools, students are frequently grouped by ability in mathematics classes. In the United States, 80 percent of principals of eighth graders reported that they provide different ability-based classes in mathematics, but only 17 percent reported this in science.

In the United States, educational expectations and teaching standards can also differ substantially among communities, based on a neighborhood's economic status and parents' expectations for their children's futures. Minority students are overrepresented in lower level classes and in schools in poorer areas.

There are various procedures for dealing with students whom teachers judge as having not learned the course material. Such students can be promoted anyway, retained in grade, moved to a lower tracked class, or given remedial assistance. Principals reported that 4 percent of the students in their schools were required to repeat grade eight.

The U.S. system does not use high-stakes gateway examinations to regulate entrance into further schooling before the end of twelfth grade. Seventeen states currently conduct an exit examination as a requirement for high school graduation, but, in most cases, this is a minimum-competency test. Scores on college entrance examinations such as the SAT and ACT are given considerable weight by most selective universities, although non-selective schools may not require them at all.

Japan

Students in Japanese elementary and junior high schools are rarely tracked or grouped by academic ability. During the nine years of compulsory education, all students study the same nationally determined curriculum, regardless of differences in motivation or ability. Until the end of ninth grade, most students are promoted automatically, whether or not they understand the material. Students who are overly or insufficiently challenged by classroom assignments can receive extra help after school from a teacher, or their parents can pay to enroll them in a *juku*, which is a private after-school class. In Japan, a substantial amount of remedial and enrichment instruction is provided by the private sector.

Before Japanese students enter high school, they are required to take a high school entrance exam covering five core subjects, including mathematics and science. Examination scores and previous academic performance are used to divide students into high-, medium-, and low-level high schools. Those with the best scores are accepted into the best academic high schools, which prepare students for the best universities. The least able students are accepted only by the lesser ranked commercial or vocational high schools, which prepare graduates to enter the labor force after high school. Students and parents clearly understand the consequences of academic performance and the examination at the end of ninth grade with respect to students' future careers and life choices. Japanese students say that the examination motivates them to study harder during junior high school.

After graduating from high school, most Japanese students enter the labor force or begin vocational training. Approximately one-third of high-school graduates apply to a university or two-year college, most of which require an entrance examination. Competition on the entrance examinations for prestigious universities is intense, although some lower ranked colleges will accept most who apply.

Germany

Schools in Germany are controlled by the 16 federal states, so there are differences in the requirements and rigor of schools. One large difference is that those states that were part of the German Democratic Republic (East Germany) require students to attend the Gymnasium for only eight years (graduating at grade 12), as opposed to nine in the former West Germany.

The German school system starts the sorting process much earlier than do Japan and the United States—usually at the end of the fourth grade. This is accomplished through a system of gateway examinations and ability grouping, which differs considerably from the Japanese. Most German students attend one of four types of schools:

- Gymnasium (academic), which provides a demanding, academic curriculum through grade 13 and leads to the Abitur exit examination (necessary to attend the university) and university study. About one-third of secondary-school students attend the Gymnasium.
- Realschule (commercial), which provides a moderately paced curriculum ending at grade 10 and leads to a school-leaving certificate and vocational training or further study at a Gymnasium. One-fifth of all secondary-school students attend Realschule.
- Hauptschule (general/vocational), which provides practically oriented instruction ending at grade nine and leads to a school-leaving certificate and vocational training or employment. Children of immigrants, foreign-workers, and other non-Germans are overrepresented in the Hauptschule. One-fourth of secondary-school students attend Hauptschule.
- Gesamtschulen (mixed), which provides academic, commercial, and vocational programs. This is the newest form of school, and about 15 percent of students attend these.

At the end of the fourth grade, children's teachers recommend which of these schools the children will attend. Parents can, and frequently do, override teacher recommendations if they believe that their child deserves to be placed in a higher track. If the student is unable to keep pace, however, he or she will have to repeat a grade, and, after repeated failure, will be returned to the next lower level of schooling. Principals reported that 5 percent of all students were required to repeat grade eight.

Most German students finishing the Hauptschule at the end of grade nine or Realschule at the end of grade 10 receive a diploma, and most states do not require an exit exam. About 10 percent of the students receive only a school-leaving certificate instead of a diploma. Approximately one-third of German students are enrolled in a Gymnasium, and about one-fourth of these end their studies before taking the Abitur examination at the end of grade 13. Few students who sit for the Abitur fail it, although those with a lower score may not be able to enter their preferred university or field of study.

Curriculum

United States

U.S. students attend school approximately 180 days per year, five days per week. Each day, school usually runs from about 8:00 a.m. until mid-afternoon, with a lunch break and five- to seven-minute breaks between classes. Schools vary in the ways they organize students. Middle schools commonly include either grades seven to nine or six to eight, although variations exist. In some schools, the student body is subdivided into "houses" or "blocks," which include several classes of students and a single group of teachers, to strengthen continuity in student-teacher and student-student relationships. In other schools, students change teachers and classmates at the end of each period.

Course content and textbooks usually differ in the higher and lower level classes. In the eighth grade, lower level classes typically focus on a review of arithmetic and other basic skills, with a small amount of algebra. Higher level classes focus more heavily on algebra, with a small amount of geometry.

U.S. eighth graders spend considerably more hours per year in mathematics classes than their Japanese and German counterparts. U.S. students average 143 hours of mathematics, while German students receive 114 hours and Japanese students 117 hours. U.S. students' instructional time is both longer and more compressed, because it takes place within a school year of approximately 180 days compared with 188 in Germany and 220 in Japan. However, TIMSS found that, by international standards, the topics taught in U.S. eighth-grade mathematics classrooms were at a seventh-grade level, while topics observed in the German and Japanese classrooms were at a high eighth-grade or even ninth-grade level.

Japan

Japanese schools are in session 220 days per year, five days per week, and two Saturday mornings per month. School usually starts at 8:00 a.m., ends by mid-afternoon, and includes a lunch break, 5- to 15-minute breaks between various periods, and a homeroom meeting at the beginning and end of each day. The number of classes per day is frequently reduced for special seasonal events, school-wide meetings, and other activities. Junior high schools include grades seven to nine. Students in a given class remain together throughout the day, and a different teacher comes to the students' classroom for each subject.

Japanese public schools offer a single curriculum for all students through the end of ninth grade. In mathematics, all eighth-grade students study a curriculum focused heavily on algebra and geometry. Review of arithmetic is not included in the official curriculum goals and textbooks. TIMSS' observers noted that there are differences in students' ability to keep up with the curriculum both within each classroom and also between schools whose students come from families with predominantly high or low economic backgrounds. However, the Japanese system is designed so that teachers throughout the country strive to meet similar standards for presentation of content, while allowing almost unlimited variation in students' standards of performance.

The Japanese curriculum is more tightly controlled and centralized than in the United States. While a typical U.S. high school may have hundreds of courses, the typical Japanese school offers under 50. Even the electives are controlled by the government. Japan places a greater emphasis on having all students master the same content rather than providing students with many options. Japanese schools emphasize the importance of trying and struggling to master the material, rather than just memorizing the right answer.

Germany

German students attend school approximately 188 days per year. School usually starts around 7:45 a.m. and ends around 1:15 p.m., with 10- to 25-minute breaks between classes. There is no lunch period, and most students return home for lunch at the end of the school day. Gymnasium usually includes students from grades five to 13, Realschule grades five to 10, and Hauptschule grades five to nine. Eighth-grade students remain together throughout the day, with teachers changing classrooms. Classes are usually kept together for several years, and students develop a strong sense of unity.

Classes in grades five to nine typically cover the same content in all three types of German schools, although there is considerable difference in the depth and rigor of instruction among the three types. Gymnasium students usually learn through a theoretical approach, while Hauptschule students learn through a practical approach to the same content. In eighth-grade mathematics, the German curriculum is focused mostly on geometry and algebra for all three types of schools, with some mixture of other topics.

Within most schools, all eighth graders follow the same course of study in mathematics and science, regardless of their ability level. Seventy-five percent of the schools reported that they provide only one course of study in mathematics, and 90 percent provide only one course in science. The German system tends to divide students of different ability levels into separate schools rather than separate classes within schools.

Teacher Preparation and Training

U.S. teachers reported more years spent in college than teachers in all but a few of the 40 other TIMSS countries. Nearly half of the teachers of U.S. eighth-graders had a master's degree, a proportion that was exceeded by teachers in only four other TIMSS countries. In Japan, few teachers had more than a bachelor's degree with teacher training. In Germany, teachers complete 13 years of primary and secondary school, followed by about six years of study at a university, after which they write a thesis and pass an examination to receive a degree considered equivalent to a U.S. master's degree.

U.S. teachers lack the long and carefully mentored instruction in teaching that Japanese and German teachers receive. In all three countries, prospective teachers first take a mixture of courses in education and in academic subject areas leading to graduation from college. In Germany, prospective teachers must pass a state examination at the end of college and spend two years in a teaching apprenticeship that progresses from classroom observation, to assisted teaching, and finally to unassisted teaching under the close supervision of a mentor teacher. They also attend seminars on their subject areas once or twice a year. In Japan, prospective teachers must pass certification and employment selection exams. In their first year, they have a reduced teaching load and must spend at least 60 days in closely mentored teaching and 30 days of further training at resource centers. Senior teachers mentor and assist junior teachers throughout their careers. They have many casual opportunities to share advice, ideas, and teaching materials. Over three-fourths of Japanese teachers say they meet to discuss curriculum at least once a month.

By contrast, prospective teachers in the United States typically spend 12 weeks or fewer in student teaching near the end of their undergraduate training. Some teachers may be hired without any formal training. Licensing requirements vary by state, and most induction programs depend on the district's desire and ability to provide it.

The teacher of U.S. eighth-grade mathematics and science students is typically a woman in her 40s—the average age of teachers in most of the TIMSS countries—with about 15 years of teaching experience. The teacher of German students is typically a man near the age of 50 who has been teaching for about 19 years, and the teacher of Japanese students is typically a man in his late 30s who has been teaching for 14 years.

U.S. teachers teach more hours per year than their Japanese and German counterparts. U.S. mathematics teachers teach 26 periods per week, compared to 24 for German and 16 for Japanese teachers. U.S. teachers are typically at school about eight hours each day and are expected to be in the building during school hours, although many come earlier or stay later. Japanese teachers are usually at school about nine hours each day, staying until student club activities end. Japanese schools also are in session for a half-day two Saturdays per month. German teachers' schedules are similar to college professors; they are not required to be in the building when they are not teaching. When school is over around 1:30 p.m. most return home, where they do their planning and grading of papers.

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FREQUENTLY ASKED QUESTIONS AND ANSWERS

What is TIMSS?

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive international study of mathematics and science achievement ever conducted. More than 500,000 students from as many as 41 countries participated in the assessments, which were administered in 30 languages to pupils in five grade levels in 1995. TIMSS analyses include student outcomes, instructional curricula, and cultural context.

Why is TIMSS important?

In addition to being the largest and most comprehensive international study of mathematics and science achievement, TIMSS goes beyond comparison of students' scores. It examines student achievement, teaching, curricula, and the lives of students and teachers. The study's innovative research techniques include analyses of textbooks and curricula, videotapes of teaching, and ethnographic studies. Until TIMSS, no large nationally representative study ever observed U.S. classrooms to assess how teachers teach.

The result is a complete and accurate portrait of how U.S. mathematics and science education differs from that of other nations. TIMSS is a treasure trove of data that combines qualitative and quantitative information. The study can help us to define what we mean by "world-class" performance and to set standards for what our children need to know and be able to do in order to compete with their international peers.

TIMSS also is vital to our strategies to improve schools. If mathematics and science education is to improve in the United States, we must carefully examine how other countries' policies and practices help students achieve. Not everything will be applicable to the United States, but this comparison opens new lines of investigation and reveals several aspects of education in the United States that can be improved.

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TIMSS helps us measure progress toward our national goal of improving children's academic performance in mathematics and science. TIMSS is more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool for helping us to examine our nation's progress toward improvement of mathematics and science education. Students, teachers, and principals shared information about their backgrounds and their attitudes, experiences, and practices in the teaching and learning of mathematics and science. Ultimately, TIMSS is important because it can illuminate how our education policies and practices compare to those of the world community.

Why should the United States be concerned about what students in other countries learn?

One of the driving forces behind TIMSS is the recognition by policymakers that mathematical and scientific literacy affect economic productivity. World-class competence in mathematics and science is essential to compete successfully in today's interdependent global marketplace. TIMSS provides a comparative international assessment of educational achievement in these two subjects and the factors that contribute to it.

By studying what children in other countries learn, we can see what our own children are capable of achieving. We also can better understand the effects of our own curricula and materials by viewing them through the prism of other countries' practices.

Who conducted TIMSS?

TIMSS is being coordinated by the International Association for the Evaluation of Educational Achievement (IEA), an independent international cooperative of research centers and departments of education in more than 50 countries. TIMSS has the largest complement of participants of any of IEA's international studies.

TIMSS was designed by task forces including members from the many participating countries. These groups were involved in developing the tests and reviewing instruments, questionnaires, and sampling plans. IEA monitored the sampling process, quality control, scaling of tests, and training. In addition, an International Steering Committee continues to monitor the activities and progress of the study, and a U.S. Steering Committee has been established to give advice regarding the implementation of the study in the United States.

The international TIMSS is funded by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government. Dr. Albert E. Beaton directs the study's international activities with his staff at the International Study Center at Boston College.

TIMSS in the United States is funded by NCES and the NSF. NCES is overseeing the collection, analysis, and reporting of the U.S. data through a contract with Westat, Inc., and Dr. William Schmidt of Michigan State University, the national research coordinator for TIMSS.

How was the study conducted?

TIMSS used data collection methodologies that go beyond those used in two previous international studies of mathematics and science. Student achievement was measured through written tests that included multiple-choice and open-ended questions. In many countries, samples of students also were selected to engage in performance assessments (design experiments, test hypotheses, and record findings through hands-on activities).

In addition, students, teachers, and administrators completed questionnaires that solicited information on 1,500 issues, such as student background, teacher instructional methods, and a country's commitment of staff and materials to science and mathematics instruction. TIMSS also analyzed the curricula in participating countries though an ambitious review of textbooks, curriculum guides, and other materials.

Beyond these approaches, NCES designed two new analysis methodologies that were carried out in the United States, Japan, and Germany. In the TIMSS Videotape Classroom Study, teachers in eighth-grade mathematics classes were videotaped for the purpose of studying classroom interactions. The videotapes offer insights into the organization of lessons and instructional methods. In the ethnographic case study, researchers conducted in-depth interviews with and observations of teachers, students, administrators, and parents in these countries. The case studies focus on the implementation of national standards, teachers' lives, the role of school in adolescents' lives, and methods of dealing with ability differences.

Why were different methods used?

TIMSS includes five parts: assessments, questionnaires, curriculum analyses, videotapes of classroom instruction, and case studies of policy topics. The study was designed to bring a variety of different and complementary research methods to bear on important policy questions. The use of multiple methods has three major benefits. First, it strengthens the conclusions of the study, because researchers are able to verify key findings by comparing results based on different research methods. Second, it provides broader information, because different types of data can be gathered and acquired than through any single method or instrument. Third, the use of multiple methodologies enriches the public's understanding of the contextual meaning of key findings. Each of the five parts represents an important advance in its field. Taken together, they provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

If the teachers in the videotaped lessons are just average teachers, then why are they being held up as models?

These teachers are not presented as models but rather as primary sources that can help us better understand teaching and learning in the three countries. The lessons and teaching on these videotapes are typical of the lessons and teaching observed in the TIMSS Videotape Classroom Study. Because these lessons are typical, they show us what ordinary day-to-day teaching is like in these countries, and they provide a reasonable point of comparison.

The purpose of these videotapes is not to present extraordinary teaching for U.S. teachers to imitate, but to help viewers discuss how typical teaching relates to student learning.

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Isn't it unfair to compare an inadequate U.S. teacher with better Japanese and German teachers?

The teachers who are on this videotape are similar to those in the TIMSS Videotape Classroom Study and therefore are typical of those observed in most eighth-grade classrooms in each country.

Also, it must be noted that the teacher is not the only one who influences what takes place in the classroom. A country's examination system, curriculum, books, materials, structure, schedule, and training and support of new teachers also have a significant impact on teaching and learning.

How comparable are the student populations? Doesn't this videotape compare average U.S. students with the best in Japan and Germany?

The two U.S. lessons shown on the videotape are from mixed- and high-ability classes. The two Japanese lessons are from mixed-ability classes, and the two German classes are from average-ability classes. Japanese public schools offer a single curriculum for all students through the end of the ninth grade. Unlike those in the United States, students in Japanese elementary and junior high schools are rarely tracked or grouped by academic ability. There is a widespread belief in Japan that the nine years of compulsory education must offer the same nationally determined curriculum to all students. Until the end of ninth grade, there are no gateway exams, and all students are automatically promoted.

By contrast, the German school system usually sorts students into one of three types of schools at the end of the fourth grade. Classes in grades five to nine cover basically the same content in all of the three types of German schools, although there is a considerable difference in the depth and rigor of instruction among the three school types. However, in eighth-grade mathematics, the German curriculum focuses mostly on geometry and algebra for all three types of schools, with some mixture of other topics.

In the United States, the content students study depends on the track in which they have been grouped. Four out of five principals of schools with an eighth grade reported that they provide different ability-based classes in mathematics. In the eighth grade, lower level classes typically focus on a review of arithmetic and other basic skills, with a small amount of algebra.

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Higher level classes focus more heavily on algebra, with a small amount of geometry. In order to compare classes with similar content, the two U.S. lessons on the videotape had to be chosen from mixed- or high-ability classes that study geometry and algebra.

Why do students in other countries do better?

It is beyond the bounds of a study such as this to suggest reasons for variations in student performance. We can, however, offer observations that give an audience the facts needed to make an informed judgment.

It can be observed from the TIMSS study that:

- The content of U.S. mathematics classes requires less high-level thought than that of classes in Japan and Germany.
- U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help them understand mathematical concepts.
- Japanese teachers widely practice many of the U.S. mathematics reform recommendations, while U.S. teachers do so less frequently, even though most U.S. teachers report familiarity with the reforms.

Is it fair to compare less diverse countries to the United States?

While the United States is more ethnically diverse than Japan, Japanese schools are not tracked by ability until high school. Thus, the typical Japanese eighth-grade classroom is likely to have students with a greater range of academic abilities than its U.S. counterpart. Also, during the period of this study, Germany was in the early stages of reunifying the East and West, adding a considerable diversity of experiences, cultures, and incomes.

During interviews in this study, teachers in all three countries frequently described student diversity as a challenge. U.S. teachers referred primarily to differences in U.S. students' social, economic, or ethnic background. German teachers referred to differences between children of German citizens and those of their country's foreign workers. Japanese teachers referred to the wide differences in academic ability within each classroom.

Moreover, because the United States, Japan, and Germany are three of the world's strongest economic powers, our children will work together in the global marketplace with children from Japan and Germany. All of our children, whatever their race or background, can and must be educated to the same high levels as their Japanese and German peers.

Don't other countries appear to have better results because they don't have the problems that we have?

No education system is perfect; each has its own advantages and disadvantages. Many of the countries whose students outperformed those in the United States have lower incomes, employment levels, and standards of living.

How does teaching differ in the three countries?

Experts recommend that well-taught lessons should be focused on having students think about and come to understand mathematical concepts. In contrast, U.S. and German eighth-grade mathematics teachers usually explained that the goal of their lesson was to have students acquire skills. The U.S. and German emphasis on skills above understanding also carries over into the types of mathematical work that students are assigned to do at their desks during class.

U.S. teachers rarely develop concepts, in contrast to German and Japanese teachers who usually do so. In Germany, the teacher often does the mental work in developing the concept, while the students listen or answer short questions designed to add to the flow of the teacher's explanation. Japanese teachers, however, design a lesson in such a way that the students themselves derive the concept from their own struggle with the problem. When a lesson included a mathematical concept, it was usually simply stated in U.S. classrooms. U.S. lessons were interrupted more frequently by announcements, visitors, and so forth, than those in Germany and Japan.

A panel of experts evaluated the mathematics used in these lessons. None of the U.S. lessons were considered to contain a high-quality sequence of mathematical ideas, compared to 30 percent of the Japanese and 23 percent of the German lessons. Instead, the lowest rating was assigned to the mathematical reasoning used in 87 percent of the U.S. lessons, but to only 40 percent of the German and 13 percent of the Japanese lessons.

Should we imitate other countries?

This study is not intended to suggest that the adoption of another country's education system is desirable or even feasible. Rather, the goal is to promote a better understanding of our current system from a global perspective. By seeing alternative ways of teaching and learning, our educators, policymakers, and the general public can have a discussion that moves beyond preconceptions about our schools and teaching. TIMSS' findings can serve as an objective basis for thinking about how to improve, not replace, the U.S. education system.

Many people think Japanese education is teacher-focused, authoritarian, and centered on memorization of facts. The videotapes offer a different picture of Japanese education. Which picture is true?

These videotapes present typical Japanese classrooms and show how their teachers teach and their students learn. The goal in a typical Japanese eighth-grade mathematics classroom is understanding, not memorization. Students are required to explain their reasoning and encouraged to explore alternate solutions and explanations. A student in a U.S. mathematics classroom is more likely to be given a formula to memorize; a Japanese student would be required to derive the formula.

How are the goals of teaching different in the three countries?

German and Japanese teachers put a greater emphasis on understanding and developing concepts, while U.S. teachers emphasize learning how to do things. In Japanese classrooms, a concept can be an interesting puzzle to analyze and comprehend, while in the U.S. classroom, it is a tool to be used to do something else.

How is the life of a teacher different in these countries?

U.S. teachers spend more years in college than do teachers in all but a few of the 40 other TIMSS countries. Teachers of U.S. and German eighth-grade students teach more classes per week than do Japanese teachers. German teachers spend the shortest amount of time at school and come and go during the day depending on their schedules, much like U.S. college professors. U.S. and German teachers do not have the rich informal opportunities to learn from each other and to share questions about teaching-related issues that are enjoyed by their Japanese colleagues. In addition, U.S. teachers lack the long and carefully mentored introduction to teaching that Japanese and German teachers receive.

What does TIMSS show about mathematics reform?

Most U.S. mathematics teachers have heard of the National Council of Teachers of Mathematics (NCTM) standards, and many believe that they are putting them into practice. Ironically, in many respects, everyday Japanese teaching appears closer to the goals of the U.S. mathematics standards than the teaching in the United States.

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HANDOUT/TRANSPARENCY MASTERS

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Prediscussion Questions

1. When you think of a typical U.S. eighth-grade mathematics classroom, what are the characteristics of teaching and learning that come to mind?

2. When you think about a typical Japanese eighth-grade mathematics classroom, what are the characteristics of teaching and learning that come to mind?

POSTDISCUSSION QUESTIONS

1. In viewing and discussing the videotapes, what was interesting or surprising to you? What did you learn about how different countries view teaching, learning, and mathematics? What about the process of teaching mathematics?

2. What questions about teaching and learning did viewing the videotaped lessons raise for you? How can you pursue these questions? Are there things you would like to try in your classroom as a result of viewing these lessons?

GENERAL SUGGESTIONS FOR VIEWING THE LESSONS

STAY FOCUSED ON THE LESSON ITSELF.

- What do you notice?
- What do you hear?
- What inferences do you find yourself making and why?
- What patterns provide clues to how and what the student/teacher was thinking?

DRAW ON YOUR EXPERIENCE WITH TEACHERS AND STUDENTS AND WITH TEACHING AND LEARNING, BUT ALSO LOOK PAST YOUR ASSUMPTIONS AND EXPERIENCES TO SEE WITH FRESH EYES.

- ☐ What do you think is the teacher's goal? What does he/she seem to want students to learn? What do you think they are learning?

- ☐ What does the teacher do? Are there key moves or moments in the lesson? Are there crucial missed opportunities?

- ☐ Why do you see this lesson in this way? What does this tell you about what is important to you? Look for patterns in your thinking.

- ☐ What questions about teaching and learning did viewing the videotape raise for you?

- ☐ Are there things you would like to try in your classroom as a result of viewing the lessons?

Questions About Mathematics Instruction

- What is the mathematics of the lesson?
- What seems to be the teacher's mathematical goals?
- How does the lesson flow?
- Are there logical connections between the parts of the lesson?

Questions About Communication Between Teacher and Students

- ☐ What does the teacher do to orchestrate the discussion in the lesson? What are the questions posed to students? When are they posed? How do the questions elicit mathematical thinking in the students?

- ☐ What does the teacher do to use students' ideas in the discussion? Are most students involved? How are students' ideas used, and what seems to be the purpose for student ideas?

- ☐ What decisions does the teacher appear to make in regard to students' ideas or discussion?

- ☐ What do the students do in the lesson discussion? What does their communication suggest about their mathematical understandings?

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Questions About Teachers' Beliefs

- What does this teacher seem to believe about mathematics? About the way students learn? About the role of the teacher?

- What do the clues in the specific evidence tell you about patterns of thinking? About apparent theories of teaching and learning?

- Are there common cultural theories of teaching and learning that seem to underlie this teacher's beliefs?

Lesson Tables

While the videotapes and their transcripts provide highlights of each of the six lessons, the following tables provide overviews of the entire lessons. Although the videotape shows roughly 12 minutes of each lesson, the full lessons were significantly longer, ranging anywhere from 37 minutes to a little over 51 minutes. The tables break each lesson down into components and briefly describe what takes place during the time specified. The tables use abbreviations such as CW (whole-class work) and SW (seatwork). In addition to providing information on lesson components not included in the videotape, the tables also include problems, diagrams, formulas, and other items discussed during the lesson but not shown on the videotape. Thus, the tables serve as valuable supplements to the videotape and should be referred to for a complete understanding of the lessons. The tables are organized to reflect the order of the lessons in the videotape, starting with the geometry lessons for the United States, Japan, and Germany, followed by the algebra lessons for these countries in the same order.

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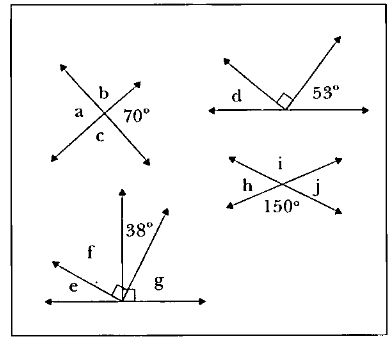
U.S. Lesson One: Geometry—Angles

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
00:01	CW: Working on Tasks/Situations (2 min 15 sec)	(Chalkboard)  m<a = m<b = m<c = m<d = m<e = m<f = m<g = m<h = m<i = m<j = What is the angle that is vertical to the 70-degree angle? (No answer) Which angle is vertical to angle A? Students: Angle 70. Teacher: Therefore, angle A is 70 degrees. What is the supplementary angle to angle A? Student 1: Angle B. Teacher: Angle B and angle C. What do the supplementary angles add up to? Students: 180 degrees. What is the other angle that I indicated in the diagram besides the 53-degree angle? Student 2: Right angle. What is the size of a right angle? Student 2: 90 degrees. Teacher: Right angle is 90 degrees. What other angle is left in the diagram? Student 3: 37 degrees. Why is it 37 degrees? Student 4: Because 53 degrees and 37 degrees add up to 90 degrees, and with the other 90 degrees, it adds up to 180 degrees.

U.S. Lesson One: Geometry—Angles (Continued)

CW: Whole-class work
SW: Seatwork

Time		Description of Activity	Description of Content
			Why do they have to add up to 180 degrees? Student 5: Because it is a straight angle. Teacher: A straight angle is 180 degrees.
02:16	CW:	Setting Up Tasks/Situations (2 sec)	Figure out the rest of the angles.
02:18	SW:	Working on Tasks/Situations Individually (40 sec)	
02:58	CW:	Sharing Tasks/Situations (2 min 15 sec)	Students: Angle G = 60 degrees Angle F = 60 degrees Angle E = 30 degrees Angle H = 30 degrees Angle J = 30 degrees Angle I = 150 degrees
05:13	CW:	Sharing Homework (9 min 46 sec)	Let's get out the worksheets that I gave you earlier this week to make sure that you understand complementary, supplementary, and angle measurements. (Worksheet pg.103) Find the measure of a complement of an angle of the given measure. 1) 38° 2) 7° 3) 84° 4) 11° 5) 67° 6) 29° 7) 53° 8) 46° 9) 1° 10) 52° 11) 45° 12) 73° Find the measure of a supplement of an angle of the given measure. 13) 2° 14) 101° 15) 92° 16) 82° 17) 15° 18) 135° 19) 44° 20) 149° 21) 168° 22) 174° 23) 59° 24) 179° Answers: 1) 52° 2) 83° 3) 6° 4) 79° 5) 23° 6) 61° 7) 37° 8) 44° 9) 79° 10) 38° 11) 45° 12) 17° 13) 178° 14) 79° 15) 88° 16) 98° 17) 165° 18) 45° 19) 136° 20) 31° 21) 12° 22) 6° 23) 121° 24) 1°

U.S. Lesson One: Geometry—Angles (Continued)

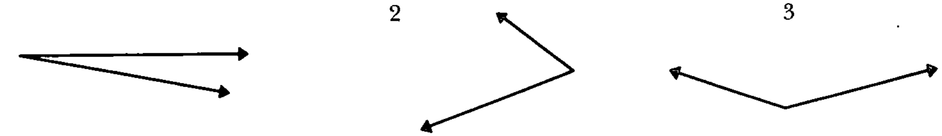
CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content

(Worksheet p.103 part b)

Find the measure of each angle.

1 2 3



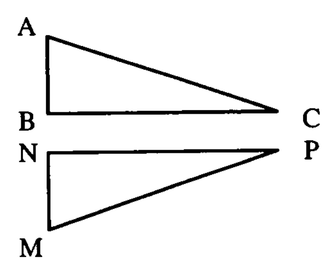
Find the complement of each angle.

7. 40
8. 83
9. 16

Find the supplement of each angle.

10. 75
11. 130
12. 5

△ ABC = △ MNP



13. Angle A
14. BC
15. Angle C A
16. AC

What kind of an angle is it?

Acute.
14 degrees.
Acute.
41 degrees.
Obtuse.
155 degrees.

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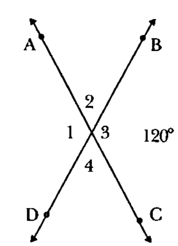
U.S. Lesson One: Geometry—Angles (Continued)

Time	Description of Activity	Description of Content
		7. 50 8. 7 9. 74 10. 105 11. 50 12. 175 ≅ This symbol means congruent, which means identically equal to. 13. Angle M 14. NP 15. Angle P 16. MP
14:59	CW: Working on Tasks/Situations (9 min 46 sec)	I'm going to give you now a worksheet based on these kinds of angles. (Worksheet p.104) ***Example 2:*** Use the figure at the right. Find the measure of each angle. a. <1 b. <2 ***Solution*** a. <3 and <1 are vertical angles, so *m*<3 = *m*<1 = 120° b. <2 and <3 are supplementary angles, so *m*<2 = 180° - *m*<3 = 180° - 120° = 60°  What angle must 1 be equal to? 120 degrees. What can you say about 2 and 3. They're supplementary. If 3 equals 120 degrees what is 2? 60. If 2 is equal to 60 what must 4 be equal to? 60.

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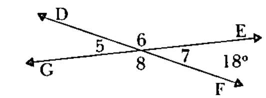
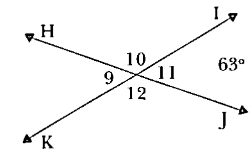
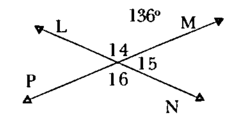
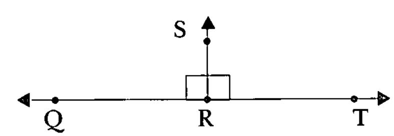
U.S. Lesson One: Geometry—Angles (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
16:53	SW: Working on Tasks/Situations Individually (9 min 26 sec)	(Worksheet p.104 continued) Use the figure at the right. Find the measure of each angle 25. <5 26. <6 27. <7 28. <8  Use the figure at the right. Find the measure of each angle. 29. <9 30. <10 31. <11 32. <12  Use the figure at the right. Find the measure of each angle. 33. <13 34. <14 35. <15 36. <16  **Spiral Review** 37. Angle *QRS* has the same measure as its supplement. Find *m<QRS* 38. Write an equation that represents the sentence: The product of 12 and a number *k* is 192. *(Lesson 4-7)* 39. Find the sum: - 26 + |-28| *(Lesson 3-2)* 40. Find the measure of an angle that is complementary to an 83-degree angle. *(Lesson 5-3)*
26:19	CW: Sharing Tasks/Situations (41 sec)	Teacher: Problem 37  Two angles are supplementary and they add up to 180 degrees, but they are equal. Each one has to be a 90-degree angle.
27:00	SW: Working on Tasks/Situations Individually (51 sec)	(continuous)
27:51	CW: Sharing Tasks/Situations (1 min 23 sec)	Teacher: Problem 38 12k = 192
29:14	SW: Working on Tasks/Situations Individually	(continuous)
	(3 min 26 sec)	The worksheet on Friday we can go over that today.

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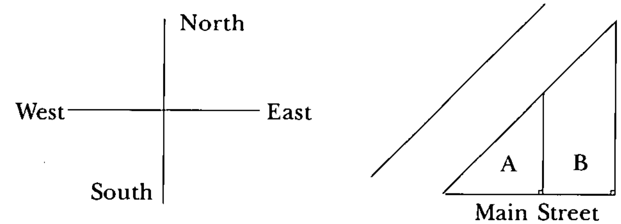
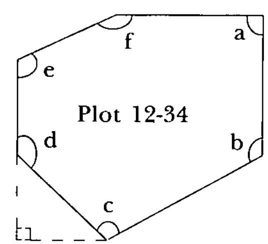
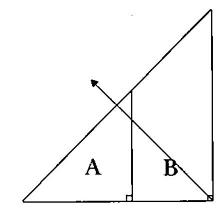
U.S. Lesson One: Geometry—Angles (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
32:40	CW: Sharing: Homework (5 min 15 sec)	(Worksheet number 3) Exercise 15 Two lots are positioned on a downtown city block, as shown below.  a. What is the angle that First Street makes with Main Street? b. What is the angle that the property line between the two lots makes with First Street? c. What is the angle that the property line between the two lots makes with Main Street? d. Could you suggest a more "equal" way to divide the two lots? (Make a sketch) Exercise 35 A survey is made of a piece of property as shown below.  a. Measure each of the labeled angles and summarize them in a table. b. The surveyor knows that the sum of the angles for a plot of land that has 6 sides should be 720 degrees. What was the total of your angle measurements? c. Suppose point D is moved down to the same level as the point C, so that the angle D is a right angle. What happens to the other angles? Will they still add up to 720 degrees? Check this out.

U.S. Lesson One: Geometry—Angles (Continued)

Time	Description of Activity	Description of Content
35:44		Exercise 15. a. 45 degrees. b. 135 degrees. c. That one was given to you. It's 90 degrees. d. Middle of First Street down to the corner  Exercise 35 b. Teacher asks students the measurements they found. c. Yes, the angles still add up to 720 degrees because there are still 6 angles.
37:55	CW: Working on Tasks/Situations (3 min 13 sec)	There is a formula, but we'll go over it during spring break, and I'm going to give you a hint right now. $(N - 2) \times 180°$ tells me how much the angles will add up to. How many degrees in the figure? 6 sided. 6 subtract 2 is 4 times 180 is 720 degrees. 5-sided figure. 540 degrees. All 5-sided figures contain 540 degrees. Triangle. 180 degrees. Square. 4 subtract 2 is 2 times 180 is 360 degrees. What is an equilateral triangle? Equal on all sides. How many degrees in each angle of the equilateral triangle, if each side is equal? 60 degrees. What is an isosceles triangle? Two angles and sides are the same. What is a scalene triangle? None of the sides are equal.

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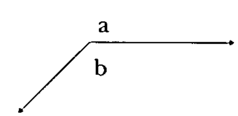
U.S. Lesson One: Geometry—Angles (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
41:08	Other (1 min 22 sec)	(Going over future activity)
42:30	CW: Working on Tasks/Situations (5 min 2 sec)	What do two supplementary angles add up to? 180. How can you remember supp and comp and what they add up to? C comes before s in the alphabet and 90 comes before 180. What can you tell me about vertical angles? Vertical angles must be equal. What is a straight angle? 180. A right angle? 90. An acute angle? Less than 90. Greater than 0. Straight angle? 180. Reflex angle?  a is reflex angle. b is obtuse angle.
47:32~ 48:28	Postlesson Activity	

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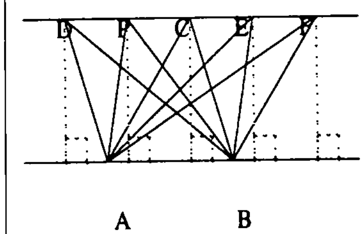
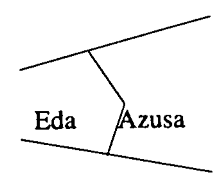
Japanese Lesson One: Geometry—Area of Triangles

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
00:01	Prelesson Activity	
00:27	CW: Working on Tasks/Situations (59 sec)	(Teacher shows a figure on computer screen.) The triangles between two parallel lines have the same areas. 
01:26	CW: Setting Up Tasks/Situations (2 min 39 sec)	(Teacher draws a diagram on chalkboard.) There is Eda's land. There is Azusa's land. And these two people's border line is bent, but we want to make it straight. 
03:34		Try thinking about the methods of changing this shape without changing the area.
04:05	SW: Working on Tasks/Situations Individually (2 min 59 sec)	
07:04	SW: Working on Tasks/Situations in Small Groups (12 min 16 sec)	People who have come up with an idea for now work with Mr. Ishikawa, and people who want to discuss it with your friends, you can do so. And for now I have placed some hint cards up here so people who want to refer to those, please go ahead.

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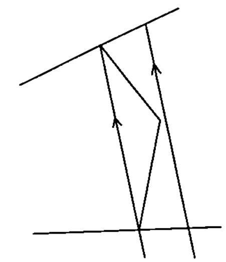
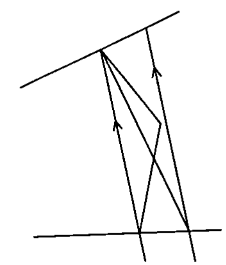
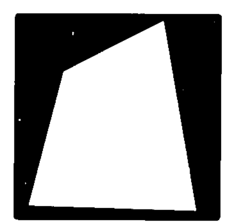
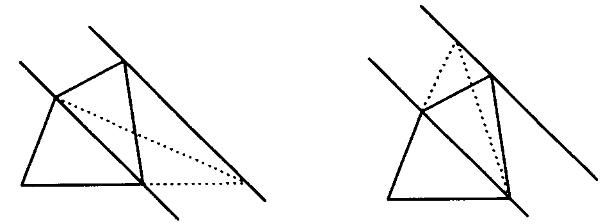
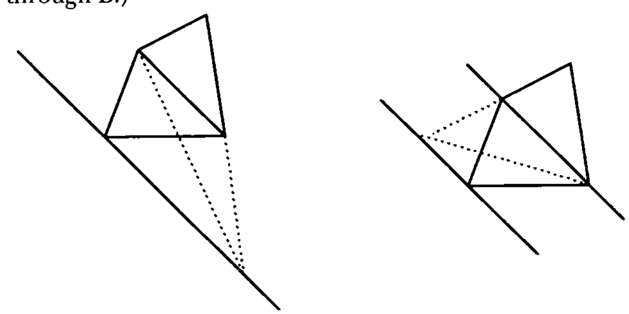
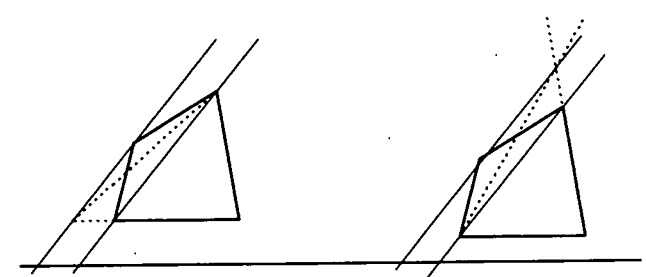
Japanese Lesson One: Geometry—Area of Triangles (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
19:20	CW: Sharing Tasks/Situations (3 min 37 sec)	 First you make a triangle. Then you draw a line parallel to the base of triangle. Since the areas of triangles between two parallel lines are the same we can draw a line here. (See the diagram)  We make a triangle and draw a line parallel to the base of the triangle by fitting it with the apex. Since the length of the base doesn't change and the height in between the parallel lines doesn't change. So wherever you draw it the area doesn't change with the triangle that we got first.
22:57 23:25	CW: Setting Up Tasks/Situations (42 sec)	(Chalkboard)  Without changing the area please try making it into a triangle.
23:39 26:47	SW: Working on Tasks/Situations Individually (3 min 8 sec) SW: Working on Tasks/Situations in Small Groups (19 min 24 sec)	Then people who are done please go to Mr. Ishikawa again. And people who want hints I will leave hint cards here, so please look at them and try doing it. It's also fine to do it with your friends. (Hint cards unidentified.)

Japanese Lesson One: Geometry—Area of Triangles (Continued)

Time	Description of Activity	Description of Content
46:11	CW: Sharing Tasks/Situations (2 min 47.sec)	We will make them ABCD. (Draw a diagonal line AC and make a triangle by drawing a parallel line going through D.)  (Draw a diagonal line AC and make a triangle by drawing a parallel line going through B.)  (Draw a diagonal line BD and make a triangle by drawing a parallel line going through A.) 

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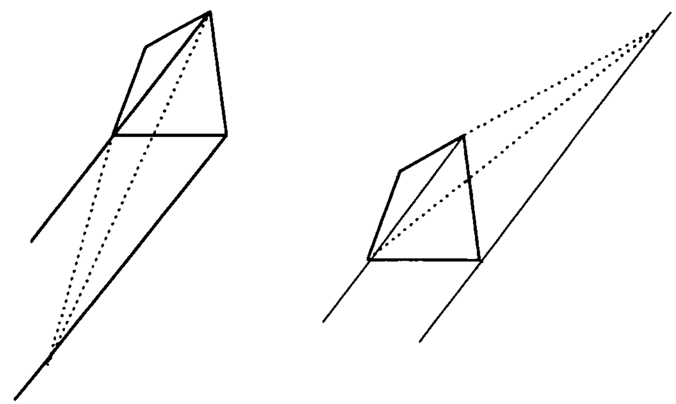
Japanese Lesson One: Geometry—Area of Triangles (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
		(Draw a diagonal line BD and make a triangle by drawing a parallel line going through C.) 
48:58 49:47	CW: Assigning Homework (49 sec)	Pentagon ABCDE. Let's try making the pentagon into a triangle...I'll make that then a homework.
50:25 ~50:45 Postlesson	Activity	

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German Lesson One: Geometry—Volume and Density

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
00:25	Prelesson Activity	
00:48	CW: Sharing Homework (10 min 56 sec)	1. A rectangular bowl of glass with a width of 14.6 cm and a length of 8.4 cm is filled with 17 mm quicksilver (density 13.6 g/cm³). What is the mass of the quicksilver?* a=8.4cm; b=14.6 cm; c=1.7 cm m $m = a \cdot b \cdot c \cdot S$ $m = 8.4 \cdot 14.6 \cdot 1.7 \cdot [13.6 g/cm^2]$ m = 2835.4368 = 2835.43(6) (student erases 6) *European style is to use commas instead of decimals. We have substituted decimal points for the commas here for clarity.
07:43		2. What is the mass of a shop window (density 2.6 g/cm³) with a height of 2.30 m, a width of 2.65 m, and a thickness of 8.5 mm? a= 265 cm; b=230 cm; c=85 cm m $m = a \cdot b \cdot c \cdot S$ $m = 265 \ 230 \cdot 85 \cdot 2.6$ m = 13469950
08:37		3. An open balcony has to be covered with lead sheet (length 4.30 m, width 2.35 m). The thickness of the lead is 2 mm, and its density is 11.34 g/cm³. What is the mass of the surface?
11:44	CW: Working on Tasks/Situations (21 min 11 sec)	Who can remember what we can calculate since yesterday? - Surface of a rectangular solid - Volume of a rectangular solid - Mass of a rectangular solid
12:41		How did we calculate the surface of a rectangular solid? $O = (a \cdot b + a \cdot c + b \cdot c) \cdot 2$
13:12		What is the formula for the volume? $V = a \cdot b \cdot c$
13:43		What is the formula for the mass? $M = V \cdot \rho$
14:19		Goal: You see an empty space on the transparency. And at the end of the lesson you will write in a fourth point—I hope—which you will be able to calculate as well. (Look at solutions to task 1)
14:26		Read the exercise! An iron sheet (rho equals 7.8 grams per centimeters cubed) with a length of 0.5 meter and a width of 20 centimeters weighs 3.90 kilograms. Calculate the height (thickness) of the sheet.

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
15:04		How could we solve this problem? Student 1: Maybe the formula H equals...M divided by rho divided by A divided by B. Student 2: H equals...(Teacher interrupts student's formulation.)
15:36		Write on the board: what is given, what are we looking for, calculation path.
17:02		given: $a = 50$ cm $b = 20$ cm $m = 3900$ g $\rho = 7.8\,\frac{g}{cm^3}$ to determine: thickness h
21:08		Student: $V = a \cdot b \cdot c$ c = (Try rejected, it's impossible.) $m = a \cdot b \cdot c \cdot \rho \mid \div a \div b \div \rho$ $\frac{m}{a \cdot b \cdot \rho} = c$ $\left[\frac{kg}{dm \cdot dm \cdot \frac{g}{cm^3}}\right]$ Student: $c = \frac{3.9}{5 \cdot 2 \cdot 7.8}$ $c \doteq 0.05$ Correction of the unit: $\left[\frac{kg}{dm \cdot dm \cdot \frac{kg}{dm^3}}\right]$
28:13		Student: Why is it still 7.8? Repeat the three relations we have stated earlier. $7.8\,\frac{g}{cm^3}$ $7.8\,\frac{kg}{dm^3}$ $7.8\,\frac{t}{m^3}$ Can it always be 7.8 or does the number have to change? Student 1: Yes it can stay the same, but it's always different numbers...bigger ones. Student 2: The number can stay like this because the measurement always get bigger as well. Can you explain that?

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Time	Description of Activity	Description of Content
32:32		Student 2: Decimeter cubed is bigger than centimeters cubed, thousand times. Student 3: A kilogram is thousand times as big as one gram. If you have a volume that is 1,000 times bigger, what can we say about the weight if the material is the same? Student 1: It has to be thousand time bigger as well. Back to our problem. Which number did we get, and what is the unit? $c = 0.05 \quad \left[\frac{kg \cdot dm^3}{dm \cdot dm \cdot kg}\right]$ $c = 0.05dm$ $c = 0.5cm$ The height of the sheet of iron is 0.5 cm.
35:10		I will come back to the top (of our list of possible calculations). Is anybody of you able to say what we just did and what you learned? Student 1: We can calculate the length, height, or width of a rectangular solid. Student 2: Two of the length, width, or height, the mass, and rho. Student 3: We can calculate the length, width, or the height of a rectangular solid if we have the mass and rho. Teacher: We can change the formula for the mass.
36:55	CW: Setting Up Tasks/Situations (2 min 20 sec)	(Teacher hands out three stacks of worksheets for the power group, the middle group, and the basic group. The students decide to which group they want to belong and choose their worksheet.) Two rectangular rods are to compare. The iron rod (spec. weight = 7.8) and the aluminum rod have a width of 5 cm and a height of 3 cm. The iron rod weighs 15.500 kg, the aluminum rod 4.860 kg. Calculate: a) the length of the iron rod b) the specific weight of the aluminum (The aluminum rod has the length of the iron rod.) A 3-cm-thick copper plate (specific weight = 8.9) is 50 cm long and 30 cm wide. How thick must be a a) Aluminum plate (specific weight = 2.7) b) Lead plate (specific weight = 11.4) of the same size, when they are supposed to have the same weight like the copper plate?

German Lesson One: Geometry—Volume and Density (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
		A receptacle has a rectangular shape, and the base area is 40 cm times 30 cm. It is filled with oil (specific weight = 0.93) and has a weight of 55.800 kg. Calculate the clear height of the receptacle. A rectangular sandstone block (specific weight = 2.3) is 30 cm wide, 20 cm high, and weighs 303.600 kg. Calculate the length. A crystal column (specific weight = 2.7) has a quadratic base area and a height of 30 cm. The weight is 5.184 kg. Calculate: a) the length of the edges of the base area. b) the surface area of the column. A step of a staircase made of sandstone (specific weight = 2.3) has a weight of 0.345 t. The step has a height of 20 cm. Calculate the base area.
39:15	SW: Working on Tasks/Situations Individually (3 min 17 sec)	(Teacher explains to a group of students the calculation of the unit one more time while the other students are working individually.)
42:32	CW: Teacher Talk/Demonstration (20 sec)	We discussed two difficult things today. One appeared in your homework. Then we clarified why the number stays the same.
42:53 ~43:32	CW: Working on Homework (39 sec)	Homework: Do number 7a and 7c page 83 from your textbook. Whoever wants to work ahead with the exercise that you got can do that.

U.S. Lesson Two: Algebra—Complex Algebraic Expressions

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
01:07	Prelesson Activity (1 min 5 sec)	
02:12	CW: Setting Up Tasks/Situations (4 sec)	Start [the] warm-up and I will be with you in a minute. 1) What is the largest integer n for which $2^n > n!$ 2) Find the number of cubic inches in the volume of a rectangular solid if the side, front, and bottom faces have areas of 12 in^2, 8 in^2, and 6 in^2. (Hint: Draw a picture.) 3) Find an ordered pair of integers (a,b), a>b, such that $a^b + b^a = 100$ 4) What is the quotient when $6x^{2a+b-c}$ is divided by $2x^{a+2b+3c}$?
02:16	SW: Working on Tasks/Situations Individually (12 min 51 sec)	
15:07	CW: Sharing Tasks/Situations (1 min 31 sec)	(Teacher elicits the solutions from the students.) 1) 3 was the largest one 2) 24 3) Student 1: 2 minus 6 Teacher: Almost, but read the directions again it says a > b. Student 1: 6 and 2 4) $2x^{a-b-4c}$
16:38	Other (40 sec)	(Discuss future project)
17:18	CW: Setting Up Tasks/Situations (12 sec)	Review: Yesterday we worked on least common denominator. Try this problem. What is the least common denominator? $\frac{1}{x-7} + \frac{1}{x^2-49} =$
17:30	SW: Working on Tasks/Situations Individually (1 min 13 sec)	(Teacher passes out homework for two nights, pages 83 and 84.)

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U.S. Lesson Two: Algebra—Complex Algebraic Expressions (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
18:43	CW: Sharing Tasks/Situations (1 min 30 sec)	(Teacher elicits the solutions from the students.) Student 1: $\frac{7x}{x^2-49}=$ Teacher: How did you get 7x? Student 1: To get x - 7 to x^2 - 49 you have to square 7 and x. (Teacher: nuh.) You have to multiply $7 \cdot 7$ and $x \cdot x$. Teacher: Not quite...you have to do some factoring. Student 2: x - 7 is a factor of x^2 - 49 so we find the other factor x+7 and add 1. $\frac{x+7+1}{x^2-49}=$
21:13	CW: Setting Up Tasks/Situations (14 sec)	(Teacher writes a situation on the board.) $\frac{5}{x+6} - \frac{2-x}{x+6} =$
21:27	SW: Working on Tasks/Situations Individually (1 min 24 sec)	
22:51 22:58	CW: Sharing Tasks/Situations (46 sec)	Subtracting is the same as what? Adding the opposite. $\frac{5}{x+6} + \frac{-2+x}{x+6} = \frac{3+x}{x+6}$
23:37	CW: Setting Up Tasks/Situations (59 sec)	Finish test (Tasks/Situations unidentified) Correct homework (yesterday's ditto) (Tasks/Situations unidentified) Finish graphing calculator worksheet (Tasks/Situations unidentified) And if you finish all of these, then you may start on your homework ditto number 83 Homework: number 83 Least Common Denominator: Find the LCD of rational expressions having the given denominators. Example: $3x - 3$; $6x - 12$ Solution: $3x - 3 = 3(x - 1)$; $6x - 12 = 6(x - 2) = 2 \cdot 3(x - 2)$ $LCD = 2 \cdot 3(x - 1)(x - 2) = 6(x - 1)(x - 2)$ 1) 12; 18 2) 9; 15 3) 5; 7 4) x^2y; x 5) $4x$; $8x$ 6) x^2y; xy^2- 7) $18x^2$; $24x$ 8) 15; 18; 30 9) x^2y; xy; y^3 10) $3x - 6$; $12x - 24$

U.S. Lesson Two: Algebra—Complex Algebraic Expressions (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
		11) $8x + 8; 12x + 12$ 12) $15x + 45; 18x - 36$ 13) $9x - 9; 18x + 18$ 14) $x^2 - 1; x^2 + 2x + 1$ 15) $y^2 - 1; y^2 - 2y + 1$ 16) $n^2 - n - 6; n^2 + n - 2$ 17) $x^2 + x -20; x^2 -2x - 8$ 18) $x^2 - 9x + 14; x^2 - 3x - 28$ 19) $x^2 - 10x + 25; x^2 - 9x + 20$ 20) $x^2 - 16; x^2 + 2x - 24$ 21) $y^2 + 10y +21; y^2 -6y -27$
24:36	SW: Working on Multiple Assignments Individually (11 min 37 sec)	
36:13- 36:27	Postlesson Activity	

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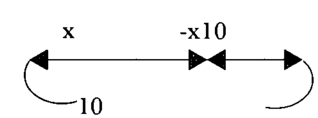
Japanese Lesson Two: Algebra—Algebraic Inequalities

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
00:01	Prelesson Activity	
00:15	CW: Sharing Homework (6 min 45 sec)	Solve inequalities. (Teacher assigns six students to write the solutions on the board.) (1) $6x-4<4x+10$ $6x-4x<+10+4$ $2x<14$ $\frac{2x}{2}<\frac{14}{2}$ $x<7$ (2) $2x-6\leq 7x+4$ $2x-7x\leq 4+6$ $-5x\leq 10$ $\frac{-5x}{-5}\geq\frac{10}{-5}$ $x\geq 2$ (3) $1.2x-4.2>0.4x+0.6$ $(1.2x-4.2>0.4x+0.6)\times 10$ $12x-4x>6+42$ $8x>48$ $\frac{8x}{8}>\frac{48}{8}$ $x>6$ (4) $3(x+4)>5x+2$ $3x+12>5x+2$ $3x-5x>2-12$ * $-2x<-10$ $\frac{-2x}{-2}<\frac{-10}{-2}$ $x<5$ (5) $4(x-2)\leq 5(2x-3)$ $4x-8\leq 10x-15$ $4x-10x\leq -15+8$ $-6x\leq -7$ $x\geq\frac{7}{6}$ (6) $1.8x+2>0.5x+0.7$ $18x+20>5x+7$ $18x-5x>7-20$ $13x>-13$ $x>-1$ *(Corrected) In the above solution, $-2x<-10$ should be $-2x>-10$
07:00 08:51 10:24	CW: Setting Up Tasks/Situations (3 min 24 sec)	(Teacher states lesson goal.) Today will be the final part of word problems. (Chalkboard) You would like to buy 10 cakes all together for less than 2,100 yen in which one cake is 230 yen each and the other cake is 200 yen each. If you want to buy as many 230-yen cakes as possible, what is the maximum number that you can buy? Think about what you need to do to find out how many you can buy and find the answer.
10:34	SW: Working on Tasks/Situations (5 min 24 sec)	

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
15:58	CW: Sharing Tasks/Situations (9 min 24 sec)	<Thinking method 1> 230-yen cakes x 3 ... x 8 x 9 x 10 690 2,070 2,300 yen 200-yen cakes x7 x 1 14.00 2.00 2,090 2,270 <Thinking method 2> You want to buy ten 230-yen cakes which would cost 2,300 yen You are short 200 yen. You want to substitute some with 200-yen cakes to make up the shortage. How many do you have to substitute? If you buy seven 200-yen cakes, you save 210 yen, which would take care of the shortage of money. Which means you buy three 230-yen cakes. <Thinking method 3> Make the number of 230-yen cakes x. Then the number of 200-yen cakes becomes 10-x. 230 yen 200 yen x 10-x $230x+200(10-x) \leq 2,100$
25:34	CW: Working On Tasks/Situations (9 min 4 sec)	(The teacher passes out worksheets.) We are going to try and do [the problem] using an inequality equation. Buy x amount of 230-yen cakes. 

CW: Whole-class work
SW: Seatwork

<table>
<tr><th>Time</th><th>Description of Activity</th><th>Description of Content</th></tr>
<tr><td></td><td></td><td>(Equation)
$230x + 200\,(10 - x) \leq 2{,}100$
$230x + 2{,}000 - 200x \leq 2{,}100$
$230x - 200x \leq 2{,}100 - 2{,}000$
$30x \leq 100$
$\leq \frac{10}{3} \quad x \quad (3.3...)$

<u>Answer: You can buy up to three of 230-yen cakes.</u>
(Chalkboard: Setting up an inequality equation facilitates finding the answer.)</td></tr>
<tr><td>34:39</td><td>CW: Setting Up Tasks/Situations
(1 min 5 sec)</td><td rowspan="3">There are two problems on the right side. Try to set up an inequality equation by yourself in the same way and try to solve the problem.
(Worksheet)
You would like to buy 20 apples and tangerines all together for less than 2,000 yen, in which one apple costs 120 yen each and one tangerine costs 70 yen each. Up to how many apples can you buy?
You would like to buy 15 pears and persimmons and a basket all together and for less than 1,000 yen, in which one pear costs 70 yen each, one persimmon costs 50 yen each, and a basket costs 80 yen. You want to buy more pears than persimmons. Up to how many pears can you buy?

Student 1:<table><tr><th></th><th>120-yen apples</th><th>70-yen tangerines</th><th>Total</th></tr><tr><td>Amount</td><td>x</td><td>20-x</td><td>20</td></tr><tr><td>Sum</td><td>120x</td><td>70(20-x)</td><td>2,000</td></tr></table>
$120x + 70\,(20 - x) \leq 2{,}000$
$120x + 1{,}400 - 70x \leq 2{,}000$
$120x - 70x \leq 2{,}000 - 1{,}400$
$\leq 50x \quad 600$
$\frac{50x}{50} \leq \frac{600}{50}$
$x \leq 12$
<u>Answer: 12 apples</u></td></tr>
<tr><td>35:44</td><td>SW: Working on Tasks/Situations Individually
(11 min 29 sec)</td></tr>
<tr><td>47:15</td><td>CW: Sharing Tasks/Situations
(2 min 33 sec)</td></tr>
</table>

944 945

CW: Whole-class work
SW: Seatwork

<table>
<tr><th>Time</th><th>Description of Activity</th><th>Description of Content</th></tr>
<tr><td></td><td></td><td>Student 2:

| | 70-yen pears | 50-yen persimmons | Basket | Total |
| Amount | x | 15-x | | 15 |
| Sum | 70x | 50(15-x) | 80 | 1000 |

$$\begin{aligned} 70x+50(15-x)+80 &\le 1{,}000 \\ 70x+750-50x+80 &\le 1{,}000 \\ 70x-50x &\le 1{,}000-750-80 \\ 20x &\le 170 \\ \frac{20x}{20} &\le \frac{170}{20} \\ x &\le \frac{17}{2}\ (8.5) \end{aligned}$$
<u>Answer: 8 pears</u></td></tr>
<tr><td>49:48</td><td>Teacher Talk/Demonstration (39 sec)</td><td>(Teacher states lesson summary.) When you work out problems instead of counting things one by one and finding the number, it's usually easier if you set up an inequality and find the answer.</td></tr>
<tr><td>50:27~ 51:38</td><td>Postlesson Activity</td><td>(The teacher passes out worksheets for the next lesson.)</td></tr>
</table>

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German Lesson Two: Algebra—Systems of Equations

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
00:54	Prelesson Activity	Greeting
01:01	CW: Working on Tasks/Situations (19 min 34 sec)	(Determine) 8 to the third power? 512
01:30		Second binomial theorem? $(a-b)^2 = a^2 - 2ab + b^2$
01:47		12 percent of 120? 14.40.
02:00		5 factorial? 120
02:26		A to the third power times A to the seventh power? A to the tenth power.
02:45		One-half minus one-third? One-sixth.
03:10		(Review) What have we done lately? Student: Equations with two variables Teacher: Systems of Equations (on Blackboard)
03:50		What various methods do you know to solve systems of equations? Setting them equal
04:04		Give an example. Student: $2y$ plus $3x$ equals 5. And $2y$ plus $5x$ equals 37. Teacher: I. $x = 3 - 4y$ Continue: Student: II. $x = 7 + 3y$
05:37		Which other method do we know? Substituting
05:50		Give an example for that. Student: I. $y = 3 - 4x$ II. $x - y = 3x$
07:13		How do we solve this? Substitute y in II.
07:44		What was the third method? Method of addition

German Lesson Two: Algebra—Systems of Equations (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
08:14		Give an example. I. $3y + 17x = 1{,}438$ II. $-3y + 28x = 17$
09:25		How do we solve this? I. + II.
10:00		Solve this problem: $\frac{2y-5}{9} = \frac{5}{6}(x-1) - 5y \wedge \frac{3x+1}{12} = \frac{8}{3}(y-2) + \frac{33x}{2}$
11:50		What would you suggest? Eliminate the parentheses: $\Rightarrow \frac{2y-5}{9} = \frac{5x-5}{6} - 5y \wedge \frac{3x+1}{12} = \frac{8y-16}{3} + \frac{33x}{2}$
13:41		Find a common denominator: $\Rightarrow 4z-10=15x-15-90y \wedge 3x+1=32y-64+198x$
18:00		Combining terms: $\Rightarrow 94y + 5 - 15x = 0 \wedge -195x + 65 - 32y = 0$
20:35	CW: Setting Up Tasks/Situations (5 sec)	Copy this in your notebook. Think about the next step.
20:40	SW: Working on Tasks/Situations Individually (5 min 27 sec)	
26:13	CW: Working on Tasks/Situations (8 min 39 sec) 950	What method do you want to use? Method of addition: I. $94y+5-15x = 0 \quad \vert \cdot(-13)$ II. $-32y+65-195x = 0$ I'. $-1{,}222y-65+195x = 0$ II.+I'. $1{,}254y = 0$ $\Rightarrow \quad \underline{y = 0}$ $\Rightarrow$ yI. $5-15x = 0 \quad \vert -5$ $\Rightarrow \quad -15x = -5 \quad \vert :(-15)$ $\Rightarrow \quad x = \frac{1}{3}$ 951

German Lesson Two: Algebra—Systems of Equations (Continued)

CW: Whole-class work
SW: Seatwork

Time	Description of Activity	Description of Content
33:34		Summarize how one has to proceed with this kind of problem: First eliminate the parentheses. Next multiply with the common denominator. Next find the approach to solve the system of equations.
34:52	CW: Setting Up Tasks/Situations (27 sec)	Solve number 12 page 195. 12a) $\frac{3x}{4}+\frac{7}{12}=2-\frac{2y}{9}$, $\frac{2y}{5}+\frac{3}{10}=1+\frac{x}{2}$ 12b) $\frac{x}{3}+2=\frac{y}{2}+\frac{5}{6}$, $\frac{y}{4}+1=\frac{3}{10}-\frac{3x}{5}$ 12c) $\frac{2y-5}{9}=\frac{5}{6}(x-1)-5y$, $\frac{3x+1}{12}=\frac{8}{3}(y-2)+\frac{33x}{2}$
35:19	Working on Tasks/Situations Individually	Who knows what "coefficient" means? It means to work together, to combine.
42:39~ 43:07	Postlesson Activity	Greeting and clean-up

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Lesson Transcripts

The following transcripts are based on the teacher/class dialogues from the lessons on the videotape, which provide highlights from six complete lessons. The transcripts represent both dialogue and utterances such as "Uhm" and other fillers. Wherever the dialogue was not clear, empty parentheses were inserted. To keep the transcripts to a reasonable length, only the portions of the lessons shown on the videotape were included, providing brief descriptions of what happened during the parts of the tapes that were cut out. Three vertical dots (⁝) are used to indicate where sections of the lessons have been omitted. Important actions of the students and teachers are shown in italics. The gaps in the time code on the left-hand column of the transcript correspond to the omitted sections. For a full understanding of the content of the complete lessons and for problems, diagrams, formulas, and other items mentioned in the transcripts, refer to the lesson tables.

THIRD INTERNATIONAL MATHEMATICS & SCIENCE STUDY
EIGHTH-GRADE MATHEMATICS LESSONS: UNITED STATES, JAPAN, AND GERMANY

00:00:00	VO:	Third International Mathematics and Science Study.
00:00:07	VO:	This video contains excerpts from six mathematics lessons taped in eighth-grade classrooms in the United States, Japan, and Germany. The first three are geometry lessons; the second three are algebra lessons.
00:00:21	VO:	The lessons shown here are not those collected in the actual TIMSS Videotape Classroom Study, because the teachers who participated in that study were guaranteed anonymity.
00:00:32	VO:	However, the lessons shown are similar to those taped for the TIMSS Videotape Study and are representative of teaching in the three countries.
00:00:41	VO:	These lessons are shown to encourage discussion, but are not intended to prescribe how teachers should teach.
00:00:48	VO:	Before viewing the videotaped math lessons, Dr. James Stigler from UCLA, who directed the video study, provides us with a brief background.
00:00:59	VO:	Dr. Stigler, you are responsible for the video study. Tell us about it.

Dr. James Stigler, Professor, Department of Psychology, UCLA

00:01:03	JS:	The TIMSS Video Study was conducted in three countries, Germany, Japan, and the United States. It was really a very simple study. We took national samples of

eighth-grade mathematics teachers in each country, and we videotaped them teaching in their classrooms. We had two goals for this study. The first goal was to find out how we teach mathematics in the United States. Actually, up until this point, we've had very little detailed information at a national level about what teachers actually do in the classroom. The second goal, of course, was to find out how they teach mathematics in other countries, particularly in a country like Japan, where we know that student achievement levels are very, very high. Of course, teaching is not the only factor that would account for high student achievement in a country like Japan. But we believe that teaching is very, very important for achievement, and that's why we wanted to do this videotape study.

00:01:56 VO: How was the study conducted?

00:02:00 JS: The study was conducted over about a seven-month period. We had one camera person in each country traveling around from place to place, shooting in a different classroom every day or two. The participants in the study, the teachers, were selected at random. First, we selected schools at random across these three nations; then we selected eighth-grade teachers in that school at random; and, finally, we randomly selected the math period that that teacher taught that was going to be included in the study.

00:02:30 VO: Is there anything we should know about your findings that would help us understand the lessons we're about to see?

00:02:37 JS: Well, I think that some general findings would be very useful. First of all, the goals that teachers have for these lessons are very different across countries. German and

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American teachers, on one hand, have a very different goal than Japanese teachers. We asked teachers, "What was the main thing you wanted students to learn from this lesson?" The majority of German and American teachers said they wanted students to learn how to solve a particular kind of problem, so they stressed skills. Japanese teachers, on the other hand, tended to stress understanding. They said, "We want students to understand some mathematical concept or principle." Now, because of these different goals, lessons appear to follow a very different script in these countries. In German and American lessons, we find that they generally are divided into two parts. The first part is where the teacher explains or demonstrates how to solve the kind of problem that the teacher wants the students to learn how to solve. So, in the first part of the lesson, the teacher might work an example at the board or work an example collaboratively with the class. Then, in the second part of the lesson, students will be given time to practice what the teacher had taught them. Japanese lessons proceed in the exact opposite direction. They tend to start with a very challenging or rich problem and the teacher will say, "Think about this problem and see if you can think of a method for solving this problem." Students will then work on their own or in groups for the first part of the class period. After that, the class gets back together and the teacher will ask various students to share the method they came up with for solving the problem. At the end of the lesson, the teacher will try to summarize or bring everything together in order to highlight the particular mathematical concept or principle that the teacher wanted the students to understand. I think it's very helpful to know how the lessons flow in order to begin watching these lessons.

00:04:29	VO:	What do you think we can learn by viewing and discuss ing these examples?
00:04:34	JS:	I don't think you can learn what's the right way to teach. That's not the goal here. The goal here is to use these examples to help you think about the way we teach in the United States. So, by studying teaching in Japan, by studying teaching in Germany, it helps us to more clearly see our own teaching, to see that it's really just one alternative form of teaching, and that there are others. So, really, the goal is to help us understand and discuss and to begin to be able to talk about teaching in ways that would be useful when we go about trying to improve it.
00:05:08	VO:	Great, let's take a look at the videotape.
00:05:10	JS:	OK.
00:05:11		Please note that the subtitles in this videotape are literal, rather than idiomatic, translations of the dialogue in each lesson. They provide the gist of the dialogue and are not intended to capture everything said.

U.S. Lesson One: Geometry—Angles

Classroom setup: There are approximately 23 students in the class. They are sitting in five rows. One student is sitting at the front behind a large desk, facing the other students. There is a large chalkboard on the front wall.

Part 1
Presenting and Checking Warm-Up Questions

00:00:00	T	(*To class*) What is the angle that is vertical to the seventy-degree angle?
00:00:04	T	Vertical angles are formed by what, Juan?
00:00:07	S	Umm... (I don't know. I was just stretching.)
00:00:09	Ss	Ha, ha, ha.
00:00:11	T	Don't get nervous (you do stretching.) When I intersect lines I get vertical angles. Right? Look at your definitions. I gave them to you. You have them. (You don't?) You can look them up.
00:00:24	T	Here we have vertical angles and supplementary angles. ...Angle A is vertical to which angle?
00:00:32	Ss	(Seventy)
00:00:33	T	Therefore angle A must be...
00:00:35	Ss	Seventy degrees.
00:00:36	T	Seventy degrees. Go from there. Now you have supplementary angles. Don't you?
00:00:42	T	What angle is supplementary to angle B?
00:00:46	S	A.
00:00:46	T	I mean...I am sorry. Angle A.
00:00:48	S	B.
00:00:48	T	B is and so is?
00:00:50	Ss	C.
00:00:50	T	C. Supplementary angles add up to what number?
00:00:56	S	One eighty.
00:00:56	T	One hundred eighty degrees. So if you know one is seventy the other one has to be?
00:01:01	S	Hundred ten.

00:01:01	T	A hundred ten. Go from there. ...Okay. You have all your information. So we already figured these out. (*Teacher begins writing on board.*) We have the measure of angle A is seventy degrees. B is a hundred ten and C is a hundred and ten. We know that.
00:01:19	T	What information are we given in the second problem for D?
00:01:23	Ss	Fifty-three degrees.
00:01:24	T	(*Walking away from board*) Okay. You—two things. You have fifty-three degrees.
00:01:29	T	What is the other angle I've indicated in there?
00:01:31	S	D.
00:01:32	T	Mike?
00:01:32	S	Right angle.
00:01:32	T	It's right angles, which add up to?
00:01:34	Ss	Ninety degrees.
00:01:35	T	Ninety degrees. Okay?
00:01:38	T	What is left?
00:01:39	S	Uh.
00:01:41	T	Somebody just gave me the answer. (*Teacher walks back to the board.*)
00:01:42	Ss	Thirty-seven.
00:01:43	T	(*Writing on board*) Thirty-seven degrees. Right?
00:01:47	T	Why thirty-seven degrees Jamie? (*Teacher turns to face class.*)
00:01:51	T	Carrie?
00:01:51	S	Because thirty-seven and fifty-three equals ninety.
00:01:56	T	Thirty-seven and fifty-three equals ninety. The middle angle is ninety. And why did they all have to add up to one eighty?
00:02:03	S	Because it's...it's a...
00:02:05	T	Because it's a...? Veronica.
00:02:08	T	What is this angle called here?
00:02:10	S	A straight...
00:02:10	T	Straight angle. And a straight angle adds up to?
00:02:13	S	One eighty.

00:02:13	T	One eighty. Okay. You think in a couple of minutes you can figure out the rest of them?

(*Students begin working on problems on their own. After realizing many students are having difficulty with two problems in particular, the teacher helps them as a class. Then the teacher turns to the homework. The students take out a worksheet that was assigned earlier in the week.*)

Part 2
Checking Homework

00:06:15	T	(*Standing in front of class, reading from paper*) Okay. What is the complement of an angle of thirty-eight degrees? Tracy?
00:06:24	T	If you didn't get a chance to do it, do it now. Complementary angles add up to what, Tracy?
00:06:31	T	(*Other students raise their hands.*) Relax, give...give... give Tracy a chance.
00:06:34	T	Look at...look up at the top definition right here. Complementary angles add up to?
00:06:39	S	Ninety degrees.
00:06:39	T	Ninety degrees. So if I have an angle of thirty-eight degrees...
00:06:44	S	(*Not Tracy*) Fifty-two.
00:06:45	T	Thank you, Tracy.
00:06:46	Ss	Ha, ha, ha.
00:06:48	T	If I have an angle of thirty-eight degrees, what is ninety minus thirty-eight?
00:06:53	S	Fifty-two.
00:06:54	T	Fifty-two. So the complement would be fifty-two degrees. Right?
00:06:59	T	What is the complement of an angle of seven degrees? Ho?
00:07:03	S	Eighty-three.

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00:07:03	T	Eighty-three. The complement of an angle of eighty-four, Lindsey, would be...
00:07:09	S	Sixteen.
00:07:10	T	You sure about your arithmetic on that one?
00:07:14	S	Six?
00:07:15	T	Six. Six degrees. Albert, number four.
00:07:19	S	Umm, seventy-nine degrees.
00:07:22	T	Number five. Joey?
00:07:24	S	Thirty-three.
00:07:26	T	Sure about that? Claudia?
00:07:28	S	Twenty.
00:07:28	T	Twenty-three. Gotta be careful with the arithmetic. Number six. Jamie.

(*The teacher reviews the remaining problems with the class.*)

Part 3
Assigning Seatwork

:

00:14:59	T	(*Standing in front of class*) All right. I'm gonna give out your worksheet...based on these kind of angles and let you get started on it. (*Teacher walks to back of room to get worksheets.*)
00:15:12	S	Will we need a protractor?
00:15:14	T	You will not need a protractor. This is gonna be by observation. Just like the warm-up. (*Teacher begins passing out worksheets.*)
00:15:43	T	All right.
00:15:46	T	Okay. When you get the worksheet, let's look at the example on the top. These are very similar—you didn't get one?
00:15:52	S	We need two more.
00:15:53	T	We need two more. Okay. (*Teacher hands students worksheets.*)

00:16:01	T	All right. Look at the examples on the top.
00:16:04	T	(*Walking back and forth in front of room*) Similar to your warm-up. Look at the figure on the right...and find the measure of each angle. If angle three is one hundred twenty degrees...and angle three and angle one are vertical, what must angle one be equal to?
00:16:22	S	One hundred twenty.
00:16:22	T	One hundred twenty degrees.
00:16:25	T	What can you tell me about angles two and three?
00:16:31	S	They are vertical.
00:16:32	T	Two and three are not vertical.
00:16:35	T	One and three are vertical. Two and four are vertical. ...Two and three are supplementary. So if three is a hundred and twenty, what must two be equal to?
00:16:46	S	Umm, sixty?
00:16:47	T	Sixty. If two is sixty, what must four be equal to?
00:16:52	Ss	Sixty.
00:16:53	T	Okay. (*Teacher begins circulating among students; looks at worksheet.*)
00:16:58	T	All the rest is done the same way. Any questions? I'm curious to see when you get down to thirty-seven and thirty-eight, you're gonna have to think a little bit. Curious to see what you can come up with for those. You do not need a protractor. This is all by observation.

(*Students start working on the worksheet, and the teacher begins helping individual students.*)

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Part 4
Providing Extra Help on Challenging Problems

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00:25:48	T	I thought you had sixty-two.
00:25:50	T	No, you had—you had an eight at the end. You had—there was an eight there at some place. One seventy-eight or something like that.
00:26:01	T	Okay. (*Student walks into classroom.*) (*To student sitting at front of room*) You have the attendance? Did you (bubble) it? (*Student at desk hands attendance sheet to other student.*)
00:26:05	T	What do you mean? Which is angle QRS? (*Walks to board and begins drawing angle*)
00:26:13	S	(Zero)
00:26:15	T	(*To attendance checkers*) Oh those are—uh...yes. Somebody came in the first period and got them. Thanks.
00:26:28	T	(*Finishes drawing and speaks to class*) I don't wanna give it away.
00:26:30	S	It is ninety?
00:26:31	T	It's gotta be. Think about it.
00:26:34	S	It's ninety.
00:26:35	T	Look at problem thirty-seven. Two angles are supplementary. Therefore they must add up to one hundred eighty degrees (*Teacher begins drawing more on figure on board.*), but they are equal, so let's call one QRS and the other SRT. Each one of them has gotta be...
00:26:36	S	Ninety.
00:26:54	T	A ninety-degree angle.
00:26:54	S	Oh, okay. I get it now.
00:26:58	T	That's the only way.

(*Students begin working on problems individually. The teacher then calls attention to a particularly difficult problem and works it through with them. The teacher then proceeds to review a worksheet with the students.*)

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Part 5
Checking More Homework and Introducing a New Formula

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00:36:46	T	Oh. Seven eighteen. That's pretty darn close. Within five degrees. How many got seven twenty? Within five degrees. (*Students raise hands.*)
00:36:53	S	Yeah (I got).
00:36:53	T	Okay.
00:36:54	S	I got seven twenty exactly.
00:36:56	T	Seven twenty exactly. You were accurate with your protractor. If I move that bottom angle...started out like this (*Teacher begins to draw figure on board.*); let me see if I can re-create it here for you.
00:37:11	T	One (was) here, then the line came down here then went back here. One, two, three, four—this is about what it looked like. This was B, A, F, E, D, and C.
00:37:27	T	(*Working on board*) If I took...this angle...and moved it...down here...and made it across this way. Moved D down here, should that change the sum—the total of my...?
00:37:44	S	No.
00:37:45	S	No.
00:37:45	T	Angles?
00:37:46	Ss	No.
00:37:46	T	It should not. Why? I still have how many angles? Joey.
00:37:51	S	You still have six.
00:37:52	T	I still have six angles.
00:37:55	T	There is a formula, and we are gonna go through this in...after spring break, but I am gonna give you a hint right now (*points toward figure on board*). If I take the number of sides...and I subtract two...and I multiply that number times one hundred eighty

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		degrees...that will tell me how many degrees these add up to. How many sides in this figure?
00:38:25	S	(Six)
00:38:27	S	(How many) sides?
00:38:28	T	How many sides in this figure? One, two, three, four, five, six. Right? Number of sides subtract two.
00:38:37	T	Gives me what?
00:38:38	Ss	Four.
00:38:38	T	Four. What is four times one hundred eighty degrees?
00:38:42	S	Uh.
00:38:45	S	Seven hundred twenty.
00:38:46	T	Should be seven hundred twenty. Right? How many...how many degrees should there be in a five-sided figure?
00:38:56	S	Uh.
00:38:56	T	A pentagon.
00:39:00	S	(Five seven)
00:39:02	T	(*Walking away from students*) Take the formula... number of sides is five. You don't have to do it in your head. You have pencil and paper.
00:39:11	T	Number of sides is five...subtract two and multiply it by one hundred eighty degrees.
00:39:19	S	Five hundred forty.
00:39:19	T	Five hundred and forty degrees. All five-sided figures contain five hundred forty degrees.
00:39:29	T	Triangle has how many sides?
00:39:31	Ss	Three.
00:39:31	T	Take away two is one. One times one eighty. A triangle contains eighty degrees.
00:39:37	S	One hundred eighty degrees.
00:39:38	T	One hundred eighty degrees. Thank you Liz. A square. Four sides or rectangle subtract two is two

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times one eighty is three hundred sixty degrees. You can always figure out the total number of degrees in a figure by taking the number of sides, subtracting two, and multiplying by one eighty.

(*The teacher uses this rule to introduce a brief discussion of isosceles triangles, the topic of the next day's lesson.*)

Part 6
Previewing the Upcoming Schedule

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00:41:08	T	(*Standing in front of class*) Tomorrow we are gonna go over triangles...Friday you're—uh tomorrow I will introduce triangles. We will review for the quiz. Your quiz on Friday will contain complementary angles, supplementary angles, vertical angles, and that's about it. Next week...next week we're gonna finish this unit.
00:41:30	T	I wanna finish the unit. (*Student raises her hand.*) Let me finish, and then you can ask questions or tell me who is going on vacation early or what. Next week I want to finish the unit because I don't wanna continue the unit past skin—uh spring break. The unit test next week will be on Thursday. ...Because I am afraid some of you may be leaving early for vacation and will not be here on Friday.

(*The class ends with students working individually. They get a quick review of rules and definitions regarding triangles, and discussion of an upcoming quiz and field trip.*)

Japanese Lesson One: Geometry—Areas of Triangles

Classroom setup: Approximately 36 students, seated in six rows of six. The teacher's desk is at the front of the room, with a large chalkboard on the front wall. A computer is set up at the front, with a large TV monitor for all of the students to see. There is a second teacher standing in the back of the classroom.

Part 1

Linking Yesterday's Lesson Topic to Today's Topic

:

(*The teacher is standing in front of the class.*)

00:00:01	S	Stand. (*Students stand.*)
00:00:14	S	Stand straight.
00:00:16	S	Bow.
00:00:17	Ss	(*Bowing*) Onegaishimasu.
00:00:18	T	Okay. (*Students sit.*)
00:00:27	T	(*Turns on computer monitor*) Umm, do you remember what we did last period?
00:00:30	S	(*Stands*) We did mathematics.
00:00:32	T	Sakurai, what kind of thing did we do?
00:00:35	S	Huh?
00:00:35	S	We did mathematics.
00:00:35	S	I don't know.
00:00:39	S	Huh? Hmm. The last period?
00:00:42	T	Umm. This study okay?
00:00:46	S	Is it that?
00:00:47	T	Yes.
00:00:47	S	Obtain the area of triangle which are in the places in the parallel lines.
00:00:52	T	That's right, huh? (*Teacher pointing to diagram on monitor*) Umm, we did a study that says on the parallel lines...the triangles on it, umm, of the same base or height are all the same...like this. For example, here. (*Monitor shows two parallel lines with two fixed points on the bottom line. Two lines are drawn from each of the base points*

		to meet on the top line, forming a triangle. The point on the top line moves back and forth, forming several different triangles.)
00:01:10	T	This.
00:01:18	T	We did a study, okay? That says since all of...umm these become the same height, the areas become equal, okay? Umm, having this as the foundation we will be going to study today.

(The teacher moves toward the chalkboard, reaches for chalk and a wooden triangle. Students get out their notebooks and get ready to take notes.)

Part 2
Posing the Problem

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00:02:13	T	(*Drawing diagram on board*) Umm. Right now, over here, okay? ...there is Eda's land. (*Teacher labels left portion. Eda is a student in the class.*)
00:02:21	T	It's okay, huh? Okay. There is Eda's land.
00:02:24	T	Okay? Over here is Azusa's land, okay? (*Teacher labels right portion. Azusa is another student in the class.*)
00:02:24	S	Ha, ha.
00:02:31	T	Is it okay? Let's say that there is a land like this.
00:02:35	T	And. Is it okay? Azusa.
00:02:37	S	(*Azusa*) Yes.
00:02:38	T	(*Pointing to line separating the two*) And these two people's... hmm...border line is bent like this, but we want to make it straight, okay?
00:02:46	T	Eda.
00:02:46	S	(*Eda*) Yes.
00:02:47	T	Is it okay here? (*Teacher indicates border giving Eda larger space.*)
00:02:50	S	(*Eda*) Yes.
00:02:50	T	Is that okay?

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00:02:51	Ss	Ha, ha, ha.
00:02:51	T	Then we'll end today's class okay?
00:02:53	Ss	Ha, ha, ha.
00:02:53	T	Ha, ha.
00:02:55	T	Azusa, is it okay here? (*Teacher indicates border giving Azusa larger share.*)
00:02:57	S	(*Azusa*) Ahhh.
00:02:59	T	No? (*Teacher moves border to the right, gradually decreasing Azusa's share.*)
00:02:59	S	(*Azusa*) No.
00:03:00	T	Where would you like it?
00:03:02	S	It would be better if mine were wider.
00:03:04	S	A lot more (to the bottom)?
00:03:05	T	Huh? A little more over here?
00:03:06	S	More.
00:03:06	T	Around where would you like?
00:03:07	S	Continue on over. (*Teacher moves border to the left.*) More. More.
00:03:09	T	More over here?
00:03:09	S	More. More. More. There.
00:03:11	Ss	Ha, ha, ha.
00:03:11	T	Oh. Ha, ha.
00:03:12	T	Eda. Is it okay here?
00:03:14	S	No.
00:03:14	T	It's not okay, right?
00:03:14	Ss	Ha, ha, ha.
00:03:15	T	Then, where would it be good?
00:03:18	T	(*Points to student—Shimizu.*) Shimizu. Around where do you think would it be good?
00:03:19	S	Huh?
00:03:20	T	Approximately.
00:03:22	S	That line…well. (*Student points to board.*)
00:03:25	T	Well, try doing it.
00:03:26	S	Huh?
00:03:26	T	Approximately. Estimate. (*Student walks to board; teacher hands her the pointer.*)

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00:03:29	S	Umm.
00:03:30	T	Yes.
00:03:31	S	Umm. [Take it] between the—this line and this line.
00:03:33	T	Yes. (*Student sits down.*)
00:03:34	T	We got an estimate that says isn't it okay if it's in the middle? I see. How about other people? Okay? Then, well in your notebook, okay? Draw a figure like this and...please try thinking about it a little using methods of changing this shape without changing the area. (*Teacher places sign on chalkboard, "Think about a method of changing the shape without changing the area."*)
00:03:53	T	Okay?
00:03:55	T	Okay, then everybody...let's try thinking about it. The [work] time is...would you think about it for three minutes? First of all, please think about it individually for three minutes. Okay, begin.

(*Students begin working on problems individually, and the teacher circulates among them.*)

Part 3
Working on the Problem

:

00:06:20	T	(*To student*) First of all, draw a figure and...
00:06:21	S	Draw the figure and...
00:06:22	T	That of last time. Is there a method that uses the area of the triangles? (*Teacher moves on to other students.*)
00:06:35	T	[That's] sharp.
00:06:37	T	You were able to make this a triangle, right? Okay? Then if you do what...okay? Would you get triangles with the same area? Would you make this the base?
00:06:49	T	[The question is] that somewhere there are parallel lines, okay?
00:06:52	T	Hmm. We did it like this and like in the last class (like

		we did it like this)...we get a triangle.
00:07:04	T	(*Walks to front of class. To class*) Okay. Then since the three minutes are up so...umm...people who have come up with an idea for now go to Teacher Ishikawa (*standing at back of room*) and do it [with him], and people who want to discuss it with his/her friends, discuss it with your friends. And for now I have placed some hint cards up here so people who want to refer to this, refer to it. Now then, umm, in three minutes... umm...we'll think about it and please try doing it with your friend or by yourself. Okay, begin.

(*Students get up and start moving. Some discuss in groups. Others look at hint cards. Still others talk with the teacher. During this time, the teacher identifies two students to present solutions to the class. Those students start preparing their explanations on the board.*)

Part 4
Students Presenting Solutions

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00:19:48	S	(*Standing at front of room at chalkboard, holding pointer, and explaining his solution*) Hmm. First of all, we make a triangle, okay?
00:19:51	S	Ha, ha.
00:19:52	Ss	Ha, ha, ha.
00:19:52	S	What are you saying?
00:19:53	S	(*At the board*) You talk too much.
00:19:54	Ss	Ha, ha, ha, ha.
00:19:55	S (b)	You make a triangle, right? And then at here...
00:20:02	S (b)	Draw a line para...para...parallel over here also, and...we make over here as the base.
00:20:09	S (b)	As the base. Here.
00:20:11	S (b)	Yes.
00:20:12	S (b)	And then we make it the height and this triangle and...

00:20:16	S (b)	That's the height? ( ).
00:20:17	S (b)	Okay?
00:20:19	S (b)	Which is it?
00:20:20	S (b)	(I think it's not that.)
00:20:21	S (b)	This triangle and a tri...somewhere.
00:20:25	S (b)	Ha, ha.
00:20:25	T	(*Standing to the side of the class.*) Umm. The red triangle.
00:20:27	S (b)	Oh. It's this, right?
00:20:28	T	Yes.
00:20:29	S (b)	[The red triangle] is.
00:20:30	S (b)	The area is...
00:20:32	T	(*Teacher walks to board and outlines triangle for student.*) Over here. Over here. Over here. (*Teacher walks away.*)
00:20:33	S (b)	What is it?
00:20:34	S (b)	(Ya—)
00:20:34	S (b)	Well, they are the same, okay?
00:20:34	Ss	Ha, ha, ha.
00:20:36	T	The triangle over here.
00:20:37	S (b)	Actually, and the triangle over here.
00:20:39	T	Yes.
00:20:42	S (b)	The fact is that the areas are the same, okay?
00:20:43	T	Hmm.
00:20:44	S (b)	Since the base and the height are the same. So...first of all...the fact is we can draw a line here.
00:20:52	S (b)	Yes, yes. Well I don't know what I am saying but...
00:20:54	Ss	Ha, ha, ha.
00:20:56	T	No. We can understand enough, right?
00:20:57	S (b)	Oh. You understand?
00:20:58	T	Is there anybody who does not understand?
00:20:59	S	Ha, ha.
00:21:00	Ss	Ha, ha.
00:21:00	T	Oh. You don't understand?
00:21:02	S	I also don't understand.
00:21:03	T	You don't understand? Then one more time then with this side. This time, please explain it, Inuma. [You're

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saying] that it was a good explanation. Okay, then, applause. Wonderful.

(Students applaud. Inuma then walks to the board to present her explanation. She does so and returns to her seat.)

Part 5
Reviewing Students' Methods and Posing Another Problem

00:22:31	T	*(Pointing to diagram on board)* Okay. Umm, okay for now? Since it's hard to see, we will make it clearer. The areas of this triangle and the red triangle over here [and] this triangle and the yellow triangle over here are the same areas, so we want to do it so here becomes straight like this, okay? So that the corner here is gone. The angle okay? It's that then we were able to draw a straight line here. [That's what we can] say. People who were able to d—who did it like this? *(A few students raise their hands.)*
00:22:51	T	[People who can say] I drew it like this over here? [People who say] I was able to draw it. [People who say] I was able to do it this way? [People who say] they were able to do both? *(Students raise their hands accordingly.)*
00:22:56	T	Okay. That's good. Umm, okay then? Next, making this as the basis, okay? Oh, I don't know if it's making it as a basis or not. A quadrilateral. *(Places cutout of quadrilateral on board.)*
00:23:06	T	Oh. Of course it can be crooked like this. Well for now (Naranai) quadrangle. [Taking] this quadrangle ...without changing the area...make it into a triangle. *(Teacher writes below the quadrilateral, "quadrilateral ==> triangle.")*

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00:23:25	T	Take this shape of the quadrangle without changing the area and please try making it into a triangle. Okay, then...please take three minutes and try doing it in your own way. Okay, begin.

(*Students begin working individually. After three minutes, the teacher asks that the students who are done go over their work with the other teacher. Those who have not finished should look at the cards, ask the teacher, or work in groups.*)

Part 6

Summarizing the Results

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00:46:37	T	For the convenience of explanation we will put in symbols. (*Teacher begins to write on board.*)
00:46:41	T	There were some who were doing it already labeled, okay? We will make them A, B, C, and D, okay? And right now in the beginning we draw a diagonal line [through] A to C and...draw a diagonal line from A to C, and we will make a triangle. We were able to make two, right? And if you ask which ones are the triangles we found that goes through D are...this and...this, right? This one is made like this on the bottom side like this. This one is on the top side. Since this triangle and the original triangle are the same, so it becomes the fact that we changed this quadrangle into a shape like this, right?
00:47:20	T	Next we drew in the same way [through] AC, but this time we drew the parallel line on the B side. Okay? Those are this and...this, okay?
00:47:31	T	It's this and this, okay. Is everything okay? Then I will ask.
00:47:35	T	About how many people are there who say he/she found this I—were able to find it? (*Many students raise their hands.*)

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00:47:40	T	Okay. People who say he/she were able to find this one. (*Other students raise their hands.*)
00:47:44	T	There are about the same [number of people] huh? Umm, how about this one?
00:47:47	T	The D one. The sharp triangle. How about this one?
00:47:50	T	Okay. That's good. Thank you. Okay. What is it? You don't understand? (*Teacher pointing to figures on board*) On this side this time we will draw it on the BD side. Then in the same way, which one is it?
00:47:50	S	I don't understand all of them.
00:48:01	T	Ones that we drew [through] BD and drew a parallel line [through] vertex A are this and...this, okay? They are the triangle that we make on this side and the triangle we make on the top, right? And also the ones we drew a line [through] BD and drew a parallel line on the C side are this and...which one is it?
00:48:22	T	Which one is it?
00:48:24	T	Is there none?
00:48:25	T	Is this it?
00:48:26	T	Huh?
00:48:28	T	It's wrong? Is this it?
00:48:30	T	This? Huh? Is it? Okay then...for the time being? We don't have much time but with the computer...I will explain it a little, okay? (*Teacher walks to the computer.*)
00:48:40	T	It's something we have done.
00:48:43	T	Well the screen is not showing up.
00:48:44	S	It's showing.
00:48:45	T	It's showing. Right, now, well the symbols are different from over there but on BD...for now...we'll draw [a line]. (*Computer shows line.*) And we will connect A.
00:48:45	S	It came out.
00:48:56	T	The parallel line is done. It's two parallel lines. Then there are a lot of them like this which are the same area with this triangle, okay? (*Computer changes figure to form different quadrilaterals.*)

00:49:05	T	There are many of them but...within these...since the fact is we're making the quadrangle into a triangle, [meaning] all we have to do is lose one of the angles. The angle here, okay? (*Teacher points to monitor.*) When it becomes a straight line, then that will become a triangle.
00:49:20	T	(We will do it) with the fact that in the same way...even if it's this side when here becomes straight...we get a triangle. Then we have done quadrangles. Next what do you want to do? ( ).
00:49:29	S	Five [Pentagon].
00:49:30	S	Six [Hexagon].
00:49:31	T	Ha, ha, ha.
00:49:32	S	We like five and six [sided].
00:49:33	T	Ishizaki. You (*Bell rings.*) want to do six by all means. Then five. Fix pentagons into triangles. (*Teacher points to board.*)
00:49:39	T	This. A pentagon's—try drawing a pentagon of your liking. Then...pentagon...
00:49:40	S	I don't have a clue.
00:49:44	S	That's impossible.
00:49:45	T	It's impossible?
00:49:46	S	It's impossible.
00:49:46	S	You don't know if it is impossible until you try it.
00:49:47	T	Okay? Then let's try making the pentagon.
00:49:49	S	Ha, ha.
00:49:50	T	Into a triangle.
00:49:52	S	From right now?
00:49:53	T	No. I'll make that homework.
00:49:56	T	Okay? People who are interested you can do ten-angled [or] twenty-angled [or] one hundred-angled [or] anything but...

(*After a brief exchange about different geometric figures, the class ends.*)

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German Lesson One: Geometry—Volume and Density

Classroom setup: There are approximately 24 students in the classroom. They are sitting in pairs at two-student desks, arranged in four rows. There is an overhead projector and screen at the front of the classroom.

Part 1
Sharing Homework

(*The class begins with a review of the homework. One student, Wilma, is chosen to come to the front of the room to present her solutions to the class, using the overhead projector. She has just presented a model solution to a homework problem. The teacher is standing at the side of the classroom.*)

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00:03:08	T	(*To class*) Who confirms this result? (*Some students raise their hands.*)
00:03:10	S	(I don't.)
00:03:14	S	That is the same.
00:03:15	T	Hmm?
00:03:17	S	That is the same.
00:03:18	T	You say you don't.
00:03:19	S	Nn nh.
00:03:20	T	Did you discover your mistake?
00:03:21	S	No. Not yet. I was just going to check it.
00:03:23	T	Then—maybe it is just a calculator mistake. You have to go through it. Umm, does anybody want to alter Wilma's result a little bit?
00:03:39	T	Dan—Mirco?
00:03:40	S	To three...point—well to three digits after the point. Four point—well two thousand eight hundred thirty-five point four three seven grams.
00:03:50	T	You rounded up correctly. And that was an agreement between us that we would round up grams and kilograms after the third digit. (*Wilma begins correcting her work on the transparency.*)

00:04:01	S	I see.
00:04:10	T	Yes. And now we have...
00:04:12	S	Grams or kilograms?
00:04:14	S	Three seven.
00:04:14	T	Yes. Look. There is your justified question. Lutz?
00:04:19	S	Grams.
00:04:23	T	Can you give her an explanation?
00:04:27	S	Yes, because, uh...because to the power of three always gets rounded up three points after the point.
00:04:36	T	That is correct. That is the reason for the seven. Right?
00:04:40	S	Yes.
00:04:40	T	Four three seven. And now Wilma's question was grams or kilograms or what?
00:04:47	S	(*Wilma*) Yes. Grams or kilograms?
00:04:50	T	You already had written grams.
00:04:52	S	(*Wilma*) Yes.
00:04:54	T	Were you sure about that?
00:04:56	S	(*Wilma*) No.
00:04:56	T	She wasn't sure about that. Who can help her...then? Katrin.
00:05:02	S	Umm, it is grams because it is centimeters cubed...and then the unit gets stated in grams.
00:05:09	T	Yes. Do you have something else in mind?
00:05:15	S	No.

(*The class goes over a total of three problems. Wilma presents the solutions for all three, as her classmates comment on her solutions.*)

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Part 2
Revisiting Previous Material

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00:11:44	T	(*Standing in front of class*) Yesterday...you guys put together what you know how to calculate already and... (*Teacher turns on overhead projector—paper is covering transparency—teacher moves it down to reveal top of transparency.*) I wrote that down on the transparency. We claim that. We hope—I hope that this is actually true...what you guys can calculate...Who can remember what it said? (*Students raise their hands.*)
00:12:24	T	Matthias.
00:12:25	S	We can calculate the surface of a rectangular solid.
00:12:30	T	Yes.
00:12:31	S	(Maybe.)
00:12:32	Ss	Ha, ha.
00:12:33	T	Natasha.
00:12:34	S	We can calculate the volume of a rectangular solid.
00:12:36	T	Yes right. Timo.
00:12:38	S	We can calculate the...the mass of a rectangular solid.
00:12:41	T	Mm hmm. (*Teacher moves paper down to reveal more of transparency.*) And again you see that you guys were right on target. Let's go back to the first one. You remember how you can calculate the surface of a rectangular solid?
00:12:59	T	Hauke.
00:13:00	S	Well, with the formula O [Oberflaeche = surface] equals A times open parenthesis A times B plus A times C plus B times C close parenthesis times two.
00:13:10	T	All right.

(*The teacher then reviews the formulas for volume and mass. Following this, the teacher indicates they will learn a fourth formula and introduces an exercise related to it.*)

Part 3
Posing a Problem

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00:14:19	T	(*At overhead*) I have an exercise for that.
00:14:26	T	Michaela. Would you please read aloud?
00:14:28	S	Yes. (*Student reads from transparency.*) An iron sheet...umm RHO equals seven point eight grams per centimeters cubed with a length of zero point five meters and a width of twenty centimeters weighs three point nine zero kilograms. Calculate the height in parentheses thickness of the sheet.
00:14:54	T	Mm hmm.
00:15:04	T	Sven?
00:15:07	S	Maybe the formula H equals...umm M divided by (RHO)...divided by A divided by B.
00:15:14	S	(Divided by O?)
00:15:17	T	You are already very far with your thoughts. Yes. What would you have said Lothar?
00:15:24	S	Well. H equals...
00:15:29	T	Yes. You want the same thing again. You want to convert the formula right away in your heads. Maybe we can first do that slowly so everybody can understand this, uh, thought. In our three steps. Given, wanted, and calculation path.
00:15:49	T	Who dares to do that here in the front? Here in the front?

(*One student, Lutz, volunteers. He walks up to the board. As Lutz is working on a problem at the chalkboard in front of the class, some students have their hands raised.*)

Part 4
Working on the Problem Together

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00:18:27	T	Lutz, would you please turn around?
00:18:31	Ss	Ha, ha.
00:18:38	T	There are a few people who would like to tell you something.
00:18:39	S	(*Lutz*) Yes. I know.
00:18:40	Ss	Ha, ha.
00:18:42	T	So then.
00:18:47	S	(*To Lutz*) I would convert that into centimeters.
00:18:49	S	I wouldn't. Nn nh.
00:18:51	T	Would you give him the reason?
00:18:53	S	Well, then the numbers are a little bigger, and rho would be better to calculate as well.
00:19:01	T	Can you repeat that one more time so everyone can understand you?
00:19:04	S	Yes, I would convert that into centimeters because one can calculate that better with the density.
00:19:11	S	Umm.
00:19:11	T	Because the density is stated in grams per centimeters cubed. Mm hmm. Bjoern?
00:19:18	S	I would calculate it in decimeters because it is stated in kilograms.
00:19:23	T	That was important. Would you please listen?
00:19:26	S	I would convert it into decimeters because it is stated in kilograms.
00:19:31	T	Sonye says but…
00:19:32	S	Well, one can also convert A and B into centimeters, and then one converts M into grams, too. Well then…
00:19:39	T	Both are possible. (*To Lutz at chalkboard*) You are supposed to decide.
00:19:45	S	Or take decimeters.
00:19:46	S	Math.
00:19:48	T	And…we will follow your calculation path along.

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00:19:49	S	Poor Lutz.
00:19:52	S	Lutz you (don't need to stand like this).
00:19:53	S	Take decimeters.

(*Lutz continues to work on the problem. The teacher then asks another student to take over for Lutz. Different students take turns working out the problems on the board, with the rest of the class watching and providing comment. Then the class arrives at a solution.*)

Part 5
Summarizing the Results

:

00:35:10	T	(*Standing at overhead in front of class*) I will come back to the top. To the fourth one. Are any of you able to say what we just...did and what you learned? (*Teacher points to transparency.*)
00:35:32	T	Michaela?
00:35:33	S	(Well) we can calculate the length, width, or height of a rectangular solid.
00:35:40	T	Well, yes. But there must be something given as a premise. We can calculate the length, the width, or height.
00:35:49	S	(Yes). Two of the...of the length, width, or height. The mass and the ( ) and rho.
00:36:00	T	You mean the right thing. We hear it one more time. Coming from the back. From (Sonye).
00:36:05	Ss	Ha, ha.
00:36:07	T	What?
00:36:07	S	I see. We can.
00:36:12	T	Mm hmm.
00:36:12	S	Well, we can calculate the length, width, or the height of a rectangular solid if we have the mass...and...and rho.

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00:36:25	T	Correct. I will sum it up a little more briefly (*Teacher writes on transparency.*) and write down we can...change the formula...for the mass. Everything you just said is contained in it.
00:36:55	T	We will leave that on the board for orientation... Because you are now supposed to find out if you are able to do it yourselves.

(*The teacher picks up pieces of paper with problems from her desk and arranges them for the students to take at the side of the classroom. The teacher then returns to the board.*)

Part 6
Assigning Seatwork

:

00:37:49	T	Look over here one more time. It is very important that you don't forget this step. (*Teacher points to step written on chalkboard.*) That you write down the units in parentheses...Reduce them, and then, at the end, find the real unit of the solution.
00:38:14	T	Okay...Here are the problems.

(*The students begin working on the problems individually. The class ends with the teacher assigning homework.*)

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U.S. Lesson Two: Algebra—Complex Algebraic Expressions

Classroom setup: There are approximately 27 students in the class. They are sitting with their desks together in groups of four. There is an overhead projector and screen at the front of the room.

Part 1
Presenting and Checking Warm-Up Problems

(*The class begins with the students working on warm-up problems individually. The teacher is circulating among them.*)

:

00:13:54	T	(*To student*) All right?
00:13:55	S	Is this it?
00:13:59	S	Did I get number two right?
00:14:04	S	For one I got three, and for two I got twenty-four, I mean for two I got twenty-four.
00:13:56	T	I'd have to look it up, but I think you are right. Minus...B minus four C? No, there—the last part is minus...(*Teacher moves to another student.*)
00:14:08	T	But two asks you for a pair of ordered—three asks you for...a pair of ordered integers.
00:14:13	T	No. I got...
00:14:15	S	I haven't done three yet. I got...got twenty-four.
00:14:20	S	Mrs. Maddock? (*Teacher walks toward student.*)
00:14:23	S	Umm, are these all right?
00:14:26	T	Very, very good. Now this one...looks good. Now...here, if I had said to you, simplify that, what would you have written?
00:14:38	S	X...to the third.
00:14:40	T	To...very good. How did you get the third? What did you do to the five and the two?
00:14:45	S	I...I subtracted them.
00:14:48	T	All right. What do you want to do to those exponents?
00:14:53	T	Subtract them.

00:14:53	S	Okay.
00:14:54	T	Same method. (*Teacher walks toward front of room and puts transparency with problems on overhead projector.*)
00:15:05	T	(*To class*) Okay, may I have your attention. Let's...look up. I've seen some n—nice work. Umm...and uh...listen carefully. First one, I think almost everybody had. Jenny you had...
00:15:05	S	For which one?
00:15:22	T	First one.
00:15:22	S	Umm...three.
00:15:23	T	Three. Three was the largest one and that was pretty much a guess and check. Number two. I think most people had it. Molly, what did you get?
00:15:34	S	Umm...I got twenty-four.
00:15:36	T	You got twenty-four. All right. And I—as I walked around I saw that most of you had it. Anybody want to ask about that?
00:15:41	T	All right. Uh...three was a little trickier.
00:15:46	T	Uh...Carrie?
00:15:48	S	Two and six?
00:15:49	T	Almost, but read the directions. It says A is greater than B.
00:15:53	S	Oh six...and two.
00:15:55	T	Six and two. Yeah. (*Teacher writes answer on transparency.*)
00:15:56	T	Lot of...uh, math is just reading the directions carefully and understanding it. All right, last one. Uh, a number of you got...eventually with a little bit of a hint. Diana?
00:16:09	S	Uh...two X mi...to A minus B minus four C. (*Teacher writes answer on transparency.*)
00:16:13	T	All right. How did you get it?
00:16:15	S	Uh...well when you divide the—you subtract the exponents.
00:16:20	T	All right.

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00:16:21	S	And two A minus A is A. B minus two B is negative B, and...negative C...minus three C is minus four C.
00:16:28	T	All right. Question on that...anybody? Anybody get four done and four right?
00:16:34	T	Quite a few of you. Okay. Nice job.

Part 2
Presenting and Discussing Problems

(*The teacher writes a least common denominator problem on the transparency, similar to ones they worked on the previous day. She also passes out homework for two nights.*)

:

00:18:41	T	Okay, uh...let's have least common denominator. Molly?
00:18:46	S	Uh...isn't it X squared minus forty-nine?
00:18:48	T	(*Writing student's answer on transparency*) X squared minus forty-nine. And...what's your numerator, Molly?
00:18:53	S	Uh...the answer?
00:18:55	T	Yeah.
00:18:55	S	Seven X...
00:18:57	T	How did you get seven X?
00:19:00	S	Uh...because to get...from X minus seven to X squared minus forty-seven
00:19:09	S	Forty-nine.
00:19:10	S	Forty—oh. You have...you have to square...seven and X.
00:19:21	T	No.
00:19:22	S	You have to mult— you have to multiply, umm, seven times seven and X times X.
00:19:27	T	Not quite Molly. You have to do some factoring.
00:19:31	T	Uh, Serti.
00:19:31	S	You need to times...x m—you need to— you...ugh...umm...X...minus seven is obviously a

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		factor of x squared minus forty-nine so you get the other fact—so you find the other factor.
00:19:47	T	Which is?
00:19:48	S	Which is X plus seven.
00:19:50	T	Right.
00:19:50	S	And then you add one. So it's X plus ( ).
00:19:53	T	Okay...so you—first you multiply one times that, which gives you the X plus seven. And then the one comes from here.
00:20:01	T	Why do you add the one?
00:20:03	T	Because we were adding these two fractions. And this one already has the denominator we want.
00:20:08	T	All right?
00:20:09	S	Right.
00:20:09	T	So X plus eight. How many got it? (*Some students raise their hands.*) Okay, Megan, look at the overhead when I'm writing please. Uh...okay. Question about it, Allison. Does it make sense now?
00:20:21	S	Wait.
00:20:21	T	Question?
00:20:22	S	Why can't you do what I did?
00:20:24	T	You have to find...a least common denominator...a least common multiple that includes both of these as factors. And X minus seven is not a f...
00:20:35	S	(*Interrupting*) No, I found, I...I...I got the least ( )—the bottom right. The top one I thought was...seven X don't you use to multiply?
00:20:44	T	I'm mult—I want to turn this denominator into X squared minus forty-nine, right?
00:20:50	S	Yeah. So...
00:20:50	T	So I— in order to do that...I have to multiply it by the identity element...X plus seven over X plus seven.
00:20:59	T	And so I do one times X plus seven, which gives me X plus seven.
00:21:06	T	All right. And then I have a one here. Umm...this one

		looks easier but there is a trick to it. (*Teacher writes new problem on transparency.*)
00:21:37	T	Raise your hands when you think you have it. It's just a small something that people tend to forget. (*Some students raise their hands.*)
00:21:51	T	Jot it down when you think you have it. (*Teacher walks over to check work of student who has raised his hand.*) No, I don't think so.
00:21:59	T	Show me again.
00:22:11	T	(*Circulating among students, checking their work*) I haven't seen what I think is right yet.
	S	I got (E minus X over)
00:22:30	T	Oh...anybody? Justin. Justin, I think that's...what's your answer?
00:22:37	T	No.
00:22:41	T	Anybody think he has it or she has it? I haven't seen it yet.
00:22:45	T	I can't read that.
00:22:49	T	All right. X plus three over X plus six. (*Teacher walks back to front of room.*)
00:22:52	Ss	Why?
00:22:54	T	Why. All right.
00:22:57	T	Subtracting is the same thing as what?
00:23:00	Ss	Adding the opposite.
00:23:01	T	Adding the opposite. (*Teacher writing on transparency*) So this is the same as...that. All right? Now our denominator is the same, and your denominator is just like a label so your denominator remains X plus six.
00:23:14	T	And from there, where do we go, Rog?
00:23:17	S	You do...five plus negative two, which is three...plus X.
00:23:23	T	Plus X. Oh—Alexa?
00:23:25	S	Why wouldn't you have to make the X negative two if you were...
00:23:29	T	Cause it was negative and a...the...subtraction makes it the opposite. Anybody else?

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00:23:31	S	Oh right. Right. Okay.
00:23:34	T	Okay. Uh, for the remainder of the period there are about...five things that, uh, I would like you to work on in the following order.

(The teacher goes over assignments, which include correcting a worksheet from the day before and a graphing calculator worksheet. The students then begin to work individually, and the teacher circulates among them.)

Part 3
Assigning Multiple Tasks for Seatwork

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00:34:40	T	Is this making sense, Jess?
00:34:42	S	Yeah.
00:34:43	T	Okay.
00:34:43	S	That's not exactly what we got.
00:34:45	S	What did you get?
00:34:48	S	Umm, I have a question.
00:34:46	S	Mrs. Maddock.
00:34:50	S	(*Showing his calculator to the teacher*) When I graph...number umm...when I graph this one, the parabola it goes down so I can't see what the Y coordinate...
00:34:57	T	Parabola? Okay, there's a way to fix it. Push...press window.
00:35:01	T	Window, window. It's...this one.
00:35:04	T	Now if—you want to make your Y minimum lower so that that...vertex will show. So, arrow down to Y MIN...and go over one. Arrow over one. No, the other direction. To the right.
00:35:18	T	Uh, two. Let's go over once more cause we want to change that Y minimum to something lower like sixteen. So type a six in...enter and graph. Now graph.

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00:35:31	S	(*Separate conversation*) I'm not there yet.
00:35:33	S	I'm still figuring out the...I'm way off.
00:35:34	S	Oh. Okay.
00:35:38	T	Yeah. And if that isn't right keep playing with the window.
00:35:41	T	Yeah, you have to do trace.
00:35:42	S	I did do a trace. Okay...okay so I did a bad trace.
00:35:47	Ss	Ha, ha, ha. (*Teacher begins circulating among students again.*)
00:36:01	T	It's so quiet in here I can't believe it.
00:36:10	T	If you can just stay a minute or two and finish, that will be very nice, or get your lunch and come back.

(Then, the class ends.)

Japanese Lesson Two: Algebra—Algebraic Inequalities

Classroom setup: There are approximately 36 students in the room. They are sitting in six rows of six. The teacher is standing behind his desk at the front of the room. On the front wall is a large chalkboard.

:

00:00:00	S	All stand. (*Students stand.*)
00:00:10	S	Onegaishimasu.
00:00:11	Ss	Onegaishimasu.
00:00:12	T	Okay. Onegaishimasu. (*Students sit.*)
00:00:15	T	Okay, we're going to start our homework answer comparisons, so, uh, please take out handout number nine.
00:00:22	T	Now I'll have you write it. Please write ( ), right? Okay, it's the one here.
00:00:27	S	What?
00:00:27	S	Oh.
00:00:28	T	(*Selecting students to write on board*) One two three four five six. Okay, then please write it. Okay.

(*The teacher checks to make sure everyone has completed the assignment. The six students write solutions to the problems on the board. The teacher and class discuss.*)

Part 2
Posing the Problem

:

00:07:00	T	(*Erasing board*) Okay, then, uh, today will be the final part of the sentence problems so...then uh...I will have everyone use their heads and think a little, okay? Until now we've just done calculation practice, but today we will have your heads a little so...asking you to use thinking methods; how to think and how to, uh, look for it and think about it may be a little difficult, you

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		know. More difficult than just simply calculating, that is. Right?
00:07:25	T	Well, then, we'll go ahead. [*Teacher places poster-sized paper on the board with problem three: "Problem 3. You would like to buy 10 cakes all together for less than 2,100 yen in which one (type of) cake is 230 yen each and the other (type of) cake is 200 yen each."*]
00:07:27	T	Okay. Well, then...please look at...the problem.
00:07:33	T	Hachino, can you see it?
00:07:34	S	Yes.
00:07:35	T	Can you see?
00:07:35	S	I can see.
00:07:36	T	You can see. Okay. Then [let's do it].
00:07:43	T	Please read the problem...in English.
00:07:45	S	Ha, ha.
00:07:48	T	Okay. Makoto, please read the problem.
00:07:51	S	(*Reading from board*) You would like to buy ten cakes all together for less than two thousand one hundred yen, in which one cake is two hundred thirty yen each and the other cake is two hundred yen each.
00:08:02	T	Yes.
00:08:03	T	Do you understand the meaning of the problem?
00:08:07	T	Abe, do you understand what this problem means?
00:08:09	T	You have two-hundred-thirty-yen cakes and two-hundred-yen cakes, right? The two-hundred-thirty-yen cakes are a wee bit more expensive.
00:08:14	T	And...you have ten people in your family, so you want to buy cakes so that each person gets one cake. However, I have only two thousand one hundred yen.
00:08:24	T	Which cake...seems more delicious?
00:08:29	S	The two-hundred-thirty-yen one.
00:08:31	T	The more expensive one is somehow more desirable, right?
00:08:33	T	And so...you want to buy as many expensive cakes...as you can, but what's the maximum that you can buy?
00:08:44	T	That's the problem. (*Teacher unfolds second part of*

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		problem from problem 3 poster on board: "If you want to buy as many two-hundred-and-thirty-yen cakes as possible, what is the maximum number that you can buy?")
00:08:46	T	Understand?
00:08:48	T	There are cakes that are two hundred and thirty yen and two hundred yen and...you only have two hundred ten yen. But you need to buy ten.
00:08:56	T	But the two-hundred-thirty-yen one looks more delicious, so you want to buy as many as possible.
00:09:01	S	Nine.
00:09:02	T	But you only have two thousand one hundred yen so...so in fact, how many two-hundred-thirty-yen cakes can you buy?
00:09:09	S	Nine.
00:09:10	T	So then today I am going to have you all think about how to find the answer. I will pass out paper, so, umm, please try and think about how to solve it.

(*Students begin working on the problem individually. After a while, the teacher stops the class and asks a student to present her solution.*)

Part 3
Students Presenting Solution Methods

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00:17:12	T	Okay then, Yokogake.
00:17:13	T	How did you think about it?
00:17:15	S	(*Yokogake*) Heh?
00:17:17	S	What?
00:17:18	T	Okay, go ahead.
00:17:20	S (Y)	(*Standing*) I
00:17:22	T	Mm.
00:17:22	S (Y)	Didn't understand it at all, but...
00:17:25	T	Mm hmm.

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00:17:28	S (Y)	First of all...
00:17:29	T	Mm hmm.
00:17:30	S (Y)	I thought that I should calculate...
00:17:36	T	Mm hmm.
00:17:36	S (Y)	How many of the two-hundred-thirty-yen one that I could buy and...
00:17:36	T	Mm hmm. (*Teacher begins writing on board.*)
00:17:40	S (Y)	In the beginning...when I did it with ten...
00:17:44	T	Mm hmm.
00:17:45	S (Y)	It ended up being two thousand and thirty yen, so...
00:17:48	T	Mm hmm.
00:17:50	S (Y)	It's not good because it's over the amount, so...
00:17:51	T	Mm hmm.
00:17:53	S (Y)	And then next when I did it with nine...
00:17:54	T	Mm hmm.
00:17:57	S (Y)	When I did it with nine...it was two thousand seventy yen, and...it was okay, but...
00:18:03	T	Mmm.
00:18:04	S (Y)	You need to buy ten, so when I calculated it...
00:18:09	T	Mmm.
00:18:10	S (Y)	To buy one two-hundred-yen-cake...
00:18:15	S (Y)	Two...two thousand seventy plus...
00:18:18	T	Mm hmm.
00:18:20	T	Two hundred yen is...
00:18:21	T	Mm hmm.
00:18:23	S (Y)	With two thousand...two hundred seventy yen and...
00:18:26	T	Mm hmm.
00:18:26	S (Y)	You go over.
00:18:27	T	You go over don't you? Okay.
00:18:28	S (Y)	So then...you keep reducing the numbers and...
00:18:28	T	Keep reducing and...when you do it with eight on this side and two this side then?
00:18:32	S (Y)	When I did it...
00:18:33	T	When you did it?
00:18:34	S (Y)	Time ran out and...

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00:18:35	T	Time ran out and...
00:18:36	S (Y)	(I couldn't do it) to the end.
00:18:38	T	You couldn't do it to the end.
00:18:39	T	Okay.
00:18:40	T	Raise your hand...if you say that when this way of thinking came up, it was really similar to yours.
00:18:45	T	Yokogake started counting from ten but...

(*The teacher asks other students how they solved the problem.*)

Part 4
Teacher and Students Presenting Alternative Solution Methods

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00:21:40	T	(*Referring to the same problem*) Then...I've thought about it too, so...what do you think about this way of thinking? Do you all understand it?
00:21:46	T	(*Writing on board*) You bought...ten...two-hundred-thirty-yen cakes.
00:21:52	T	You're told to buy a lot, and so, in reality, you want to buy all two-hundred-thirty-yen cakes, right? (*Written on board: "Method of thinking. Ten 230-yen cakes."*)
00:21:56	T	Then how much money is needed?
00:21:58	S	Two thousand three ( ).
00:21:59	T	(*Continues to write on board, illustrating verbal explanation*) In reality, two thousand three hundred yen is required, right?
00:22:02	T	But you're short two hundred yen.
00:22:05	T	You are short...two hundred yen.
00:22:09	T	He's short, so to tell you what that person thought...that he would buy a cake that is...thirty yen cheaper than...the two-hundred-thirty-yen cake. Buy a cake that is thirty yen cheaper and...you buy a cheap cake and...replace this

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		needed two hundred yen in a cake that is thirty yen cheaper, okay? [*On board.* (*"Short 200 yen"*) (*"30-yen cake"*)]
00:22:26	T	You're short two hundred yen, you know.
00:22:27	T	But let's buy them a cake—not two hundred thirty yen, but a cake...that is thirty yen cheaper.
00:22:32	T	Then thirty yen is going to float. With each...thirty yen is going to float.
00:22:35	T	How many cakes that are thirty yen cheaper do you need to buy inorder to save the two hundred ten yen?
00:22:40	T	This needed part. (*Pauses*)
00:22:46	T	How many cakes that are thirty yen cheaper do you need to buy to save two hundred ten yen? Can you save two hundred ten yen?
00:22:51	S	Seven.
00:22:52	T	Yeah. If you buy six, six times three is one hundred eighty yen, so you are still twenty yen in the red, right?
00:22:58	T	However, if you buy seven of these...if you buy seven...you will have two hundred ten yen left over, right? The money right? [*On board* (*"Seven"*)]
00:23:05	T	That two hundred ten yen is applied to this two hundred yen, you know.
00:23:09	T	Then if you buy seven of the cakes that are thirty yen cheaper, if you do that, then what about this side?
00:23:13	S	Three.
00:23:14	T	It's three...did anyone do it like that? Someone who did it like this?
00:23:19	T	There probably isn't anyone right?
00:23:20	T	Start off by buying ten.
00:23:21	T	You're short two hundred yen, so...let's bury the missing cost with a cake that is thirty yen cheaper.
00:23:26	T	You can save it if you buy seven, so this is three. In that way.
00:23:30	T	It was ( ) right? Then I'll ask you. Okay...Rika.
00:23:33	T	Then, how did you think...about this one?
00:23:36	S	(*Rika*) (*Standing*) Umm...the total two hundred thirty

		yen, oh...It's for some amount, and make that amount X and...umm...you need to buy ten of the two-hundred-yen one, so ten...make it ten minus X and...and the to...total has some amount of two—two-hundred-thirty-yen ones...and the two-hundred-thirty-yen ones are two hundred thirty X and...the two-hundred-yen one is two hundred...bracket ten minus X.. and then...then...umm...two hundred—two hundred thirty X plus two hundred bracket ten minus X...is less—less than minus, uh, less than or equal to two thousand one hundred yen, and you form the inequality equation.
00:24:42	T	Okay.
00:24:42	T	You said that this was the inequality equation, right?
00:24:45	T	Okay. (*Student sits.*)
00:24:45	T	(*To class*) Did you understand the meaning?
00:24:49	T	Perfect.
00:24:50	T	You'll get it better with Rika's explanation than with mine.
00:24:51	T	Okay. Try and raise your hands.
00:24:53	T	People who say that they got it with Rika's explanation. (*Some students raise their hands.*)
00:24:55	T	One person?
00:24:57	T	Only Kanzaki? Two people? Three people?
00:24:59	T	Four people? Just four people is it? Five people? Okay.
00:25:02	T	Then...please explain it next, Ryo.
00:25:04	T	Please explain it in a way that is a little more understandable.
00:25:05	T	Try and explain it in a way in which...a few more people will say...that they understood.
00:25:12	T	The method of explanation is okay with this. (*Teacher begins to draw chart around Rika's solution method on board.*)
00:25:15	T	Okay.
00:25:17	T	Go ahead.

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(*The teacher passes out a worksheet and works through it with the class. The discussion of the worksheet continues.*)

Part 5
Teacher Elaborating on a Student's Method

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00:33:11	T	Which is easier, doing it one by one or using an in equality equation?
00:33:16	S	An inequality equation.
00:33:16	T	It's easier with the inequality equation, isn't it? And so today what I would like you to do from now is we did this in the method of thinking but...inequality equation, right?
00:33:26	T	(*Begins writing on small chalkboard.*) I would like you...umm to know...the good qualities of...finding the answer by...the answer by...setting up an...inequality equation right...inequality equation...inequality equation so...we thought about it...with a problem like this. [*On Board* (*"Having you know the good qualities of finding the answer by setting up an inequality equation."*)]
00:33:52	T	If you were to solve it without using an inequality equation you need to check it out quite a lot, one by one a lot.
00:33:57	T	Yokogake could solve it because it was ten (*points to Yokogake's solution on board*), but what if you were to buy one hundred of these two cakes together...ninety figure out one hundred and figure out ninety-nine and figure out ninety-eight and figure out ninety-seven and you need to figure out all of the numbers between one and a hundred, don't you?
00:34:16	T	However, if you used a method like this that Rika used...(*teacher pointing to Rika's solution on board*) the

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		answer will come out quickly.
00:34:22	T	Therefore you don't need to figure out each number one by one (*pointing to Yokogake's solution*), so working it out by making...an inequality equation has a lot more...good qualities...than counting it one by one. That's what it's about, all right?
00:34:35	T	So then, and so...if there are good qualities like that then...we're saying that so, umm, there are two problems on the right side.

Part 6
Posing and Solving Follow-Up Problems

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00:34:43	T	This time, please buy twenty apples and oranges all together.
00:34:46	T	If you count it one by one, you will be in an incredibly terrible situation.
00:34:50	T	In the same way that we just did the cake situation, set up an inequality equation by yourself and find out up to how many apples you can buy.
00:34:56	T	Either that, or if it were the problem at the bottom, try to solve a problem about how many pears can you buy by setting up an inequality equation, work it out, and find an answer.
00:35:04	T	Because finding the answers one by one is hard, I wonder if you see the numerous good points of setting up inequality equations and, well, that you'll set up inequality equations yourself and try to find the solutions. That's what it's all about, okay?
00:35:16	T	Is it okay?
00:35:19	T	Okay. Then and so...eh...people who haven't written this here write it and then problem one. Try to set up

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		an inequality equation by yourself in the same way and try to solve the problem.
00:35:32	T	Okay. Go ahead.

(*Students begin working on problems individually. After about 11 minutes, the teacher goes over the problems with the class.*)

Part 7
Summarizing the Lesson Objective

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00:49:48	T	What we talked about today was...the answer from inequality equations...that is...when you work out problems instead of counting things one by one and finding the number, it's usually easier if you set up an inequality equation and...find the answer.
00:50:03	T	That's why although it may be tedious...uh...about the applied problems of inequality equations, okay? Rather than looking for the answers one by one, you can get them by translating the parts written in Japanese into mathematical terms and solving [them].
00:50:17	T	Because an inequality equation has a good quality like this. This is what we talked about.
00:50:22	T	Is it okay?
00:50:24	T	Is it okay?

(*The teacher ends the class by passing out a homework assignment.*)

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German Lesson Two: Algebra—Systems of Equations

Classroom setup: There are approximately 15 students in the classroom. Nine students are seated along the right-hand and back walls. From the left-hand wall, two groups of students are seated in short rows. There is a large open space on the right-hand side of the room. There is a large chalkboard on the front wall.

Part 1
Presenting Warm-Up Problems

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00:00:54	T	(*Standing in front of class*) Well, good morning.
00:00:55	Ss	Good morning.
00:00:57	T	Arne, did you want to change places? I mean, we can also put you up here with a mike on you. Eight to the third power. (*Teacher begins walking back and forth in front of class.*)
00:01:14	T	Gabi.
00:01:15	S	Hundred twenty-eight.
00:01:18	T	I don't know at what point you miscalculated there. We'll have to go over that again right away. Sebastian?
00:01:21	S	Five hundred twelve.
00:01:22	T	Please calculate it for us.
00:01:24	S	Uh well. Eight squared is sixty-four. That times eight is five hundred twelve.
00:01:29	T	Yes, Gabi.
00:01:30	S	Yes, that's right.
00:01:30	T	Yes. You agree with that? Second binomial formula. We have aspecialist for that. Right, Rieke?
00:01:36	S	A minus B in parentheses squared.
00:01:37	T	Rieke speak (a little [louder])—look I got this thing around me. Man, why don't you at least speak up?
00:01:39	S	Yes.
00:01:41	S	A minus B in parentheses squared equals A squared minus two A B plus B squared.
00:01:47	T	And twelve percent of hundred twenty.

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00:01:57	T	Claudia.
00:01:58	S	(Fourteen point forty)?
00:01:59	T	Right on. And five factorial?

(*The teacher asks a few more review questions.*)

Part 2
Reviewing Previous Material

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00:03:10	T	(*Walking back and forth in front of class*) Gesa, your turn. Very briefly. What have we done lately?
00:03:14	S	Umm...umm.
00:03:17	Ss	Ha, ha, ha.
00:03:18	S	Umm.
00:03:19	T	Well, guys. Take note of this. Finally, Gesa got put in her place, right? (*Teacher sits on empty desk at front of room.*) Usually she...she is gabbing away all over the place and now she's sitting all small and mhm... Gesa, come on. Go on.
00:03:29	S	Well, I don't know anymore. Umm, this thing with two variables.
00:03:31	T	Well? (*Teacher walks to chalkboard.*)
00:03:35	T	Name?
00:03:38	S	Huh? X and Y.
00:03:39	T	No. The heading.
00:03:41	S	Equation with two variables.
00:03:43	T	(*Begins writing*) All right. Okay. [*On board,* (*"Systems of equations"*)]
00:03:50	T	Okay, Hannah? What methods do you know? What various methods do you know to solve systems of equations?
00:03:58	S	Umm, equating?
00:04:00	T	Well, then.
00:04:04	T	(*Begins writing on board again*) Christian, will you give

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		an example for that?
00:04:16	T	Christian. Hello?
00:04:21	T	(*Turns around to face class*) Christian. Christian. Come on. Let's forget about it. Patrick? (*Teacher walks to back of room among students.*) Any example where you apply the method of equating?
00:04:27	S	Mhm.
00:04:30	S	In a problem or what?
00:04:32	T	Yes. (*Teacher walks back toward front of room.*)
00:04:33	S	Mhm...two Y...
00:04:38	T	Go on.
00:04:39	S	Plus three X...equals five. And the other one, two Y plus five X equals thirty-seven.
00:04:51	T	And you want to use the method of equating on this?
00:04:55	S	Yes, mhm.
00:04:56	Ss	Ha, ha, ha.
00:04:57	T	Ha, ha.
00:04:58	S	Maybe. Yes.
00:04:59	T	Well? Hannah?
00:05:01	S	Umm...two X plus three...
00:05:03	T	Yes.
00:05:06	S	Uh...
00:05:07	T	Mm hmm. You're right. Three minus four Y. And now? Yes? Well, go on.
00:05:12	Ss	Ha, ha, ha.
00:05:13	S	Yes, but I didn't think of that.
00:05:15	T	You didn't say that?
00:05:16	S	No ( ).
00:05:17	T	But Sven, continue then.
00:05:19	S	Okay. And well, Y equals...seven plus seven plus three (Y).
00:05:30	T	(*Writing student's solution on board*) Okay, and what can you do now? (Fokko)?
00:05:32	S	Equating it.
00:05:33	T	Okay. (*Teacher writes on board.*) Method. Right?
00:05:37	T	And so on. Okay, which other method (Ina)?

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00:05:41	S	Substituting.
00:05:43	T	Okay.

(*The teacher continues reviewing the material with the students.*)

Part 3
Posing and Working on the Problem

:

00:09:57	T	(*To Class*). Oh, boy. But I'm granting that you are shy because you actually should have known this better. (*Teacher reading from book*) Let's see.
00:10:10	T	Mhm. (*Teacher begins writing problem from book on board. Finishes writing, closes book, sits on empty desk at the side of the room. Students look at problem on board and discuss among themselves.*)
00:11:42	T	(*Student raises his hand.*) Are you raising your hand, Patrick?
00:11:43	S	Yes.
00:11:44	T	Okay. Can you wait a little? Maybe some more people will raise their hands. Let's wait some more. (*Other students raise their hands.*) Yep. Yes, four. Well, that's pretty nice already. Okay, Patrick, what are you suggesting?
00:11:57	S	Well, first I would get rid of the parentheses.
00:12:00	T	Do you also want to do it yourself?
00:12:02	S	Yes ( ).
00:12:03	T	Come on then.
00:12:13	T	And nice and loud please. Right? So everyone understands what you're doing.
00:12:18	Ss	Ha, ha, ha.
00:12:19	T	Uh huh.
00:12:20	S	Well.
00:12:26	Ss	Ha, ha, ha.
00:12:28	T	Hey. That is...well let's go. Mm?

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00:12:28	S	Well, ha, ha.
00:12:31	S	(*Begins writing on board*) This stays the same for now.
00:12:36	S	And then I'm doing the distributive law well.
00:12:41	T	Yes.

(*The teacher and students continue working on the problem. Students then copy what has been done so far in their notebooks and work on problems individually.*)

Part 4
Sharing the Result

⋮

00:26:13	T	(*Sitting on empty desk at front of room. To class*) Yes...then let's see. We should all be done with the copying down by now. Some of you already had different ideas. If you would perhaps briefly explain them. Rieke?
00:26:22	S	(*Rieke*) Umm...times minus thirteen.
00:26:24	T	Well—can you tell me what you want to do? What method will you want to do?
00:26:29	S (R)	The method of equating. Oh no—that is the method of adding.
00:26:30	S (R)	No. Addition.
00:26:33	T	Okay, you want to use the method of addition. And then you want to—you just said something with thirteen.
00:26:34	S (R)	Yes.
00:26:38	S (R)	Yes. Umm, that—we take the equation times minus thirteen.
00:26:39	T	Why? Why?
00:26:42	S (R)	Then the—then that's exactly one hundred ninety-five X and then ( )...
00:26:47	T	Hold on. Hold on. I think—complete it first?
00:26:52	S	(*Another student*) The left, well, the left—left equation times thirteen.

00:26:55	T	I think that's what she wanted. She wanted to go into that direction, Sven. And if she's making a little mis take just doing it mentally, that's no big deal. I think Rieke just may show us what she's thinking of. Right?
00:27:06	S	Now?
00:27:07	T	Umm, should we wait till tomorrow? (*Rieke walks to chalkboard.*)
00:27:15	T	And Jochen. Hello. The board is here and not there.
00:27:19	T	Okay.
00:27:20	S	(*Rieke*) Should I write it down again?
00:27:21	T	Yes. I think that would be good for an overview, to write it down your way.
00:27:25	S	Maybe first like this. (*Student writes on board.*)
00:27:26	T	Yes.
00:27:36	T	(*While Rieke writes*) If she writes it down like that. Gesa, think of that hint again. If you want to use the method of addition, how are you supposed to write down the second equation?
00:27:43	S	Further down.
00:27:44	T	No (because you)—no, no. That's not what it's all about.
00:27:48	T	No.
00:27:50	T	Sorted. That she also has Y now—on top she wrote Y some number X. And that is exactly the same in the—mm hmm.
00:27:52	S	I see.
00:28:02	T	Arne?
00:28:04	S	Yes?
00:28:05	T	Behave yourself for once.
00:28:08	T	Okay, Rieke. Loudly.
00:28:10	S	(*Rieke*) And this one times minus thirteen.
00:28:11	S	(*Another student, to Rieke*) No, thirteen.
00:28:12	S	(*Rieke*) Yes, times minus thirteen.
00:28:14	S	No, thirteen.
00:28:15	S	(*Rieke*) If you add this up, then this must be plus in order for this to be omitted.

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00:28:19	S	Oh, I see. Uh. Excuse me.
00:28:20	Ss	Ha, ha, ha.
00:28:22	T	Gotcha.
00:28:23	S	Yes.
00:28:27	T	Oh, now we're getting serious. Sven, get busy. Ninety-four times minus thirteen.
00:28:32	S	Ninety-four times?
00:28:33	S	Minus thirteen.
00:28:35	S	Umm (should I roughly estimate it?)
00:28:38	Ss	Ha, ha, ha.

(*The teacher continues going over the problems with the students.*)

Part 5
Summarizing the Objective and Assigning Seatwork

⋮

00:33:27	T	(*Sitting on empty desk at front of classroom*) Well, Gesa. This problem. What would you say? It wasn't that easy was it?
00:33:32	S	No.
00:33:34	T	Well, how—how is it then with complicated problems like that? How do you have to proceed? Maybe you should summarize before you start writing it down.
00:33:41	S	First get rid of the parentheses, then multiply with the common denominator...
00:33:47	T	Yes.
00:33:48	S	Then...uh...umm make it so there is an equal number of Ys ( )...
00:33:57	T	Yes, that actually is the most difficult part. Right? To find the approach. How should I solve the problem now? Right? (*Teacher walks to chalkboard*) So that this—let's say this times minus thirteen. (*Teacher points to Rieke's solution.*) I think that was—that means to write it

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		down like this with minus three so you can see that a multiple of fifteen is hundred ninety-five. Because it wouldn't have worked so nicely with the Ys. Right, Holger?
00:34:17	S	Huh?
00:34:18	S	No (that would have been)...
00:34:19	T	Something with ninety-four written there and back there it's thirty-two. (*Teacher walking toward class*) With multiplying we would have gotten into really high numbers. Right? (*To student*) You would have seen it?
00:34:26	S	What? No.
00:34:28	T	What?
00:34:28	S	If I wouldn't have seen that that works, I would have equated them or something. I think I would have used the method of equating.
00:34:35	T	Yes. Yes. (*Teacher walking toward board*) But, where would you have wanted to equate something? You would have—take a look you would have had to divide by thirty-two. Here. (*Teacher points to board.*)
00:34:41	S	Yes, of course, that would have been very difficult.
00:34:42	T	And then you would have had a major fraction. Right?
00:34:43	S	Yes.
00:34:44	T	(*Walks back toward class*) Well, if possible always remember not to make fractions. It's better to multiply bigger numbers. You got that so far?
00:34:51	S	Mm hmm.
00:34:52	T	(*Picks up book, opens it, looks at problems.*) Then I'd like to ask you to try something on your own after you're done copying this. On page hundred ninety-five we've got nice problems like that. To let you know right away this one was the most difficult of all.
00:35:05	T	Well, I think you should do the problems twelve and thirteen.
00:35:14	T	Twelve is enough for now.

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(The teacher closes the book and puts it down. Students begin working on the problems. The teacher circulates among them. After about eight minutes, the class ends.)

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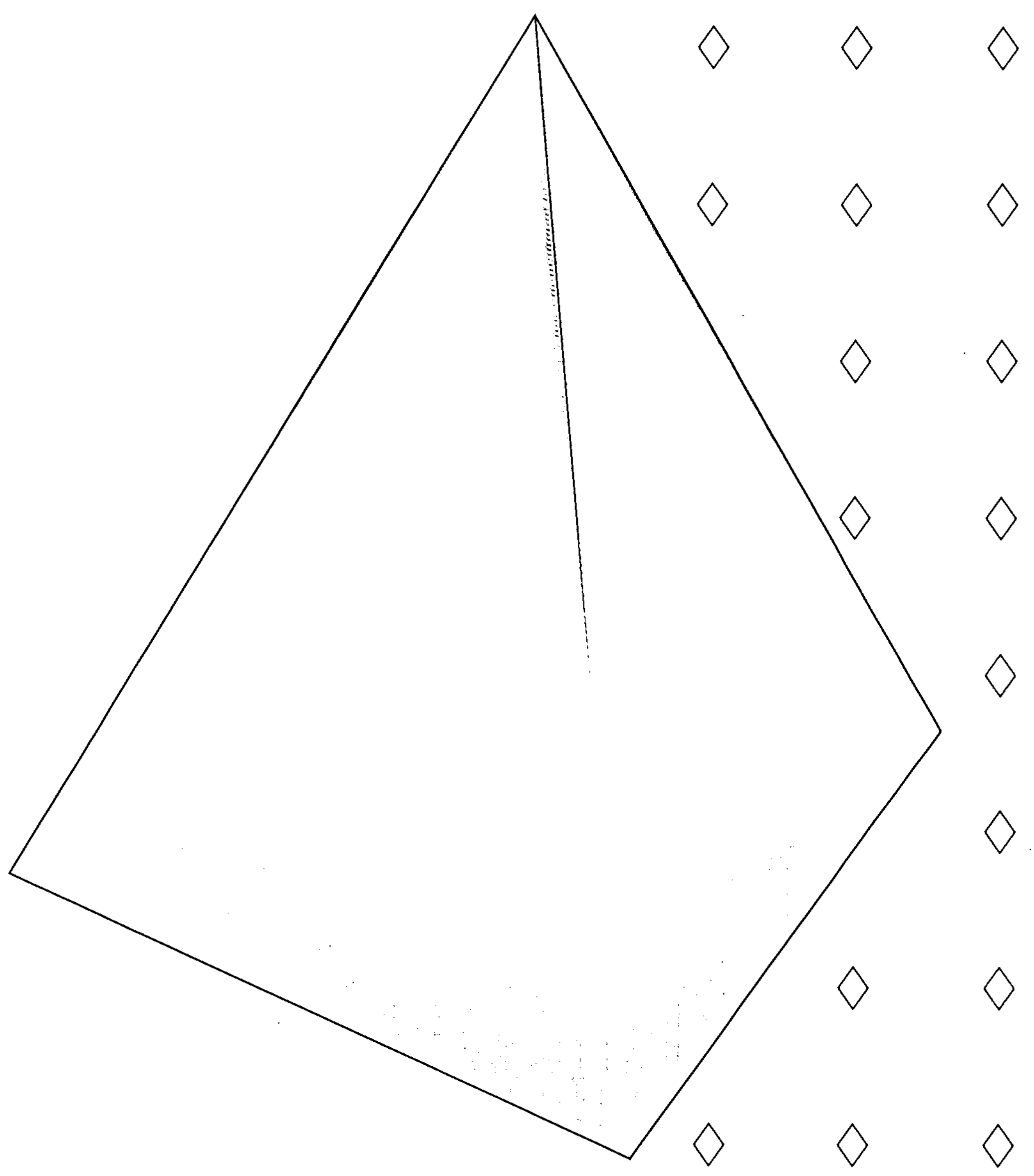
Fostering Algebraic and Geometric Thinking

Selections from the NCTM *Standards*



NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

1012

FOSTERING ALGEBRAIC AND GEOMETRIC THINKING

SELECTIONS FROM THE NCTM *STANDARDS*

July 1997

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
1906 Association Drive
Reston, VA 20191-1593

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PREFACE

The National Council of Teachers of Mathematics is pleased to support *Achieving Excellence: A TIMSS Resource Kit* by supplying excerpts from the *Curriculum and Evaluation Standards for School Mathematics* (1989) and the *Professional Standards for Teaching Mathematics* (1991). The selected Curriculum Standards offer some context for discussing the teaching of algebra and geometry seen in the videotapes that are part of this kit. The selected Teaching Standards can be considered as the context for instruction in a variety of areas. Occasional reference is made to portions of the complete documents that are not included here. The complete set of Curriculum and Evaluation Standards can be found by accessing the NCTM Web site at www.nctm.org and selecting the heading "About NCTM." The complete books can be ordered from the National Council of Teachers of Mathematics at (800) 220-8483.

By way of additional background, the *Curriculum and Evaluation Standards for School Mathematics* describes the mathematics content that all students should know and be able to do. The document is divided into grade levels K–4, 5–8, and 9–12, with each level having twelve to fourteen standards.

These standards identify the basic skills and understandings that students should have in number and number theory, geometry, measurement, probability and statistics, patterns and functions, discrete mathematics, algebra, and beyond. While students are mastering such important basic skills, they must also—

◊ learn to value mathematics;

◊ become confident in their ability to do mathematics;

◊ become mathematical problem solvers;

◊ learn to communicate mathematically;

◊ learn to reason mathematically.

Given these content goals, the *Professional Teaching Standards for Mathematics* illustrates ways that teachers can structure classroom activities to encourage such learning. In four major areas, teachers strongly influence students' opportunities to make sense of mathematics by—

◊ choosing worthwhile mathematical tasks;

◊ establishing and promoting classroom discussion;

◊ creating an environment for learning; and

◊ analyzing one's own teaching, including the efficacy of assessing students' learning.

In addition, the Council has published *Assessment Standards for School Mathematics* (1995), which provides a set of principles for teachers and others to use in examining assessment practices. Educators must ensure that assessment reflects the mathematics that all students need to know and be able to do. Those responsible for mathematics education must be able to draw valid inferences about students' mathematics learning so that assessment results can be used to modify the teaching process as needed. Moreover, assessment must promote equity, so that all students have the opportunity to demonstrate their mathematical understanding and all teachers work to help students when understanding is not yet complete. For all this to occur, assessment must be an open, coherent process.

We hope that *Fostering Algebraic and Geometric Thinking* along with the other items in this resource kit will prompt reflection on the goals of teaching mathematics as well as related classroom practice in an international context. We can learn a great deal from this setting that can lead to improving the mathematical growth of children and the professional development of teachers.

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EXCERPTS FROM THE

CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS

OVERVIEW

This section presents thirteen curriculum standards for grades K–4:

1. ***Mathematics as Problem Solving***
2. ***Mathematics as Communication***
3. ***Mathematics as Reasoning***
4. ***Mathematical Connections***
5. ***Estimation***
6. ***Number Sense and Numeration***
7. ***Concepts of Whole Number Operations***
8. ***Whole Number Computation***
9. ***Geometry and Spatial Sense***
10. ***Measurement***
11. ***Statistics and Probability***
12. ***Fractions and Decimals***
13. ***Patterns and Relationships***

The Need for Change

The need for curricular reform in K–4 mathematics is clear. Such reform must address both the content and emphasis of the curriculum as well as approaches to instruction. A long-standing preoccupation with computation and other traditional skills has dominated both *what* mathematics is taught and *the way* mathematics is taught at this level. As a result, the present K–4 curriculum is narrow in scope; fails to foster mathematical insight, reasoning, and problem solving; and emphasizes rote activities. Even more significant is that children begin to lose their belief that learning mathematics is a sense-making experience. They become passive receivers of rules and procedures rather than active participants in creating knowledge.

The Direction of Change

The Introduction describes a vision for school mathematics built around five overall curricular goals for students to achieve: learning to value mathematics, becoming confident in one's own ability, becoming a mathematical problem solver, learning to communicate mathematically, and learning to reason mathematically. This vision addresses what mathematics is, what it means to know and do mathematics, what teachers should do when they teach mathematics, and what children should do when they learn mathematics. The K-4 standards reflect the implications of this vision for the curriculum in the early grades and present a coherent viewpoint about mathematics, about children, and about the learning of mathematics by children.

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Children and Mathematics: Implications for the K–4 Curriculum

An appropriate curriculum for young children that reflects the Standards' overall goals must do the following:

1. *Address the relationship between young children and mathematics.* Children enter kindergarten with considerable mathematical experience, a partial understanding of many concepts, and some important skills, including counting. Nonetheless, it takes careful planning to create a curriculum that capitalizes on children's intuitive insights and language in selecting and teaching mathematical ideas and skills. It is clear that children's intellectual, social, and emotional development should guide the kind of mathematical experiences they should have in light of the overall goals for learning mathematics. The notion of a *developmentally appropriate* curriculum is an important one.

A developmentally appropriate curriculum encourages the exploration of a wide variety of mathematical ideas in such a way that children retain their enjoyment of, and curiosity about, mathematics. It incorporates real-world contexts, children's experiences, and children's language in developing ideas. It recognizes that children need considerable time to construct sound understandings and develop the ability to reason and communicate mathematically. It looks beyond what children appear to know to determine how they think about ideas. It provides repeated contact with important ideas in varying contexts throughout the year and from year to year.

Programs that provide limited developmental work, that emphasize symbol manipulation and computational rules, and that rely heavily on paper-and-pencil worksheets do not fit the natural learning patterns of children and do not contribute to important aspects of children's mathematical development.

2. *Recognize the importance of the qualitative dimensions of children's learning.* The mathematical ideas that children acquire in grades K-4 form the basis for all further study of mathematics. Although quantitative considerations have frequently dominated discussions in recent years, qualitative considerations have greater significance. Thus, how well children come to understand mathematical ideas is far more important than how many skills they acquire. The success with which programs at later grade levels achieve their goals depends largely on the quality of the foundation that is established during the first five years of school.

3. *Build beliefs about what mathematics is, about what it means to know and do mathematics, and about children's view of themselves as mathematics learners.* The beliefs that young children form influence not only their thinking and performance during this time but also their attitude and decisions about studying mathematics in later years. Beliefs also become more resistant to change as children grow older. Thus, affective dimensions of learning play a significant role in, and must influence, curriculum and instruction.

ASSUMPTIONS

Several basic assumptions governed the selection and shaping of the K–4 standards.

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1. *The K–4 curriculum should be conceptually oriented.* The view that the K–4 curriculum should emphasize the development of mathematical understandings and relationships is reflected in the discussions about the content and emphasis of the curriculum. A conceptual approach enables children to acquire clear and stable concepts by constructing meanings in the context of physical situations and allows mathematical abstractions to emerge from empirical experience. A strong conceptual framework also provides anchoring for skill acquisition. Skills can be acquired in ways that make sense to children and in ways that result in more effective learning. A strong emphasis on mathematical concepts and understandings also supports the development of problem solving.

Emphasizing mathematical concepts and relationships means devoting substantial time to the development of understandings. It also means relating this knowledge to the learning of skills by establishing relationships between the conceptual and procedural aspects of tasks. The time required to build an adequate conceptual base should cause educators to rethink when children are expected to demonstrate a mastery of complex skills. A conceptually oriented curriculum is consistent with the overall curricular goals in this report and can result in programs that are better balanced, more dynamic, and more appropriate to the intellectual needs and abilities of children.

2. *The K–4 curriculum should actively involve children in doing mathematics.* Young children are active individuals who construct, modify, and integrate ideas by interacting with the physical world, materials, and other children. Given these facts, it is clear that the learning of mathematics must be an active process. Throughout the Standards, such verbs as *explore, justify, represent, solve, construct, discuss, use, investigate, describe, develop,* and *predict* are used to convey this active physical and mental involvement of children in learning the content of the curriculum.

The importance of active learning by children has many implications for mathematics education. Teachers need to create an environment that encourages children to explore, develop, test, discuss, and apply ideas. They need to listen carefully to children and to guide the development of their ideas. They need to make extensive and thoughtful use of physical materials to foster the learning of abstract ideas.

K–4 classrooms need to be equipped with a wide variety of physical materials and supplies. Classrooms should have ample quantities of such materials as counters; interlocking cubes; connecting links; base-ten, attribute, and pattern blocks; tiles; geometric models; rulers; spinners; colored rods; geoboards; balances; fraction pieces; and graph, grid, and dot paper. Simple household objects, such as buttons, dried beans, shells, egg cartons, and milk cartons, also can be used.

3. *The K–4 curriculum should emphasize the development of children's mathematical thinking and reasoning abilities.* An individual's future uses and needs for mathematics make the ability to think, reason, and solve problems a primary goal for the study of mathematics. Thus, the curriculum must take seriously the goal of instilling in students a sense of confidence in their ability to think and communicate mathematically, to solve problems, to demonstrate flexibility in working with mathematical ideas

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and problems, to make appropriate decisions in selecting strategies and techniques, to recognize familiar mathematical structures in unfamiliar settings, to detect patterns, and to analyze data. The K–4 standards reflect the view that mathematics instruction should promote these abilities so that students understand that knowledge is empowering and that individual pieces of content are all related to this broader perspective.

Developing these characteristics in children requires that schools build appropriate reasoning and problem-solving experiences into the curriculum from the outset. Further, this goal needs to influence the way mathematics is taught and the way students encounter and apply mathematics throughout their education.

4. *The K–4 curriculum should emphasize the application of mathematics.* If children are to view mathematics as a practical, useful subject, they must understand that it can be applied to a wide variety of real-world problems and phenomena. Even though most mathematical ideas in the K–4 curriculum arise *from* the everyday world, they must be regularly applied to real-world situations. Children also need to understand that mathematics is an integral part of real-world situations and activities in other curricular areas. The mathematical aspects of that work should be highlighted.

Learning mathematics has a purpose. At the K–4 level, one major purpose is helping children understand and interpret their world and solve problems that occur in it. Children learn computation to solve problems; they learn to measure because measurement helps them answer questions about how much, how big, how long, and so on; and they learn to collect and organize data because doing so permits them to answer other questions. By applying mathematics, they learn to appreciate the power of mathematics.

5. *The K–4 curriculum should include a broad range of content.* To become mathematically literate, students must know more than arithmetic. They must possess a knowledge of such important branches of mathematics as measurement, geometry, statistics, probability, and algebra. These increasingly important and useful branches of mathematics have significant and growing applications in many disciplines and occupations.

The curriculum at all levels needs to place substantial emphasis on these branches of mathematics. Mathematical ideas grow and expand as children work with them throughout the curriculum. The informal approach at this level establishes the foundation for further study and permits children to acquire additional knowledge they will need. These topics are highly appropriate for young learners because they make important contributions to children's mathematical development and help them see the usefulness of mathematics. They also provide productive, intriguing activities and applications.

The inclusion of a broad range of content in the curriculum also allows children to see the interrelated nature of mathematical knowledge. When teachers take advantage of the opportunity to relate one mathematical idea to others and to other areas of the curriculum, as will be described in Standard 4, children acquire broader notions about the interconnectedness of mathematics and its relationships to other fields. The curriculum should enable all children to do a substantial amount of work in each of these topics at each grade level.

6. *The K–4 curriculum should make appropriate and ongoing use of calculators and computers.* Calculators must be accepted at the K–4 level as valuable tools for learning mathematics. Calculators enable children to explore number ideas and patterns, to have valuable concept-development experiences, to focus on problem-solving processes, and to investigate realistic applications. The thoughtful use of calculators can increase the quality of the curriculum as well as the quality of children's learning.

Calculators do not replace the need to learn basic facts, to compute mentally, or to do reasonable paper-and-pencil computation. Classroom experience indicates that young children take a commonsense view about calculators and recognize the importance of not relying on them when it is more appropriate to compute in other ways. The availability of calculators means, however, that educators must develop a broader view of the various ways computation can be carried out and must place less emphasis on complex paper-and-pencil computation. Calculators also highlight the importance of teaching children to recognize whether computed results are reasonable.

The power of computers also needs to be used in contemporary mathematics programs. Computer languages that are geometric in nature help young children become familiar with important geometric ideas. Computer simulations of mathematical ideas, such as modeling the renaming of numbers, are an important aid in helping children identify the key features of the mathematics. Many software programs provide interesting problem-solving situations and applications.

The thoughtful and creative use of technology can greatly improve both the quality of the curriculum and the quality of children's learning. Integrating calculators and computers into school mathematics programs is critical in meeting the goals of a redefined curriculum.

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STANDARD 9: GEOMETRY AND SPATIAL SENSE

In grades K–4, the mathematics curriculum should include two- and three-dimensional geometry so that students can—

- ◊ ***describe, model, draw, and classify shapes;***
- ◊ ***investigate and predict the results of combining, subdividing, and changing shapes;***
- ◊ ***develop spatial sense;***
- ◊ ***relate geometric ideas to number and measurement ideas;***
- ◊ ***recognize and appreciate geometry in their world.***

Focus

Geometry is an important component of the K–4 mathematics curriculum because geometric knowledge, relationships, and insights are useful in everyday situations and are connected to other mathematical topics and school subjects. Geometry helps us represent and describe in an orderly manner the world in which we live. Children are naturally interested in geometry and find it intriguing and motivating; their spatial capabilities frequently exceed their numerical skills, and tapping these strengths can foster an interest in mathematics and improve number understandings and skills.

Spatial understandings are necessary for interpreting, understanding, and appreciating our inherently geometric world. Insights and intuitions about two- and three-dimensional shapes and their characteristics, the interrelationships of shapes, and the effects of changes to shapes are important aspects of spatial sense. Children who develop a strong sense of spatial relationships and who master the concepts and language of geometry are better prepared to learn number and measurement ideas, as well as other advanced mathematical topics.

In learning geometry, children need to investigate, experiment, and explore with everyday objects and other physical materials. Exercises that ask children to visualize, draw, and compare shapes in various positions will help develop their spatial sense. Although a facility with the language of geometry is important, it should not be the focus of the geometry program but rather should grow naturally from exploration and experience. Explorations can range from simple activities to challenging problem-solving situations that develop useful mathematical thinking skills.

Evidence suggests that the development of geometric ideas progresses through a hierarchy of levels. Students first learn to recognize whole shapes and then to analyze the relevant properties of a shape. Later they can see relationships between shapes and make simple deductions. Curriculum development and instruction must consider this hierarchy because although learning can occur at several levels simultaneously, the learning of more complex concepts and strategies requires a firm foundation of basic skills.

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STANDARD 13: PATTERNS AND RELATIONSHIPS

In grades K–4, the mathematics curriculum should include the study of patterns and relationships so that students can—

- ◊ ***recognize, describe, extend, and create a wide variety of patterns;***
- ◊ ***represent and describe mathematical relationships;***
- ◊ ***explore the use of variables and open sentences to express relationships.***

Focus

Patterns are everywhere. Children who are encouraged to look for patterns and to express them mathematically begin to understand how mathematics applies to the world in which they live. Identifying and working with a wide variety of patterns help children to develop the ability to classify and organize information. Relating patterns in numbers, geometry, and measurement helps them understand connections among mathematical topics. Such connections foster the kind of mathematical thinking that serves as a foundation for the more abstract ideas studied in later grades.

From the earliest grades, the curriculum should give students opportunities to focus on regularities in events, shapes, designs, and sets of numbers. Children should begin to see that regularity is the essence of mathematics. The idea of a functional relationship can be intuitively developed through observations of regularity and work with generalizable patterns.

Physical materials and pictorial displays should be used to help children recognize and create patterns and relationships. Observing varied representations of the same pattern helps children identify its properties. The use of letters and other symbols in generalizing descriptions of these properties prepares children to use variables in the future. This experience builds readiness for a generalized view of mathematics and the later study of algebra.

OVERVIEW

This section presents thirteen curriculum standards for grades 5–8:

1. ***Mathematics as Problem Solving***
2. ***Mathematics as Communication***
3. ***Mathematics as Reasoning***
4. ***Mathematical Connections***
5. ***Number and Number Relationships***
6. ***Number Systems and Number Theory***
7. ***Computation and Estimation***
8. ***Patterns and Functions***
9. ***Algebra***
10. ***Statistics***
11. ***Probability***
12. ***Geometry***
13. ***Measurement***

The Need for Change

Mathematics is a useful, exciting, and creative area of study that can be appreciated and enjoyed by all students in grades 5–8. It helps them develop their ability to solve problems and reason logically. It offers to these curious, energetic students a way to explore and make sense of their world. However, many students view the current mathematics curriculum in grades 5–8 as irrelevant, dull, and routine. Instruction has emphasized computational facility at the expense of a broad, integrated view of mathematics and has reflected neither the vitality of the subject nor the characteristics of the students.

An ideal 5–8 mathematics curriculum would expand students' knowledge of numbers, computation, estimation, measurement, geometry, statistics, probability, patterns and functions, and the fundamental concepts of algebra. The need for this kind of broadened curriculum is acute. An examination of textbook series shows the repetition of topics, approach, and level of presentation in grade after grade. A comparison of the tables of contents shows little change over grades 5–8. It is even more disconcerting to realize that the very chapters that contain the most new material, such as probability, statistics, geometry, and prealgebra, are covered in the last half of the books—the sections most often skipped by teachers for lack of time. The result is an ineffective curriculum that rehashes material students already have seen. Such a curriculum promotes a negative image of mathematics and fails to give students an adequate background for secondary school mathematics.

These thirteen standards promote a broad curriculum for students in grades 5–8. Developing certain computational skills is important but constitutes only a part of this curriculum. Nevertheless, the existing curriculum in some schools prohibits many students from studying a broader curriculum until they have "mastered" basic computational skills. Shifting the focus to a broader curriculum is important for the following reasons:

1. Basic skills today and in the future mean far more than computational proficiency. Moreover, the calculator renders obsolete much of the complex paper-and-pencil proficiency traditionally emphasized in mathematics courses. Topics such as geometry, probability, statistics, and algebra have become increasingly more important and accessible to students through technology.
2. If students have not been successful in "mastering" basic computational skills in previous years, why should they be successful now, especially if the same methods that failed in the past are merely repeated? In fact, considering the effect of failure on students' attitudes, we might argue that further efforts toward mastering computational skills are counterproductive.
3. Many of the mathematics topics that are omitted actually can help students recognize the need for arithmetic concepts and skills and provide fresh settings for their use. For example, in probability, students have many opportunities to add and multiply fractions.

The vision articulated in the 5–8 standards is of a broad, concept-driven curriculum, one that reflects the full breadth of relevant mathematics and its interrelationships with technology. This vision is built on five overall curricular goals for students: learning to value mathematics, becoming confident in their ability, becoming a mathematical problem solver, learning to communicate mathematically, and learning to reason mathematically. The teaching of this curriculum should be related to the characteristics of middle school students and their current and future needs.

Features of the Mathematics Curriculum

The 5–8 curriculum should include the following features:

◊ Problem situations that establish the need for new ideas and motivate students should serve as the context for mathematics in grades 5–8. Although a specific idea might be forgotten, the context in which it is learned can be remembered and the idea re-created. In developing the problem situations, teachers should emphasize the application of mathematics to real-world problems as well as to other settings relevant to middle school students.

◊ Communication with and about mathematics and mathematical reasoning should permeate the 5–8 curriculum.

◊ A broad range of topics should be taught, including number concepts, computation, estimation, functions, algebra, statistics, probability, geometry, and measurement. Although each of these areas is valid mathematics in its own right, they should be taught as an integrated whole, not as isolated topics; the connections among them should be a prominent feature of the curriculum.

◊ Technology, including calculators, computers, and videos, should be used when appropriate. These devices and formats free students from tedious computations and allow them to concentrate on problem solving and other important content. They also give them new means to explore content. As paper-and-pencil computation becomes less important, the skills and understanding required to make proficient use of calculators and computers become more important.

Instruction

The standards are not intended to each constitute a chapter in a text or a particular unit of instruction; rather, learning activities should incorporate topics and ideas across standards. For example, an instructional activity might involve problem solving and use geometry, measurement, and computation. All mathematics should be studied in contexts that give the ideas and concepts meaning. Problems should arise from situations that are not always well formed. Students should have opportunities to formulate problems and questions that stem from their own interests.

Learning should engage students both intellectually and physically. They must become active learners, challenged to apply their prior knowledge and experience in new and increasingly more difficult situations. Instructional approaches should engage students in the process of learning rather than transmit information for them to receive. Middle grade students are especially responsive to hands-on activities in tactile, auditory, and visual instructional modes.

Classroom activities should provide students the opportunity to work both individually and in small- and large-group arrangements. The arrangement should be determined by the instructional goals as well as the nature of the activity. Individual work can help students develop confidence in their own ability to solve problems but should constitute only a portion of the middle school experience. Working in small groups provides students with opportunities to talk about ideas and listen to their peers, enables teachers to interact more closely with students, takes positive advantage of the social characteristics of the middle school student, and provides opportunities for students to exchange ideas and hence develops their ability to communicate and reason. Small-group work can involve collaborative or cooperative as well as independent work. Projects and small-group work can empower students to become more independent in their own learning. Whole-class discussions require students to synthesize, critique, and summarize strategies, ideas, or conjectures that are the products of individual and group work. These mathematical ideas can be expanded to, and integrated with, other subjects.

Materials

The 5–8 standards make the following assumptions about classroom materials:

◊ Every classroom will be equipped with ample sets of manipulative materials and supplies (e.g., spinners, cubes, tiles, geoboards, pattern blocks, scales, compasses, scissors, rulers, protractors, graph paper, grid-and-dot paper).

◊ Teachers and students will have access to appropriate resource materials from which to develop problems and ideas for explorations.

◊ All students will have a calculator with functions consistent with the tasks envisioned in this curriculum. Calculators should include the follow-

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ing features: algebraic logic including order of operations; computation in decimal and common fraction form; constant function for addition, subtraction, multiplication, and division; and memory, percent, square root, exponent, reciprocal, and +/− keys.

- ◊ Every classroom will have at least one computer available at all times for demonstrations and student use. Additional computers should be available for individual, small-group, and whole-class use.

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STANDARD 8: PATTERNS AND FUNCTIONS

In grades 5–8, the mathematics curriculum should include explorations of patterns and functions so that students can—

- ◊ ***describe, extend, analyze, and create a wide variety of patterns;***
- ◊ ***describe and represent relationships with tables, graphs, and rules;***
- ◊ ***analyze functional relationships to explain how a change in one quantity results in a change in another;***
- ◊ ***use patterns and functions to represent and solve problems.***

Focus

One of the central themes of mathematics is the study of patterns and functions. This study requires students to recognize, describe, and generalize patterns and build mathematical models to predict the behavior of real-world phenomena that exhibit the observed pattern. The widespread occurrence of regular and chaotic pattern behavior makes the study of patterns and functions important. Exploring patterns helps students develop mathematical power and instills in them an appreciation for the beauty of mathematics.

The study of patterns in grades 5–8 builds on students' experiences in K–4 but shifts emphasis to an exploration of functions. However, work with patterns continues to be informal and relatively unburdened by symbolism. Students have opportunities to generalize and describe patterns and functions in many ways and to explore the relationships among them. When students make graphs, data tables, expressions, equations, or verbal descriptions to represent a single relationship, they discover that different representations yield different interpretations of a situation. In informal ways, students develop an understanding that functions are composed of variables that have a dynamic relationship: Changes in one variable result in change in another. The identification of the special characteristics of a relationship, such as minimum or maximum values or points at which the value of one of the variables is 0 (*x*- and *y*-intercepts), lays the foundation for a more formal study of functions in grades 9–12.

The theme of patterns and functions is woven throughout the 5–8 standards. It begins in K–4, is extended and made more central in 5–8, and reaches maturity with a natural extension to symbolic representation and supporting concepts, such as domain and range, in grades 9–12. Examples appropriate for grades 5–8 are incorporated into other standards for this age group.

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STANDARD 9: ALGEBRA

In grades 5–8, the mathematics curriculum should include explorations of algebraic concepts and processes so that students can—

- ◊ ***understand the concepts of variable, expression, and equation;***
- ◊ ***represent situations and number patterns with tables, graphs, verbal rules, and equations and explore the interrelationships of these representations;***
- ◊ ***analyze tables and graphs to identify properties and relationships;***
- ◊ ***develop confidence in solving linear equations using concrete, informal, and formal methods;***
- ◊ ***investigate inequalities and nonlinear equations informally;***
- ◊ ***apply algebraic methods to solve a variety of real-world and mathematical problems.***

Focus

The middle school mathematics curriculum is, in many ways, a bridge between the concrete elementary school curriculum and the more formal mathematics curriculum of the high school. One critical transition is that between arithmetic and algebra. It is thus essential that in grades 5–8, students explore algebraic concepts in an informal way to build a foundation for the subsequent formal study of algebra. Such informal explorations should emphasize physical models, data, graphs, and other mathematical representations rather than facility with formal algebraic manipulation. Students should be taught to generalize number patterns to model, represent, or describe observed physical patterns, regularities, and problems. These informal explorations of algebraic concepts should help students to gain confidence in their ability to abstract relationships from contextual information and use a variety of representations to describe those relationships.

Activities in grades 5–8 should build on students' K–4 experiences with patterns. They should continue to emphasize concrete situations that allow students to investigate patterns in number sequences, make predictions, and formulate verbal rules to describe patterns. Learning to recognize patterns and regularities in mathematics and make generalizations about them requires practice and experience. Expanding the amount of time that students have to make this transition to more abstract ways of thinking increases their chances of success. By integrating informal algebraic experiences throughout the K–8 curriculum, students will develop confidence in using algebra to represent and solve problems. In addition, by the end of the eighth grade, students should be able to solve linear equations by formal methods and some nonlinear equations by informal means.

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STANDARD 12: GEOMETRY

In grades 5–8, the mathematics curriculum should include the study of the geometry of one, two, and three dimensions in a variety of situations so that students can—

- ◊ ***identify, describe, compare, and classify geometric figures;***
- ◊ ***visualize and represent geometric figures with special attention to developing spatial sense;***
- ◊ ***explore transformations of geometric figures;***
- ◊ ***represent and solve problems using geometric models;***
- ◊ ***understand and apply geometric properties and relationships;***
- ◊ ***develop an appreciation of geometry as a means of describing the physical world.***

Focus

> Geometry is grasping space ... that space in which the child lives, breathes and moves. The space that the child must learn to know, explore, conquer, in order to live, breathe and move better in it. (Freudenthal 1973, p. 403).

The study of geometry helps students represent and make sense of the world. Geometric models provide a perspective from which students can analyze and solve problems, and geometric interpretations can help make an abstract (symbolic) representation more easily understood. Many ideas about number and measurement arise from attempts to quantify real-world objects that can be viewed geometrically. For example, the use of area models provides an interpretation for much of the arithmetic of decimals, fractions, ratios, proportions, and percents.

Students discover relationships and develop spatial sense by constructing, drawing, measuring, visualizing, comparing, transforming, and classifying geometric figures. Discussing ideas, conjecturing, and testing hypotheses precede the development of more formal summary statements. In the process, definitions become meaningful, relationships among figures are understood, and students are prepared to use these ideas to develop informal arguments. The informal exploration of geometry can be exciting and mathematically productive for middle school students. At this level, geometry should focus on investigating and using geometric ideas and relationships rather than on memorizing definitions and formulas.

The study of geometry in grades 5–8 links the informal explorations begun in grades K–4 to the more formalized processes studied in grades 9–12. The expanding logical capabilities of students in grades 5–8 allow them to draw inferences and make logical deductions from geometric problem situations. This does not imply that the study of geometry in grades 5–8 should be a formalized endeavor; rather, it should simply provide increased opportunities for students to engage in more systematic explorations.

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CURRICULUM STANDARDS FOR GRADES 9–12

OVERVIEW

This section presents fourteen curriculum standards for grades 9–12:

1. ***Mathematics as Problem Solving***
2. ***Mathematics as Communication***
3. ***Mathematics as Reasoning***
4. ***Mathematical Connections***
5. ***Algebra***
6. ***Functions***
7. ***Geometry from a Synthetic Perspective***
8. ***Geometry from an Algebraic Perspective***
9. ***Trigonometry***
10. ***Statistics***
11. ***Probability***
12. ***Discrete Mathematics***
13. ***Conceptual Underpinnings of Calculus***
14. ***Mathematical Structure***

Background

Historically, the purposes of secondary school mathematics have been to provide students with opportunities to acquire the mathematical knowledge, skills, and modes of thought needed for daily life and effective citizenship, to prepare students for occupations that do not require formal study after graduation, and to prepare students for postsecondary education, particularly college. The *Standards'* Introduction describes a vision of school mathematics in which these purposes are embedded in a context that is both broader and more consistent with accelerating changes in today's society. High school graduates during the remainder of this century can expect to have four or more career changes. To develop the requisite adaptability, high school mathematics instruction must adopt broader goals for *all* students. It must provide experiences that encourage and enable students to value mathematics, gain confidence in their own mathematical ability, become mathematical problem solvers, communicate mathematically, and reason mathematically. The fourteen standards for grades 9–12 establish a framework for a core curriculum that reflects the needs of all students, explicitly recognizing that they will spend their adult lives in a society increasingly dominated by technology and quantitative methods.

In view of existing disparities in educational opportunity in mathematics and the increasing necessity that all individuals have options for further education and alternative careers, each standard identifies the mathemati-

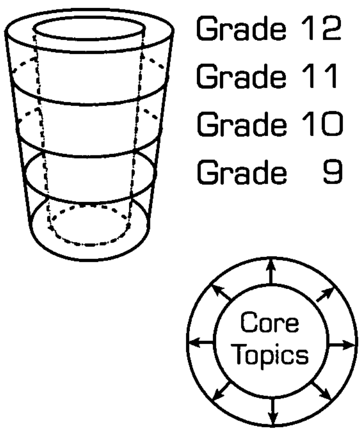

Fig. 1. A differentiated core curriculum

cal content or processes and the associated student activities that should be included in the curriculum for *all* students. As suggested by figure 1, the core curriculum is intended to provide a common body of mathematical ideas accessible to all students. We recognize that students entering high school differ in many ways, including mathematical achievement, but we believe these differences are best addressed by enrichment and extensions of the proposed content rather than by deletions. The mathematics curriculum must set high, but reasonable, expectations for *all* students.

The core curriculum can be extended in a variety of ways to meet the needs, interests, and performance levels of individual students or groups of students. To illustrate, many of the standards also specify topics that should be studied by college-intending students. We use the term *college-intending* not in an exclusionary sense, but only as a means by which to identify the additional mathematical topics that should be studied by students who plan to attend college. In fact, we believe that these additional curricular topics should be studied by all students who have demonstrated interest and achievement in mathematics.

A school curriculum in line with these standards should be organized so as to permit all students to progress as far into the mathematics proposed here as their achievement with the topic allows. In particular, students with exceptional mathematical talent who advance through the material more quickly than others may continue to college-level work in the mathematical sciences. However, we strongly recommend against acceleration that either omits content identified in these standards or advances students through it superficially.

Figure 1 also is intended to portray an expectation that mathematical ideas will grow and deepen as students progress through the curriculum and that the consolidation of learning is essential for all students during the senior year. Such a synthesis of mathematical knowledge will enhance students' prospects for securing employment and for both entering and successfully completing collegiate programs. It is, therefore, an underpinning of the proposed curriculum.

Underlying Assumptions

The standards for grades 9–12 are based on the following assumptions:

◊ Students entering grade 9 will have experienced mathematics in the context of the broad, rich curriculum outlined in the K–8 standards.

◊ The level of computational proficiency suggested in the K–8 standards will be expected of all students; however, no student will be denied access to the study of mathematics in grades 9–12 because of a lack of computational facility.

◊ Although arithmetic computation will not be a direct object of study in grades 9–12, number and operation sense, estimation skills, and the ability to judge the reasonableness of results will be strengthened in the context of applications and problem solving, including those situations dealing with issues of scientific computation.

◊ Scientific calculators with graphing capabilities will be available to all students at all times.

◊ A computer will be available at all times in every classroom for demon-

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stration purposes, and all students will have access to computers for individual and group work.

◊ At least three years of mathematical study will be required of all secondary school students.

◊ These three years of mathematical study will revolve around a core curriculum differentiated by the depth and breadth of the treatment of topics and by the nature of applications.

◊ Four years of mathematical study will be required of all college-intending students.

◊ These four years of mathematical study will revolve around a broadened curriculum that includes extensions of the core topics and for which calculus is no longer viewed as the capstone experience.

◊ All students will study appropriate mathematics during their senior year.

Features of the Mathematics Content

Initially, it may appear that an excessive amount of curriculum content is described in the 9–12 standards. When this content is evaluated, however, it should be remembered that the proposed 5–8 curriculum will enable students to enter high school with substantial gains in their conceptual and procedural understandings of algebra, in their knowledge of geometric concepts and relationships, and in their familiarity with informal, but conceptually based, methods for dealing with data and situations involving uncertainty. Moreover, additional instructional time can be gained by organizing the curriculum so that student learning is systematically maintained and review is embedded in the context of new topics or problem situations. With these conditions satisfied, it is our belief that it will be possible to address the recommended content within a three- or four-year sequence with the expectation of a reasonable level of student proficiency.

Traditional topics of algebra, geometry, trigonometry, and functions remain important components of the secondary school mathematics curriculum. However, the 9–12 standards call for a shift in emphasis from a curriculum dominated by memorization of isolated facts and procedures and by proficiency with paper-and-pencil skills to one that emphasizes conceptual understandings, multiple representations and connections, mathematical modeling, and mathematical problem solving. The integration of ideas from algebra and geometry is particularly strong, with graphical representation playing an important connecting role. Thus, frequent reference to graphing utilities will be found throughout these standards; by this we mean a computer with appropriate graphing software or a graphing calculator. In addition, topics from statistics, probability, and discrete mathematics are elevated to a more central position in the curriculum for all students. Specific topics that should be given either increased or reduced emphasis are summarized in the chart.

Patterns of Instruction

The broadened view of mathematics described in the Introduction to this document under the rubric *mathematical power*, together with the capabilities of available and emerging technology, suggests a need for changes in instructional patterns and in the roles of both teachers and students.

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A variety of instructional methods should be used in classrooms in order to cultivate students' abilities to investigate, to make sense of, and to construct meanings from new situations; to make and provide arguments for conjectures; and to use a flexible set of strategies to solve problems from both within and outside mathematics. In addition to traditional teacher demonstrations and teacher-led discussions, greater opportunities should be provided for small-group work, individual explorations, peer instruction, and whole-class discussions in which the teacher serves as a moderator.

These alternative methods of instruction will require the teacher's role to shift from dispensing information to facilitating learning, from that of director to that of catalyst and coach. The introduction of new topics and most subsumed objectives should, whenever possible, be embedded in problem situations posed in an environment that encourages students to explore, formulate and test conjectures, prove generalizations, and discuss and apply the results of their investigations. Such an instructional setting enables students to approach the learning of mathematics both creatively and independently and thereby strengthen their confidence and skill in doing mathematics.

The role of students in the learning process in grades 9–12 should shift in preparation for their entrance into the work force or higher education. Experiences designed to foster continued intellectual curiosity and increasing independence should encourage students to become self-directed learners who routinely engage in constructing, symbolizing, applying, and generalizing mathematical ideas. Such experiences are essential in order for students to develop the capability for their own lifelong learning and to internalize the view that mathematics is a process, a body of knowledge, and a human creation.

The use of technology in instruction should further alter both the teaching and the learning of mathematics. Computer software can be used effectively for class demonstrations and independently by students to explore additional examples, perform independent investigations, generate and summarize data as part of a project, or complete assignments. Calculators and computers with appropriate software transform the mathematics classroom into a laboratory much like the environment in many science classes, where students use technology to investigate, conjecture, and verify their findings. In this setting, the teacher encourages experimentation and provides opportunities for students to summarize ideas and establish connections with previously studied topics.

The most fundamental consequence of changes in patterns of instruction in response to technology-rich classroom environments is the emergence of a new classroom dynamic in which teachers and students become natural partners in developing mathematical ideas and solving mathematical problems.

Assessment of student learning should be viewed as an integral part of instruction and should be aligned with key aspects of instruction, such as the use of technology.

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STANDARD 5: ALGEBRA

In grades 9–12, the mathematics curriculum should include the continued study of algebraic concepts and methods so that all students can—

- ***represent situations that involve variable quantities with expressions, equations, inequalities, and matrices;***
- ***use tables and graphs as tools to interpret expressions, equations, and inequalities;***
- ***operate on expressions and matrices, and solve equations and inequalities;***
- ***appreciate the power of mathematical abstraction and symbolism;***

and so that, in addition, college-intending students can—

- ***use matrices to solve linear systems;***
- ***demonstrate technical facility with algebraic transformations, including techniques based on the theory of equations.***

Focus

Algebra is the language through which most of mathematics is communicated. It also provides a means of operating with concepts at an abstract level and then applying them, a process that often fosters generalizations and insights beyond the original context.

Aspects of this standard represent extensions of algebraic concepts developed first in grades 5–8. Whereas this earlier work was developed as a generalization of arithmetic, algebra in grades 9–12 will focus on its own logical framework and consistency. As a result, for example, algebraic symbols may represent objects rather than numbers, as in "p + q" representing the sum of two polynomials. This more sophisticated understanding of algebraic representation is a prerequisite to further formal work in virtually all mathematical subjects, including statistics, linear algebra, discrete mathematics, and calculus. Moreover, the increasing use of quantitative methods, both in the natural sciences and in such disciplines as economics, psychology, and sociology, have made algebraic processing an important tool for applying mathematics.

The proposed algebra curriculum will move away from a tight focus on manipulative facility to include a greater emphasis on conceptual understanding, on algebra as a means of representation, and on algebraic methods as a problem-solving tool. For the core program, this represents a trade-off in instructional time as well as in emphasis. For college-intending students who can expect to use their algebraic skills more often, an appropriate level of proficiency remains a goal. Even for these students, however, available and projected technology forces a rethinking of the level of skill expectations.

STANDARD 6: FUNCTIONS

In grades 9–12, the mathematics curriculum should include the continued study of functions so that all students can—

- ***model real-world phenomena with a variety of functions;***
- ***represent and analyze relationships using tables, verbal rules, equations, and graphs;***
- ***translate among tabular, symbolic, and graphical representations of functions;***
- ***recognize that a variety of problem situations can be modeled by the same type of function;***
- ***analyze the effects of parameter changes on the graphs of functions;***

and so that, in addition, college-intending students can—

- ***understand operations on, and the general properties and behavior of, classes of functions.***

Focus

The concept of function is an important unifying idea in mathematics. Functions, which are special correspondences between the elements of two sets, are common throughout the curriculum. In arithmetic, functions appear as the usual operations on numbers, where a pair of numbers corresponds to a single number, such as the sum of the pair; in algebra, functions are relationships between variables that represent numbers; in geometry, functions relate sets of points to their images under motions such as flips, slides, and turns; and in probability, they relate events to their likelihoods. The function concept also is important because it is a mathematical representation of many input-output situations found in the real world, including those that recently have arisen as a result of technological advances. An obvious example is the [$\sqrt{x}$] key on a calculator.

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STANDARD 7: GEOMETRY FROM A SYNTHETIC PERSPECTIVE

In grades 9–12, the mathematics curriculum should include the continued study of the geometry of two and three dimensions so that all students can—

- ◊ ***interpret and draw three-dimensional objects;***
- ◊ ***represent problem situations with geometric models and apply properties of figures;***
- ◊ ***classify figures in terms of congruence and similarity and apply these relationships;***
- ◊ ***deduce properties of, and relationships between, figures from given assumptions;***

and so that, in addition, college-intending students can—

- ◊ ***develop an understanding of an axiomatic system through investigating and comparing various geometries.***

Focus

This component of the 9–12 geometry strand should provide experiences that deepen students' understanding of shapes and their properties, with an emphasis on their wide applicability in human activity. The curriculum should be infused with examples of how geometry is used in recreations (as in billiards or sailing); in practical tasks (as in purchasing paint for a room); in the sciences (as in the description and analysis of mineral crystals); and in the arts (as in perspective drawing).

High school geometry should build on the strong conceptual foundation students develop in the new K–8 programs. Students should have opportunities to visualize and work with three-dimensional figures in order to develop spatial skills fundamental to everyday life and to many careers. Physical models and other real-world objects should be used to provide a strong base for the development of students' geometric intuition so that they can draw on these experiences in their work with abstract ideas.

STANDARD 8: GEOMETRY FROM AN ALGEBRAIC PERSPECTIVE

In grades 9–12, the mathematics curriculum should include the study of the geometry of two and three dimensions from an algebraic point of view so that all students can—

- ***translate between synthetic and coordinate representations;***
- ***deduce properties of figures using transformations and using coordinates;***
- ***identify congruent and similar figures using transformations;***
- ***analyze properties of Euclidean transformations and relate translations to vectors;***

and so that, in addition, college-intending students can—

- ***deduce properties of figures using vectors;***
- ***apply transformations, coordinates, and vectors in problem solving.***

Focus

One of the most important connections in all of mathematics is that between geometry and algebra. Historically, mathematics took a great stride forward in the seventeenth century when the geometric ideas of the ancients were expressed in the language of coordinate geometry, thus providing new tools for the solution of a wide range of problems.

More recently, the study of geometry through the use of transformations-the geometric counterpart of functions—has changed the subject from static to dynamic, providing in the process great additional power that can be used, for example, to describe and produce moving figures on a video screen. Viewed as an algebraic system, transformations also provide college-intending students with valuable experiences with properties of function composition and group structure.

The interplay between geometry and algebra strengthens students' ability to formulate and analyze problems from situations both within and outside mathematics. Although students will at times work separately in synthetic, coordinate, and transformation geometry, they should have as many opportunities as possible to compare, contrast, and translate among these systems. A fundamental idea students should come to understand is that specific problems are often more easily solved in one or another of these systems.

EXCERPTS FROM THE

PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS

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STANDARDS FOR TEACHING MATHEMATICS

The *Professional Standards for Teaching Mathematics* is designed, along with the *Curriculum and Evaluation Standards for School Mathematics*, to establish a broad framework to guide reform in school mathematics in the next decade. In particular, these standards present a vision of what teaching should entail to support the changes in curriculum set out in the *Curriculum and Evaluation Standards*. This document spells out what teachers need to know to teach toward new goals for mathematics education and how teaching should be evaluated for the purpose of improvement. We challenge all who have responsibility for any part of the support and development of mathematics teachers and teaching to use these standards as a basis for discussion and for making needed change so that we can reach our goal of a quality mathematics education for every child.

—From the preface of *Professional Standards for Teaching Mathematics*

OVERVIEW

This section presents six standards for the teaching of mathematics organized under four categories.

Tasks

Standard 1. Worthwhile Mathematical Tasks

Discourse

Standard 2. Teacher's Role in Discourse

Standard 3. Students' Role in Discourse

Standard 4. Tools for Enhancing Discourse

Environment

Standard 5. Learning Environment

Analysis

Standard 6. Analysis of Teaching and Learning

INTRODUCTION

The *Curriculum and Evaluation Standards for School Mathematics* represents NCTM's vision of what students should learn in mathematics classrooms. Congruent with the aims and rhetoric of the current reform movement in mathematics education (e.g., National Research Council 1989, 1990), the *Standards* is threaded with a commitment to developing the mathematical literacy and power of all students. Being mathematically literate includes having an appreciation of the value and beauty of mathematics as well as being able and inclined to appraise and use quantitative information. Mathematical power encompasses the ability to "explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems" and the self-confidence and disposition to do so (National Council of Teachers of Mathematics 1989, p. 5). It also includes being able to formulate and solve problems, to judge the role of mathematical reasoning in a real-life situation, and to communicate mathematically.

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ASSUMPTIONS

The standards for teaching are based on four assumptions about the practice of mathematics teaching:

1. *The goal of teaching mathematics is to help all students develop mathematical power.* The *Curriculum and Evaluation Standards for School Mathematics* furnishes the basis for a curriculum in which mathematical reasoning, communication, problem solving, and connections are central. Teachers must help every student develop conceptual and procedural understandings of number, operations, geometry, measurement, statistics, probability, functions, and algebra and the connections among ideas. They must engage all students in formulating and solving a wide variety of problems, making conjectures and constructing arguments, validating solutions, and evaluating the reasonableness of mathematical claims. Along with all this, teachers must foster in students the disposition to use and engage in mathematics, an appreciation of its beauty and utility, and a tolerance for getting stuck or sidetracked. Teachers must help students realize that mathematical thinking involves dead ends and detours and encourage them to persevere when confronted with a puzzling problem and to develop the self-confidence and interest to do so.

2. *WHAT students learn is fundamentally connected with how they learn it.* Students' opportunities to learn mathematics are a function of the setting and the kinds of tasks and discourse in which they participate. What students learn—about particular concepts and procedures as well as about thinking mathematically—depends on the ways in which they engage in mathematical activity in their classrooms. Their dispositions toward mathematics are also shaped by such experiences. Consequently, the goal of developing students' mathematical power requires careful attention to pedagogy as well as to curriculum.

3. *All students can learn to think mathematically.* The goals described in the *Curriculum and Evaluation Standards for School Mathematics* are goals for all students. Goals such as learning to make conjectures, to argue about mathematics using mathematical evidence, to formulate and solve problems—even perplexing ones—and to make sense of mathematical ideas are not just for some group thought to be "bright" or "mathematically able." Every student can—and should—learn to reason and solve problems, to make connections across a rich web of topics and experiences, and to communicate mathematical ideas. By "every student" we mean specifically—

◊ students who have been denied access in any way to educational opportunities as well as those who have not;

◊ students who are African American, Hispanic, American Indian, and other minorities as well as those who are considered to be part of the majority;

◊ students who are female as well as those who are male;

◊ students who have not been successful as well as those who have been successful in school and in mathematics.

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This assumption is supported by the vignettes, which were drawn from classrooms with students of diverse cultural, linguistic, and socioeconomic backgrounds.

4. *Teaching is a complex practice and hence not reducible to recipes or prescriptions.* First of all, teaching mathematics draws on knowledge from several domains: knowledge of mathematics, of diverse learners, of how students learn mathematics, of the contexts of classroom, school, and society. Such knowledge is general. However, teachers must also consider the particular, for teaching is context-specific. Theoretical knowledge about adolescent development, for instance, can only partly inform a decision about particular students learning a particular mathematical concept in a given context. Second, as teachers weave together knowledge from these different domains to decide how to respond to a student's question, how to represent a particular mathematical idea, how long to pursue the discussion of a problem, or what task to use to engage students in a new topic, they often find themselves having to balance multiple goals and considerations. Making such decisions depends on a variety of factors that cannot be determined in the abstract or governed by rules of thumb.

Because teaching mathematics well is a complex endeavor, it cannot be reduced to a recipe for helping students learn. Instead, good teaching depends on a host of considerations and understandings. Good teaching demands that teachers reason about pedagogy in professionally defensible ways within the particular contexts of their own work. The standards for teaching mathematics are designed to help guide the processes of such reasoning, highlighting issues that are crucial in creating the kind of teaching practice that supports the learning goals of the *Curriculum and Evaluation Standards for School Mathematics.* This section circumscribes themes and values but does not—indeed, it could not—prescribe "right" practice.

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STANDARD 1: WORTHWHILE MATHEMATICAL TASKS

The teacher of mathematics should pose tasks that are based on—

- ***sound and significant mathematics;***
- ***knowledge of students' understandings, interests, and experiences;***
- ***knowledge of the range of ways that diverse students learn mathematics;***

and that

- ***engage students' intellect;***
- ***develop students' mathematical understandings and skills;***
- ***stimulate students to make connections and develop a coherent framework for mathematical ideas;***
- ***call for problem formulation, problem solving, and mathematical reasoning;***
- ***promote communication about mathematics;***
- ***represent mathematics as an ongoing human activity;***
- ***display sensitivity to, and draw on, students' diverse background experiences and dispositions;***
- ***promote the development of all students' dispositions to do mathematics.***

Elaboration

Teachers are responsible for the quality of the mathematical tasks in which students engage. A wide range of materials exists for teaching mathematics: problem booklets, computer software, practice sheets, puzzles, manipulative materials, calculators, textbooks, and so on. These materials contain tasks from which teachers can choose. Also, teachers often create their own tasks for students: projects, problems, worksheets, and the like. Some tasks grow out of students' conjectures or questions. Teachers should choose and develop tasks that are likely to promote the development of students' understandings of concepts and procedures in a way that also fosters their ability to solve problems and to reason and communicate mathematically. Good tasks are ones that do not separate mathematical thinking from mathematical concepts or skills, that capture students' curiosity, and that invite them to speculate and to pursue their hunches. Many such tasks can be approached in more than one interesting and legitimate way; some have more than one reasonable solution. These tasks, consequently, facilitate significant classroom discourse, for they require that students reason about different strategies and outcomes, weigh the pros and cons of alternatives, and pursue particular paths.

In selecting, adapting, or generating mathematical tasks, teachers must base their decisions on three areas of concern: the mathematical content, the students, and the ways in which students learn mathematics.

In considering the mathematical content of a task, teachers should consider how appropriately the task represents the concepts and procedures entailed. For example, if students are to gather, summarize, and interpret

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data, are the statistics they are expected to generate appropriate? Does it make sense to calculate a mean? If there is an explanation of a procedure, such as calculating a mean, does that explanation focus on the underlying concepts or is it merely mechanical? Teachers must also use a curricular perspective, considering the potential of a task to help students progress in their cumulative understanding of a particular domain and to make connections among ideas they have studied in the past and those they will encounter in the future.

A second content consideration is to assess what the task conveys about what is entailed in doing mathematics. Some tasks, although they deal nicely with the concepts and procedures, involve students in simply producing right answers. Others require students to speculate, to pursue alternatives, to face decisions about whether or not their approaches are valid. For example, one task might require students to find means, medians, and modes for given sets of data. Another might require them to decide whether to calculate means, medians, or modes as the best measures of central tendency, given particular sets of data and particular claims they would like to make about the data, then to calculate those statistics, and finally to explain and defend their decisions. Like the first task, the second would offer students the opportunity to practice finding means, medians, and modes. Only the second, however, conveys the important point that summarizing data involves decisions related to the data and the purposes for which the analysis is being used. Tasks should foster students' sense that mathematics is a changing and evolving domain, one in which ideas grow and develop over time and to which many cultural groups have contributed. Drawing on the history of mathematics can help teachers to portray this idea: exploring alternative numeration systems or investigating non-Euclidean geometries, for example. Fractions evolved out of the Egyptians' attempts to divide quantities—four things shared among ten people. This fact could provide the explicit basis for a teacher's approach to introducing fractions.

A third content consideration centers on the development of appropriate skill and automaticity. Teachers must assess the extent to which skills play a role in the context of particular mathematical topics. A goal is to create contexts that foster skill development even as students engage in problem solving and reasoning. For example, elementary school students should develop rapid facility with addition and multiplication combinations. Rolling pairs of dice as part of an investigation of probability can simultaneously provide students with practice with addition. Trying to figure out how many ways 36 desks can be arranged in equal-sized groups—and whether there are more or fewer possible groupings with 36, 37, 38, 39, or 40 desks—presses students to produce each number's factors quickly. As they work on this problem, students have concurrent opportunities to practice multiplication facts and to develop a sense of what factors are. Further, the problem may provoke interesting questions: How many factors does a number have? Do larger numbers necessarily have more factors? Is there a number that has more factors than 36? Even as students pursue such questions, they practice and use multiplication facts, for skill plays a role in problem solving at all levels. Teachers of algebra and geometry must similarly consider which skills are essential and why and seek ways to develop essential skills in the contexts in which they matter. What do students need to memorize? How can that be facilitated?

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The content is unquestionably a crucial consideration in appraising the value of a particular task. Defensible reasoning about the mathematics of a task must be based on a thoughtful understanding of the topic at hand as well as of the goals and purposes of carrying out particular mathematical processes.

Teachers must also consider the students in deciding on the appropriateness of a given task. They must consider what they know about their particular students as well as what they know more generally about students from psychological, cultural, sociological, and political perspectives. For example, teachers should consider gender issues in selecting tasks, deliberating about ways in which the tasks may be an advantage either to boys or to girls—and a disadvantage to the others—in some systematic way.

In thinking about their particular students, teachers must weigh several factors. One centers on what their students already know and can do, what they need to work on, and how much they seem ready to stretch intellectually. Well-chosen tasks afford teachers opportunities to learn about their students' understandings even as the tasks also press the students forward. Another factor is their students' interests, dispositions, and experiences. Teachers should aim for tasks that are likely to engage their students' interests. Sometimes this means choosing familiar application contexts: for example, having students explore issues related to the finances of a school store or something in the students' community. Not always, however, should concern for "interest" limit the teacher to tasks that relate to the familiar everyday worlds of the students; theoretical or fanciful tasks that challenge students intellectually are also interesting: number theory problems, for instance. When teachers work with groups of students for whom the notion of "argument" is uncomfortable or at variance with community norms of interaction, teachers must consider carefully the ways in which they help students to engage in mathematical discourse. Defensible reasoning about students must be based on the assumption that all students can learn and do mathematics, that each one is worthy of being challenged intellectually. Sensitivity to the diversity of students' backgrounds and experiences is crucial in selecting worthwhile tasks.

Knowledge about ways in which students learn mathematics is a third basis for appraising tasks. The mode of activity, the kind of thinking required, and the way in which students are led to explore the particular content all contribute to the kind of learning opportunity afforded by the task. Knowing that students need opportunities to model concepts concretely and pictorially, for example, might lead a teacher to select a task that involves such representations. An awareness of common student confusions or misconceptions around a certain mathematical topic would help a teacher to select tasks that engage students in exploring critical ideas that often underlie those confusions. Understanding that writing about one's ideas helps to clarify and develop one's understandings would make a task that requires students to write explanations look attractive. Teachers' understandings about how students learn mathematics should be informed by research as well as their own experience. Just as teachers can learn more about students' understandings from the tasks they provide students, so, too, can they gain insights into how students learn mathematics. To capitalize on the opportunity, teachers should deliberately select tasks that provide them with windows on students' thinking.

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STANDARD 2: THE TEACHER'S ROLE IN DISCOURSE

The teacher of mathematics should orchestrate discourse by—

- ***posing questions and tasks that elicit, engage, and challenge each student's thinking;***
- ***listening carefully to students' ideas;***
- ***asking students to clarify and justify their ideas orally and in writing;***
- ***deciding what to pursue in depth from among the ideas that students bring up during a discussion;***
- ***deciding when and how to attach mathematical notation and language to students' ideas;***
- ***deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty;***
- ***monitoring students' participation in discussions and deciding when and how to encourage each student to participate.***

Elaboration

Like a piece of music, the classroom discourse has themes that pull together to create a whole that has meaning. The teacher has a central role in orchestrating the oral and written discourse in ways that contribute to students' understanding of mathematics.

The kind of mathematical discourse described above does not occur spontaneously in most classrooms. It requires an environment in which everyone's thinking is respected and in which reasoning and arguing about mathematical meanings is the norm. Students, used to the teacher doing most of the talking while they remain passive, need guidance and encouragement in order to participate actively in the discourse of a collaborative community. Some students, particularly those who have been successful in more traditional mathematics classrooms, may be resistant to talking, writing, and reasoning together about mathematics.

One aspect of the teacher's role is to provoke students' reasoning about mathematics. Teachers must do this through the tasks they provide and the questions they ask. For example, teachers should regularly follow students' statements with, "Why?" or by asking them to explain. Doing this consistently, irrespective of the correctness of students' statements, is an important part of establishing a discourse centered on mathematical reasoning. Cultivating a tone of interest when asking a student to explain or elaborate on an idea helps to establish norms of civility and respect rather than criticism and doubt. Teachers also stimulate discourse by asking students to write explanations for their solutions and provide justifications for their ideas.

Emphasizing tasks that focus on thinking and reasoning serves to provide the teacher with ongoing assessment information. Well-posed questions can simultaneously elicit and extend students' thinking. The teacher's skill at formulating questions to orchestrate the oral and written discourse in the direction of mathematical reasoning is crucial.

A second feature of the teacher's role is to be active in a different way from that in traditional classroom discourse. Instead of doing virtually all the talking, modeling, and explaining themselves, teachers must encourage and expect students to do so. Teachers must do more listening, students more reasoning. For the discourse to promote students' learning, teachers must orchestrate it carefully. Because many more ideas will come up than are fruitful to pursue at the moment, teachers must filter and direct the students' explorations by picking up on some points and by leaving others behind. Doing this prevents student activity and talk from becoming too diffuse and unfocused. Knowledge of mathematics, of the curriculum, and of students should guide the teacher's decisions about the path of the discourse. Other key decisions concern the teacher's role in contributing to the discourse. Beyond asking clarifying or provocative questions, teachers should also, at times, provide information and lead students. Decisions about when to let students struggle to make sense of an idea or a problem without direct teacher input, when to ask leading questions, and when to tell students something directly are crucial to orchestrating productive mathematical discourse in the classroom. Such decisions depend on teachers' understandings of mathematics and of their students—on judgments about the things that students can figure out on their own or collectively and those for which they will need input.

A third aspect of the teacher's role in orchestrating classroom discourse is to monitor and organize students' participation. Who is volunteering comments and who is not? How are students responding to one another? What are different students able to record or represent on paper about their thinking? What are they able to put into words, in what kinds of contexts? Teachers must be committed to engaging every student in contributing to the thinking of the class. Teachers must judge when students should work and talk in small groups and when the whole group is the most useful context. They must make sensitive decisions about how turns to speak are shared in the large group—for example, whom to call on when and whether to call on particular students who do not volunteer. Substantively, if the discourse is to focus on making sense of mathematics, on learning to reason mathematically, teachers must refrain from calling only on students who seem to have right answers or valid ideas to allow a broader spectrum of thinking to be explored in the discourse. By modeling respect for students' thinking and conveying the assumption that students make sense, teachers can encourage students to participate within a norm that expects group members to justify their ideas. Teachers must think broadly about a variety of ways for students to contribute to the class's thinking—using means that are written or pictorial, concrete or representational, as well as oral.

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STANDARD 3: STUDENTS' ROLE IN DISCOURSE

The teacher of mathematics should promote classroom discourse in which students—

- ◊ ***listen to, respond to, and question the teacher and one another;***
- ◊ ***use a variety of tools to reason, make connections, solve problems, and communicate;***
- ◊ ***initiate problems and questions;***
- ◊ ***make conjectures and present solutions;***
- ◊ ***explore examples and counterexamples to investigate a conjecture;***
- ◊ ***try to convince themselves and one another of the validity of particular representations, solutions, conjectures, and answers;***
- ◊ ***rely on mathematical evidence and argument to determine validity.***

Elaboration

The nature of classroom discourse is a major influence on what students learn about mathematics. Students should engage in making conjectures, proposing approaches and solutions to problems, and arguing about the validity of particular claims. They should learn to verify, revise, and discard claims on the basis of mathematical evidence and use a variety of mathematical tools. Whether working in small or large groups, they should be the audience for one another's comments—that is, they should speak to one another, aiming to convince or to question their peers. Above all, the discourse should be focused on making sense of mathematical ideas, on using mathematical ideas sensibly in setting up and solving problems.

STANDARD 4: TOOLS FOR ENHANCING DISCOURSE

The teacher of mathematics, in order to enhance discourse, should encourage and accept the use of—

- ◊ ***computers, calculators, and other technology;***
- ◊ ***concrete materials used as models;***
- ◊ ***pictures, diagrams, tables, and graphs;***
- ◊ ***invented and conventional terms and symbols;***
- ◊ ***metaphors, analogies, and stories;***
- ◊ ***written hypotheses, explanations, and arguments;***
- ◊ ***oral presentations and dramatizations.***

Elaboration

In order to establish a discourse that is focused on exploring mathematical ideas, not just on reporting correct answers, the means of mathematical communication and approaches to mathematical reasoning must be broad and varied. Teachers must value and encourage the use of a variety of tools rather than placing excessive emphasis on conventional mathematical symbols. Various means for communicating about mathematics should be accepted, including drawings, diagrams, invented symbols, and analogies. The teacher should introduce conventional notation at points when doing so can further the work or the discourse at hand. Teachers should also help students learn to use calculators, computers, and other technological devices as tools for mathematical discourse. Given the range of mathematical tools available, teachers should often allow and encourage students to select the means they find most useful for working on or discussing a particular mathematical problem. At other times, in order to develop students' repertoire of mathematical tools, teachers may specify the means students are to use.

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STANDARD 5: LEARNING ENVIRONMENT

The teacher of mathematics should create a learning environment that fosters the development of each student's mathematical power by—

- ***providing and structuring the time necessary to explore sound mathematics and grapple with significant ideas and problems;***
- ***using the physical space and materials in ways that facilitate students' learning of mathematics;***
- ***providing a context that encourages the development of mathematical skill and proficiency;***
- ***respecting and valuing students' ideas, ways of thinking, and mathematical dispositions;***

and by consistently expecting and encouraging students to—

- ***work independently or collaboratively to make sense of mathematics;***
- ***take intellectual risks by raising questions and formulating conjectures;***
- ***display a sense of mathematical competence by validating and supporting ideas with mathematical argument.***

Elaboration

This standard focuses on key dimensions of a learning environment in which serious mathematical thinking can take place: a genuine respect for others' ideas, a valuing of reason and sense-making, pacing and timing that allow students to puzzle and to think, and the forging of a social and intellectual community. Such a learning environment should help all students believe in themselves as successful mathematical thinkers.

What teachers convey about the value and sense of students' ideas affects students' mathematical dispositions in the classroom. Students are more likely to take risks in proposing their conjectures, strategies, and solutions in an environment in which the teacher respects students' ideas, whether conventional or nonstandard, whether valid or invalid. Teachers convey this kind of respect by probing students' thinking, by showing interest in understanding students' approaches and ideas, and by refraining from ridiculing students. Furthermore, and equally important, teachers must teach students to respect and be interested in one another's ideas.

Demonstrating respect for students' ideas does not imply, however, that teachers or students accept all ideas as reasonable or valid. The purpose of valuing students' ideas and ways of thinking is not just to make students feel good but to foster the development of their understanding of, and power with, mathematics. Therefore, the central focus of the classroom environment must be on sense-making. Mathematical concepts and procedures—indeed, mathematical skills—are central to making sense of mathematics and to reasoning mathematically. Teachers should consistently expect students to explain their ideas, to justify their solutions, and to

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persevere when they are stuck. Teachers must also help students learn to expect and ask for justifications and explanations from one another. Teachers' own explanations must similarly focus on underlying meanings; something a teacher says is not true simply because he or she "said so."

Emphasizing reasoning and justification implies that students should be encouraged and expected to question one another's ideas and to explain and support their own ideas in the face of others' challenges. Teachers must help students learn how to do this: Students need to learn how to question another's conjecture or solution with respect for that person's thinking and knowledge. They also need to learn how to justify their own claims without becoming hostile or defensive.

Serious mathematical thinking takes time as well as intellectual courage and skills. A learning environment that supports problem solving must allow time for students to puzzle, to be stuck, to try alternative approaches, and to confer with one another and with the teacher. Furthermore, for many worthwhile mathematical tasks, tasks that require reasoning and problem solving, the speed, pace, and quantity of students' work are inappropriate criteria for "doing well." Too often, students have developed the idea that if they cannot answer a mathematical question almost immediately, then they might as well give up. Teachers must encourage and expect students to persevere, to take the time to figure things out. In discussions, the teacher must allow time for students to respond to questions and must also expect students to give one another time to think, without bursting in, frantically waving hands, or showing impatience.

Students' learning of mathematics is enhanced in a learning environment that is built as a community of people collaborating to make sense of mathematical ideas. It is a key function of the teacher to develop and nurture students' abilities to learn with and from others—to clarify definitions and terms to one another, consider one another's ideas and solutions, and argue together about the validity of alternative approaches and answers. Classroom structures that can encourage and support this collaboration are varied: students may at times work independently, conferring with others as necessary; at other times students may work in pairs or in small groups. Whole-class discussions are yet another profitable format. No single arrangement will work at all times; teachers should use these arrangements flexibly to pursue their goals.

STANDARD 6: ANALYSIS OF TEACHING AND LEARNING

The teacher of mathematics should engage in ongoing analysis of teaching and learning by—

- ***observing, listening to, and gathering other information about students to assess what they are learning;***
- ***examining effects of the tasks, discourse, and learning environment on students' mathematical knowledge, skills, and dispositions;***

in order to—

- ***ensure that every student is learning sound and significant mathematics and is developing a positive disposition toward mathematics;***
- ***challenge and extend students' ideas;***
- ***adapt or change activities while teaching;***
- ***make plans, both short- and long-range;***
- ***describe and comment on each student's learning to parents and administrators, as well as to the students themselves.***

Elaboration

Assessment of students and analysis of instruction are fundamentally interconnected. Mathematics teachers should monitor students' learning on an ongoing basis in order to assess and adjust their teaching. Observing and listening to students during class can help teachers, on the spot, tailor their questions or tasks to provoke and extend students' thinking and understanding. Teachers must also use information about what students are understanding to revise and adapt their short- and long-range plans: for the tasks they select and for the approaches they choose to orchestrate the classroom discourse. Similarly, students' understandings and dispositions should guide teachers in shaping and reshaping the learning environment of the classroom. Additionally, teachers have the responsibility of describing and commenting on students' learning to administrators, to parents, and to the students themselves.

Students' mathematical power depends on a varied set of understandings, skills, and dispositions. Teachers must attend to the broad array of dimensions that contribute to students' mathematical competence as outlined in the *Curriculum and Evaluation Standards for School Mathematics*. They should assess students' understandings of concepts and procedures, including the connections they make among various concepts and procedures. Teachers must also assess the development of students' ability to reason mathematically—to make conjectures, to justify and revise claims on the basis of mathematical evidence, and to analyze and solve problems. Students' dispositions toward mathematics—their confidence, interest, enjoyment, and perseverance—are yet another key dimension that teachers should monitor.

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Paper-and-pencil tests, although one useful medium for judging some aspects of students' mathematical knowledge, cannot suffice to provide teachers with the insights they need about their students' understandings in order to make instruction as effectively responsive as possible. Teachers need information gathered in a variety of ways and using a range of sources. Observing students participating in a small-group discussion may contribute valuable insights related to their abilities to communicate mathematically. Interviews with individual students will complement that information and also provide information about students' conceptual and procedural understanding. Students' journals are yet another source that can help teachers appraise their students' development. Teachers can also learn a great deal from closely watching and listening to students during whole-group discussions.

As they monitor students' understandings of, and dispositions toward, mathematics, teachers should ask themselves questions about the nature of the learning environment they have created, of the tasks they have been using, and of the kind of discourse they have been fostering. They should seek to understand the links between these and what is happening with their students. If, for example, students are having trouble understanding inverse functions, is it because of the kinds of tasks in which they have been engaged? Is it related to the ways in which the group has explored and discussed ideas about functions and their inverses? Although it may be that the students lack prerequisite understandings, it could also be that this is a difficult piece of mathematics or that the teacher needs to consider alternative ways to help students "unpack" the ideas. Or, if students quickly give up when a direct route for solving a problem is not apparent, teachers must consider how the experiences that students have been having and the environment in which they have been working may not have helped them to develop the perseverance and confidence they need. Teachers need to analyze continually what they are seeing and hearing and explore alternative interpretations of that information. They need to consider what such insights suggest about how the environment, tasks, and discourse could be enhanced, revised, or adapted in order to help students learn.

ORAD 97-1030

MATHEMATICS PROGRAM IN JAPAN

(Kindergarten to Upper Secondary School)

Japan Society of Mathematical Education
(J S M E)

January, 1990

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Excerpt from the National Courses of Study

Revised by the Ministry of Education

CURRICULUM FOR THE KINDERGARTEN

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1990.

Excerpt from the Course of Study for the Kindergarten

1. Lessons must be given over at least 39 weeks a year.
2. Standard number of class periods per day is 4 hours.
3. Objectives and content are classified into four domains as follows:
   Health, Human Relations, Environment, Language.
   (Arithmetic is not specified as a subject.)

Notes :

1) Children can enter the kindergarten between the ages of 3 and 5.
2) Objectives and content concerning arithmetic are involved in the third domain, ie, Environment.

Environment

1. Objectives

(1) To help children become familiar with the environment around them and become interested in various phenomena through contact with nature.

(2) To help children become involved in the environment around them and become attentive it by incorporating it into their lives.

(3) To help children enrich their sense of the properties of things, numbers and quantities, by seeing, thinking and treating the phenomena around them.

2. Content

(8) Children feel interested in numbers, quantities and geometrical figures in their daily lives.

[(1)～(7) & (9), (10) are omitted, since those items have no relation with arithmetic.]

3. Remarks

(2) As for number and quantity, the teacher should evaluate children's experience based on their needs in their daily lives. Their interest, concern and sense of the number and quantity should be fostered naturally.

【(1) is omitted, since the item has no relation with arithmetic.】

CURRICULUM OF MATHEMATICS FOR THE ELEMENTARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1992.

Excerpt from the General Provision of the Course of Study for the Elementary School

1. Arithmetic is a required subject in each grade.
2. Standard numbers of class periods per year required for Arithmetic are prescribed as follows:

1st grade (6 years old)	136
2nd grade (7 years old)	175
3rd grade (8 years old)	175
4th grade (9 years old)	175
5th grade (10 years old)	175
6th grade (11 years old)	175

Notes :

1) Each class period is 45 minutes long.
2) Lessons on Arithmetic must be given over at least 34 weeks in the 1st grade, and over at least 35 weeks in other grades.

Arithmetic

I. OBJECTIVES

The aims are to help children develop their abilities to consider their daily-life phenomena insightfully and logically, acquiring the fundamental knowledge and skills regarding numbers, quantities and geometrical figures ,and thereby to foster their attitude to appreciate the mathematical coping with and to willingly make use of it in their lives.

II. OBJECTIVES AND CONTENT IN EACH GRADE

[1 st grade]

1. Objectives

(1) Through activities such as concrete manipulation, to help children understand the concept of number and how to represent numbers, and to help them be able to use addition and subtraction in simple cases.

(2) Through activities such as concrete manipulation, to help children enrich their experiences basic to understand the concepts of quantity and measurement.

(3) Through activities such as concrete manipulation, to help children enrich their experiences basic to understand the concepts of geometrical figures and space.

2. Content

A. Numbers and Calculations

(1) To enable children to correctly represent the number and order of objects by using numbers, and through these activities, understand the concept of numbers.

a. To compare the numbers of objects by manipulation such as one-to-one correspondence.

b. To correctly count or represent the number and order of objects.

c. To know about the size and order of numbers, to make a sequence of them and to represent them on a number line.

d. To consider a number in relation to other numbers by regarding it as a sum or difference of them.

e. To know how to represent 2-digits numbers and the meaning of place value in them.

(2) To enable children to understand addition and subtraction of numbers and use them.

a. To know about the cases in which addition and subtraction are applied, to represent them by mathematical expressions and to interpret them.

b. To be able to surely carry out addition of 1-digit numbers and subtraction as its inverse operation.

c. To know that addition and subtraction may be applied, in simple cases, to 2-digits numbers as well as to 1-digit numbers.

(3) To enable children to count concrete objects by grouping, dividing them into equal

parts and to represent the result in a neatly arranged way.

B. Quantities and Measurements

(1) To enable children to enrich their experiences basic to understand the concepts of quantities and their measurement through activities such as comparing their sizes.

a. To directly compare quantities such as length, area and volume through concrete manipulation.

b. To compare sizes in terms of the number of unit by regarding size of objects around children as a unit.

(2) To enable children to read a clock.

C. Geometrical Figures

(1) To enable children to enrich their experiences basic to understand the concepts of geometrical figures and space through such manipulative activities as observing the shapes of concrete objects and constructing them.

a. To recognize the shapes of objects or to grasp their features.

b. To construct the various shapes and decompose them into more basic shapes.

c. To represent the position of an object by correctly using such words concerning directions and positions as "front and rear", "right and left" and "upward and downward".

【 Terms / Symbols 】

ones place, tens place, +, −, =

3. Remarks concerning Content

(1) As for the content A-(1)-e, it is necessary to assure the understanding of 2-digits numbers through alluding to simple 3-digits numbers.

(2) As for the content C-(1)-a, it is necessary to help children gradually pay attention to the functional aspect of shapes of objects.

[2 nd grade]

1. Objectives

(1) Through activities such as concrete manipulation, to help children deepen their understanding of the concept of number and how to represent numbers. Furthermore, to help them understand addition, subtraction and multiplication and

become able to do in basic calculations as well as to help them become able to adequately apply them.

(2) Through activities such as concrete manipulation, to help children gradually understand the concepts of quantities such as length and volume and their measurement as well as to help them become able to measure them.

(3) To help children become able to gradually understand the concepts of fundamental geometrical figures by paying attention to the elements that compose them.

2. Content

A. Numbers and Calculations

(1) To enable children to understand the concept of number and how to represent numbers, and develop their abilities to use them.

a. To count objects by rearranging them into groups of the same size or by classifying them.

b. To understand how to represent numbers up to 4-digits numbers by the decimal positional numeration system (Hindu-Arabic numeration system) and the size and order of the numbers.

c. To understand relative size of numbers by regarding 10 as a unit or 100 as a unit through concrete manipulation.

d. To consider a number in relation to other numbers by regarding it as a product.

e. To classify simple facts and represent them by using numbers.

(2) To enable children to develop their abilities to use addition and subtraction through getting deeper understanding of them.

a. To understand the mutual relation between addition and subtraction.

b. To understand that addition and subtraction of 2- or 3- digits numbers are accomplished by using the basic facts of these operations for 1-digit numbers and to know and use them in column form.

c. To know about the simple properties of addition and subtraction and to use them for the purposes of devising algorithms or checking their results.

(3) To enable children to understand the meaning of multiplication and to use it.

a. To know about the cases in which multiplication may be applied, to represent them by mathematical expressions, and to interpret them.

b. To know about the way of increase in the product when the multiplier increases one by one and the commutative law as the properties of multiplication and to use them in constructing multiplication table and checking the results of computing.

c. To know about the multiplication table and to be able to correctly multiply 1-digit numbers.

(4) To enable children to concisely represent the affairs or the relations of quantities in a form of mathematical expression, for example, to represent equivalence and order relations among quantities by using equality or inequality signs, and to interpret them.

B. Quantities and Measurements

(1) To enable children to gradually understand the concepts of length and volume, and to measure these quantities in simple cases.

a. To understand the meaning of the units and the measurements of length and volume.

b. To know about the units (millimeter(mm), centimeter(cm), and meter(m)) to be used in measuring length.

c. To know about the units (milliliter (ml), deciliter(dl) and liter(l)) to be used in measuring volume.

(2) To enable children to gradually understand the concept of time and to use them.

a. To know about day, hour and minute and understand their mutual relations.

C. Geometrical Figures

(1) To enable children to consider the shapes of objects through concrete manipulation and gradually understand the concepts of fundamental geometrical figures.

a. To know about the elements that compose the geometrical figures through experiences in observing and making the objects which have the shape of box.

b. To know about triangles and quadrilaterals by paying attention to the elements that compose the geometrical figures.

c. To know about squares, rectangles and right-angled triangles and to draw and make them.

【 Terms / Symbols 】

unit, straight line, right angle, ×, >, <

3. Remarks concerning Content

(1) As for the content A-(1)-e, it is necessary for children to become able to represent affairs in the form of tables or graphs by arranging objects and to interpret these

tables or graphs.

(2) As for the content A-(2)-b, it is necessary to help children consider the way of computing and check the results of computing on the basis of their estimation of the results.

(3) As for the content A-(2) and -(4), parentheses ( ) and a frame □ may be used, if necessary.

(4) As for the content C-(1)-c, it is necessary to help children understand that squares and rectangles are frequently used around them as well as to help children enrich their experiences basic to understand the concept of plane extention through manipulative activities such as tessellation.

[**3 rd grade**]

1. Objectives

(1) To help children become able to use decimal fractions and common fractions to represent the size of quantities. Furthermore, to help them understand the meanings of multiplication and division of whole numbers and become able to compute in basic calculations, as well as to help children appreciate their usefulness and become able to apply them exactly and efficiently according to their purposes.

(2) To help children understand the concepts of weight and time and become able to measure the fundamental quantities such as length through appropriately choosing units and tools according to their purposes.

(3) To help children deepen their understanding of fundamental geometrical figures and become able to construct and use them.

(4) To help children become able to arrange data, and use mathematical expressions and graphs, and to help children appreciate their meaning and become gradually able to represent or investigate the sizes of quantities and their mathematical relations.

2. Content

A. Numbers and Calculations

(1) To enable children to deepen their understanding of whole numbers and the way of representing them.

a. To know about the place of ten thousands ("man" in Japanese pronunciation).

b. To know about the sizes of 10 times, 100 times, $\frac{1}{10}$ of a whole numbers and how to represent them.

c. To deepen their understanding of the relative size of numbers.

(2) To enable children to more surely carry out addition and subtraction of whole numbers and to develop their abilities to use them.

a. To utilize the properties of addition and subtraction for considering how to compute and check the results of computing.

(3) To enable children to deepen their understanding of the multiplication of whole numbers and to develop their abilities to use them.

a. To understand that multiplication of 2- or 3- digits number by 1- or 2- digits number is based on the multiplication table and the properties of operations. Furthermore, to know about the column form of multiplication and to be able to use it.

b. To know about the variation in the product when the multiplier increases one by one and commutative and associative laws as the properties of multiplication and, to use them in considering the way of computation and checking the results of computing.

(4) To enable children to understand the meaning of division and to use it.

a. To know about the case in which division may be applied, to represent them in mathematical expressions and to interpret them.

b. To understand the relations between division and multiplication and between division and subtraction, and to use these relations in formulating mathematical expressions, or calculating and checking the results of computing. Furthermore, to know about the meaning of remainder in division.

c. To know about the column form of division by 1-digit divisor and to use it.

(5) To enable children to understand decimal fractions and common fractions in simple cases and appropriately use them, thereby to gradually appreciate their significance.

a. To use the decimals or fractions to represent the size of fractional parts or size of parts induced by equally dividing. Furthermore, to know about the notations of decimals and fractions.

b. To know that addition and subtraction can be also applied to decimals and fractions.

(6) To enable children to know how numbers are set on the abacus ("soroban" in Japanese pronunciation) and to use it in simple addition and subtraction.

a. To know how to set numbers on the abacus.

b. To know how to add and subtract with the abacus.

B. Quantities and Measurements

(1) To enable children to gradually understand the concept of weight and to measure it.

a. To understand the meaning of unit of measure for weight and of measurement in weight.

b. To know about the units (gram(g) and kilogram(kg)) to be used in measuring weight.

(2) To enable children to measure the length through appropriately choosing units and tools according to their purposes.

a. To know about the unit (kilometer (km)) to be used in measuring distance (length).

b. To estimate length and to concisely represent it by using appropriate units.

(3) To enable children to deepen their understanding of the concept of time, and, in simple cases, to get necessary time and number of hours by computation.

C. Geometrical Figures

(1) To enable children to deepen their understanding of fundamental geometrical figures and to construct or use them.

a. To know about isosceles and equilateral triangles and gradually pay attention to their relation through construction etc.

b. To know about angles in relation to fundamental geometrical figures.

c. To know about center, diameter and radius of a circle. Furthermore, to know about sphere and its diameter etc. in relation to the circle.

D. Quantitative Relations

(1) To enable children to gradually represent relations between quantities by mathematical expressions, to interpret those expressions and to appreciate its significance.

a. To represent a quantitative relation in a formula and interpret it.

b. To represent quantities by using a frame □ and to investigate the values to be filled in it.

(2) To enable children to plainly represent data in simple tables or graphs and to

interpret them.

a. To classify and arrange data from such simple view points as day, time or place. and to represent them in a table.

b. To know how to interpret and draw bar-graphs.

【 Terms / Symbols 】

whole number, number line, decimal point, place of $\frac{1}{10}$ (tenth), numerator, denominator, second, sign of equality, sign of inequality, ÷

3. Remarks concerning Content

(1) As for the content A-(2), -(3) and -(4), it is necessary to help children carry out simple computations mentally.

(2) As for the fundamental geometrical figures in the content C-(1), such activities as drawing and checking the figures with a ruler and compasses should be emphasized as well as it is necessary to help children become interested in beauties which pertain to the figures, through concrete activities such as drawing patterns based on triangles and circles.

(3) As for the content D-(2), in the teaching of graph, it is necessary to help children gradually become able to read minimum scales graduated by 2, 5 or 20, 50 etc.

[4 th grade]

1. Objectives

(1) To help children deepen their understanding of whole numbers and how to express decimal fractions and common fractions as well as understand the meaning of round numbers and become able to use it according to their purposes. Furthermore, to help them become able to master the four basic operations with whole numbers and effectively apply to consideration of phenomena and use addition and subtraction of decimals and fractions.

(2) To help children understand the concept of area and become able to measure the area of simple geometrical figures, and become able to measure the size of an angle.

(3) To help children consider geometrical figures by paying attention to the elements that compose them and their positional relationship and deepen their understanding of the fundamental geometrical plane figures, and also, become able to understand the fundamental solid figures and how to represent the position of

objects.

(4) To help children become able to represent or consider quantities and their mathematical relations by using mathematical expressions or graphs, and further, to help them become able to investigate dependence relation between them according to their purposes and classify and arrange them.

2. Content

A. Numbers and Calculations

(1) To enable children to further deepen their understanding that whole numbers are represented by the decimal positional numeration system.

a. To know about the units such as hundred million ("oku" in Japanese pronunciation), trillion(U.S. etc., =billion (U.K. etc.), "chou" in Japanese pronunciation) etc. and to summarize the decimal positional numeration system.

(2) To enable children to understand round number and to use it according to their purposes as well as to appreciate the meaning.

a. To know about the cases in which round numbers may be used.

b. To understand the meaning of rounding, or counting a fraction of 0.5 and over as one and disregarding the rest.

c. To represent the results of computing as round numbers according to their purposes and estimate the sum or difference in round numbers.

(3) To enable children to more accurately compute the multiplication of whole numbers and to develop their abilities of using it.

(4) To enable children to deepen their understanding of the meaning of division of whole numbers and to develop their abilities of using it.

a. To know that division is possible even when the divisor is a 2-digits number and to understand how to carry out the computation.

b. To summarize the following relation: (dividend) = (divisor) × (quotient) + (remainder)

c. To know that the quotient is not changed if divisor and dividend are multiplied or divided by the same number as the property regarding division and use it in considering how to carry out the computation and checking the results of computing.

(5) To enable children to deepen their understanding of the meaning of decimal fractions and to compute in decimals.

a. To know that the system of representation of decimals is the same as of whole numbers as well as deepen the understanding of relative size of numbers.

b. To be able to add and subtract in decimals.

c. To be able to carry out multiplication and division in the cases where the multiplier and divisor are whole numbers.

(6) To enable children to deepen their understanding of the meaning of fractions and to compute in fractions in simple cases.

a. To deepen their understanding of the representation of fractions and their meanings. Furthermore, in simple cases to pay attention to the fact that there are equivalent fractions.

b. To be able to add and subtract in fractions with the common denominator.

(7) To enable children to summarize their understanding of the meanings and properties of the four fundamental operations and to adequately use them, and thereby to apply and check the operations in concrete situations.

a. To summarize their understanding of the cases in which the four operations may be used and the mutual relations among them.

b. To pay attention to the fact that how to compute is based on the commutative, associative and distributive laws.

(8) To enable children to add and subtract with the abacus ("soroban").

B. Quantities and Measurements

(1) To enable children to understand the concept of area and to measure the area in simple cases.

a. To understand the meaning of unit and measurement in area.

b. To know about the units (square centimeter(cm^2), square meter(m^2), square kilometer(km^2), are(a) and hectare(ha)) to be used in measuring area.

c. To know how to measure the area of squares and rectangles.

(2) To enable children to deepen their understanding of the concept of angle and to measure it.

a. To know the unit degree(°) to be used in measuring angle.

b. To understand the meanings of half-rotation and full-rotation etc.

C. Geometrical Figures

(1) To enable children to deepen their understanding of the fundamental plane figures through observing and constructing geometrical figures, and further, to consider geometrical figures by paying attention to their elements that compose them and

positional relations.

a. To understand the relations such as parallelism and perpendicularity of lines.

b. To know about parallelograms,trapezoids and rhombuses etc.

c. To pay attention to mutual relation among quadrangles through construction.

(2) To enable children to understand fundamental solid figures through observing, composing and decomposing geometrical figures, and to consider the space in simple cases.

a. To understand a cube and a rectangular parallelopiped.

b. To understand parallelism and perpendicularity of lines and planes in connection with the rectangular parallelopiped.

(3) To enable children to understand how to represent the position of an object in space.

D. Quantitative Relations

(1) To enable children to gradually represent and investigate the relations between two quantities which vary in company with each other.

a. To investigate the quantitative relations in simple cases by considering the corresponding quantities or by representing the ordered pairs of corresponding values in a table.

b. To represent how the quantities are varying in a broken-line graph and to interpret the features of their variation.

(2) To enable children to concisely represent mathematical relations in quantitative expressions and interpret those expressions.

a. To understand the meanings of the expressions with the some of four operations and those with parentheses ( ), and to correctly compute.

b. To understand the idea of formula and to use it.

c. To represent variable quantities by using frames □, △, to represent the relation in mathematical expressions and to investigate the values to be filled in them.

(3) To enable children to develop their abilities to gather, classify and arrange data according to their purposes and to investigate their features.

a. To investigate all possible cases as regards two affairs.

b. To check up on omissions and duplications in data.

c. To represent the data in broken-line graph etc., and to investigate the features and tendencies from these graphs.

【 Terms / Symbols 】

sum, difference, product, quotient, mixed fraction, proper fraction, improper fraction, parallel, perpendicular, diagonal line, plane

3. Remarks concerning Content

(1) As for the content A-(3) and -(4), in cases where the multiplier or divisor is 3-digits number, it is necessary to guide children to devise algorithms in a similar manner as the algorithms with 2-digits multiplier or divisor. Complex calculations should be avoided.

(2) As for the content A-(5)-c, the cases in which a whole numbers is divided by a whole number and the quotient is decimal should be included.

(3) As for the content C-(2), it is necessary for children to become able to draw simple sketchmaps and development figures as an occasion demands and to gradually appreciate the significance of representing a solid geometrical figures in a plane.

[5 th grade]

1. Objectives

(1) To help children understand the meanings of multiplication and division of decimal fractions and become able to compute in decimals and fractions, as well as become able to make use of them in considering phenomena. Furthermore, to help them deepen their understanding of the concept of whole numbers.

(2) To help children become able to measure the area of fundamental geometrical plane figures, and further, to help them understand the concept of volume and become able to measure the volume of simple geometrical figures. And also to help children become able to understand the concept of speed and measured values.

(3) To help children understand the meaning of congruence and become able to consider fundamental geometrical figures by paying attention to the elements that compose them.

(4) To help children become able to concisely represent the mathematical expression by using letters, and to investigate the mathematical relations represented by them. Furthermore, to help them become able to consider statistical data by using percentage and circle graph.

2. Content

A. Numbers and Calculations

(1) To enable children to deepen their understanding of whole numbers.

a. To know that the set of whole numbers may be classified into some subsets such as odd numbers and even numbers if some viewpoints are determined.

b. To know about divisors and multiples.

(2) To enable children to deepen their understanding of both whole numbers and decimal fractions from the standpoint of numeration system and to efficiently use this property in computation.

a. To make the multiples of a number multiplied by 10, 100, $\frac{1}{10}$ or $\frac{1}{100}$ by moving the decimal point.

(3) To enable children to deepen their understanding of the meaning of multiplication and division in decimal fraction and to develop their abilities to use them.

a. To summarize the meaning of multiplication and division, including the case in which the multiplier and divisor are decimal fractions.

b. To know how to carry out multiplication and division of decimal fractions.

c. To understand that the same relations and rules for multiplication and division of whole numbers also apply to decimal fractions.

(4) To enable children to deepen their understanding of the meaning of fractions and to develop their abilities to compute with fraction.

a. To transform fractions into decimals and to represent whole numbers and decimals as fractions .

b. To understand that the value of a fraction is not changed when both its numerator and denominator are multiplied or divided by the same number.

c. To summarize the methods for comparing fractions by size.

d. To be able to carry out addition and subtraction of fractions having different denominators.

e. To know that the result of division of whole numbers can be always represented as a single number by using fractions.

(5) To enable children to develop their abilities to estimate the size of a product or a quotient by using round numbers according to their purposes.

B. Quantities and Measurements

(1) To enable children to deepen their understanding that the area of fundamental geometrical plane figures may be found by computation and to develop their

abilities to measure the area.

a. To know how to find the area of triangles, parallelograms and trapezoids etc.

b. To find the area of a polygon by decomposing it into triangles or others.

c. To know about the area of a circle.

(2) To enable children to understand the concept of volume and to measure the volume in simple cases.

a. To understand the meaning of unit of volume and of measurement.

b. To know about the units (cubic centimeter(cm^2) and cubic meter(m^2)) to be used in measuring volume.

c. To know how to measure volume of a cube and a rectangular parallelopiped.

d. To understand the meaning of capacity.

(3) To enable children to deepen their understanding of estimating the sizes of quantities by rough measurement and of the meaning of measured values.

a. To approximate a given figure by fundamental figures and to roughly estimate their length, area or volume from such approximation.

b. To understand the meaning of the average and to use it.

(4) To enable children to understand how to compare and express the quantity which may be represented as the ratio of two different kinds of quantities and to use it.

a. To use the idea of "per unit".

b. To understand the meaning of speed and its way of representation and to calculate speed.

C. Geometrical Figures

(1) To enable children to further deepen their understanding of fundamental plane figures through observing and constructing geometrical figures.

a. To understand congruence of geometrical figures and the correspondence of vertices, sides and angles etc. in congruent figures.

b. To gradually pay attention to elements to determine shape and size of a geometrical figure.

c. To investigate and construct geometrical figures by finding the simple properties of fundamental figures.

d. To understand the meaning of the ratio of the circumference of a circle to its diameter.

e. To draw regular polygons and to investigate their fundamental properties by using circles.

D. Quantitative Relations

(1) To enable children to understand the meaning of percentage and to use it.

(2) To enable children to deepen their understanding of the way of viewing or investigating the quantitative relations represented by simple expressions by paying attention to the correspondence between two quantities and or to the aspect of variation.

(3) To enable children to represent the relation or law between quantities more concisely and generally with mathematical expressions and to interpret them.

a. To know that the relation represented by a formula holds true, whether involved numbers are whole numbers or decimal fractions.

b. To know that the letters such as a, x etc., may be used instead of frames, □, △ or the words standing for quantities and investigate them by substituting numbers to them.

(4) To enable children classify and arrange data according to their purposes, and to represent data by using circle graphs and tape graphs.

【 Terms / Symbols 】

reduction, reduction to a common denominator, greatest common divisor, least common multiple, congruence, sector, central angle, %

3. Remarks concerning Content

(1) As for the content A-(1)-b, it is necessary for teaching the greatest common divisor and the least common multiple to base on concrete situations, and not to bias to formal computation.

(2) As for the content B-(1)-c and C-(1)-d, though 3.14 is used as the circular constant, it is necessary to guide children to become able to deal with the situations by using 3 according to their purposes.

(3) As for the content C-(1), it is necessary to emphasize manipulative activities such as tessellation of plane by congruent figures.

(4) As for the content D-(1), it is necessary to simply allude to the meaning of the ratio based on 10 percent ("buai" in Japanese pronunciation).

(5) As for the content D-(3)-b, when using letters such as a, x the understanding of the meaning represented by such letters should be stressed. However, the teaching should be restricted to the extent to make children familiar with expressions letters.

[6 th grade]

1. Objectives

(1) To help children understand the meaning of multiplication and division of fractions and become able to use them as well as to help them deepen their understanding of multiplication and division in general.

(2) To help children become able to measure the volume of fundamental solid figures. Furthermore, to help children know about the system of units of measuring and become able to efficiently measure the quantities.

(3) To help children consider geometrical figures from a view point of the symmetry and to help them more thoroughly deepen their understanding of the geometrical figures.

(4) To help children deepen their idea of function through their understanding of proportion and become able to efficiently use it in considering quantitative relations. Furthermore, to help children become able to statistically consider and represent by investigating the distribution of data etc.

2. Content

A. Numbers and Calculations

(1) To enable children to understand the meaning of multiplication and division of fractions and to use them, as well as to deepen their understanding of multiplication and division in general.

a. To summarize the meaning of multiplication and division, including the cases in which the multiplier or the divisor is a whole number or a fraction.

b. To know how to multiply and divide in fractions.

c. To regard division as multiplication by the reciprocal.

d. To integrate multiplication and division of whole numbers and decimals respectively into those of fractions. Furthermore, to represent a number expressed by multiplication and division as a fractional form.

B. Quantities and Measurements

(1) To enable children to measure the volume of fundamental solid figures through experiments and actual measurement, etc.

a. To know how to measure the volume and surface area of fundamental prisms and circular cylinders.

b. To know how to measure the volume of fundamental pyramids and circular cones. Furthermore, to know how to measure their surface area in simple cases.

(2) To enable children to deepen their understanding of the measurements and units of quantities and to further develop their abilities to measure.

a. To efficiently measure by using the proportional relationships.

b. To understand the metric system and relations among their units and to efficiently use them in measurement.

C. Geometrical Figures

(1) To enable children to further deepen their understanding of plane figures.

a. To understand the meaning of line and point symmetry, and to consider the fundamental figures from the viewpoint of symmetry.

b. To summarize their understanding of shapes and size of the figures, and to interpret and draw simple scale drawings.

(2) To enable children to deepen their understanding of the fundamental solid figures through manipulation such as composition and decomposition.

a. To know about the fundamental prisms and circular cylinders.

b. To know about the fundamental pyramids and circular cones.

D. Quantitative Relations

(1) To enable children to understand the meaning of ratio and to use it.

(2) To enable children to develop their abilities to consider relations between two quantities which vary in company with each other.

a. To understand the meaning of direct proportion. Furthermore, to investigate its features by using mathematical expressions and graphs in simple cases.

b. To understand the meaning of inverse proportion. Furthermore, to represent it by using mathematical expressions.

c. To know that there are many cases which may be efficiently treated by paying attention to the proportional relation.

(3) To enable children to develop their abilities of statistically considering and representing by investigating the dispersion of data in simple cases.

a. To know about a table and graph to represent frequency distribution.

b. To know that there is a case in which the tendency of a population is conjectured by the ratios gained from a part of statistical data.

c. To choose adequate tables and graphs according to their purposes and to devise some useful ones.

(4) To enable children to gradually arrange in order and investigate the possible cases concerning simple affairs.

【 Terms / Symbols 】

reciprocal, base, side face, axis of symmetry, center of symmetry, value of ratio, more than or equal to, less than, :

3. Remarks concerning Content

(1) As for the content A-(1), it is necessary to pay attention to allude that the relation represented in a formula is also valid for fractions.

(2) As for the content B-(1)-b, solid figures to be taught should be restricted to such ones as their development figures can be easily drawn, and circular cones to be taught in measuring the surface area should be restricted to those whose side faces are developed to a half circle or a quadrant circle.

(3) As for the content B-(2)-b, kiloliter(kl), milligram(mg) and ton(t) should be simply alluded.

(4) In the teaching on the content B and D, it is necessary to pay attention to use letters such as a, x and help children become familiar with them.

(5) As for the content C-(2), interpreting and drawing such figures as sketchmaps and development figures, and vertical planes and ground plans in simple cases should be taught as an occasion demands.

(6) As for the content D-(2), it should be treated in following manners :

a. In teaching graphs of direct proportion in (2)-a, consideration should be given to help children gradually pay attention to continuous changes and the domain.

b. In teaching inverse proportion in (2)-b, the feature of variation of two quantities may be alluded only by using broken-line graph.

III. THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT IN EACH GRADE

1. When constructing teaching plans, the following points should be considered :

(1) The content of each grade in II must continue to be taught in the following

grades, in case of necessity.

(2) As much of the content in each domain of II may be efficiently used in the teaching of other domains, it should be designed to teach the content of each domain so as to well relate each other.

(3) For mastering and maintaining the fundamental skills such as calculation and measurement, the opportunity to exercise them should be intentionally provided as an occasion demands.

(4) As regards numbers, quantities and geometrical figures, the teacher should help children become able to grasp rough size and approximate shape, adequately judge and think out how to efficiently cope with them based on them.

2. As to the content of II, the following points should be considered :

(1) The teacher should suitably provide the situation in which children think for themselves, and help them become able to carry out activities such as concrete manipulation and thought experiments suitable for their developmental levels and states of achievement in learning, and the teacher should gradually foster their abilities of logical thinking and of intuition.

(2) Terms and symbols indicated in each grade are for the purposes of clarifying the extent and the range of content dealt with in the respective grades, and for teaching those terms and symbols, it is necessary to deal with them in relation to the content of each grade and to help children appreciate the significance of using them in their representing and thinking.

(3) In the lower grades, the teacher should carefully pay attention to the relationships of this subject with various experiences in daily-life, while emphasize the process of abstracting numbers, quantities and geometrical figures from concrete objects and their manipulation, and help children become interested in and familiar with numbers, quantities and geometrical figures.

(4) On the teaching of the units in B, the teacher should help children enrich their sense of quantities, and become able to grasp approximate shapes, adequately choose the units and cope with, as well as the teacher should not bias toward formal conversion of units.

(5) On the teaching of computation in decimals and fractions in A, the teacher should avoid complex computations and assure for children to understand the meaning of

computation and how to compute.

(6) At the fifth grade or later, the teacher should help children adequately use "soroban" or hand-held calculators, for the purposes of lightening their burden to compute and of improving the effectiveness of teaching, in situations where many large numbers to be processed are involved for statistically considering or representing, or where they confirm whether the laws of computation still hold in multiplication and division of decimal fractions. At that time, the teacher should pay attention to provide adequate situations in which the results of computation may be estimated and computation may be checked through rough estimation.

CURRICULUM OF MATHEMATICS FOR THE LOWER SECONDARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1993.

Excerpt from the General Provision of the Course of Study for the Lower Secondary School

1. Mathematics is a required subject in each grade.
2. Standard numbers of class periods per year required for Mathematics are prescribed as follows:

1st grade	(12 years old)	105
2nd grade	(13 years old)	140
3rd grade	(14 years old)	140

3. Mathematics is one of several optional subjects at the 3rd grade.

Notes :

1) Each class period is 50 minutes long.
2) Lessons on Mathematics must be given over at least 35 weeks a year.
3) Number of class periods for mathematics as an optional subject at the 3rd grade is at most 35 periods per year, in addition to mathematics as a required subject.

Mathematics

I. OBJECTIVES

The aims are to help students deepen their understanding of the basic concepts, principles and rules concerning numbers, quantities and figures, and acquire the way of mathematically representing and coping with, and to enhance their abilities of mathematically considering things, as well as to help them appreciate the mathematical way of viewing and thinking, and thereby to foster their attitudes of willingly applying them.

II. OBJECTIVES AND CONTENT IN EACH GRADE

[1 st Grade]

1. Objectives

(1) To help students deepen their understanding of the concept of numbers, through the enlarging of the scope of numbers to include positive and negative numbers. Furthermore, to help them understand the significance of using letters as symbols and the meaning of equation, and to help students become able to represent relations among quantities and the rules generally and briefly and handle them.

(2) Through manipulation and experiments, of plane and solid geometrical figures, to help students deepen an intuitive way of viewing and thinking those figures, and thereby to foster the foundation for logically considering.

(3) To help students deepen their views and concepts of changes and correspondence, and understand functional relations, and develop their abilities to represent and use them.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to understand the meaning of positive and negative numbers, and to compute with those numbers according to four fundamental operations.

(2) To enable students to develop their abilities to represent relations and rules in a formula by use of letters, and to calculate simple expressions.

a. The use of letters as symbols.

b. The way of representing multiplication and division in an algebraic expression by using letters.

c. Addition and subtraction of linear expressions.

(3) To enable students to understand the meaning of equation, and to apply linear equations.

a. The meaning of letters and solution in an equation.

b. The properties of equality.

c. To solve linear equations with one variable.

【 Terms/Symbols 】

natural number, sign, absolute value, term, coefficient, ≦, ≧

B. Geometrical Figures

(1) To enable students to develop their abilities to insightfully construct figures that meets given conditions, and thereby deepen their understanding of plane figures.

a. To construct basic figures such as the bisector of an angle, perpendicular bisector of a line segment, perpendicular, etc.

b. Translation, symmetry and rotation.

c. To consider a figure as a set of points that meet certain conditions, and to construct the figure.

(2) To enable students to consider geometrical figures through various manipulation and to deepen their understanding of figures in space.

a. Positional relations between straight lines and planes in space.

b. Construction of solid geometrical figures by movement of plane figures.

c. Section, projection and development of solid geometrical figures.

【 Terms/Symbols 】

arc, chord, solid of revolution, π, $/\!/$, $\perp$, $\angle$, $\triangle$

C. Quantitative Relations

(1) To enable students to understand the functional relation, through extracting two quantities — varying in company with each other — from phenomena, considering the relationship between them and clarifying its characteristics.

a. Variation and Correspondence.

b. The meaning of coordinates.

c. To represent a functional relation in table, graph, and formula, etc.

(2) To enable students to develop their abilities to consider and represent mathematical relationships, through deepening of their understanding of the characteristics of algebraic expressions and graphs of direct and inverse proportions.

【 Terms/Symbols 】

variable, domain

3. Remarks concerning Content

(1) As for the content A-(1), the applicability of four fundamental operations should be taught.

(2) As for the content A-(2)-c, the computations of algebraic expressions should be limited to the level needed in solving linear equations.

(3) As for the content B-(2)-c, the teacher should not go too far into a technical and

applied aspects of the section and projection.

(4) As for the content C-(2), correctly drawing graphs should be included.

[2 nd Grade]

1. Objectives

(1) To help students develop their abilities to compute and transform algebraic expressions using letter symbols according to their purposes, and to help them understand linear inequalities and simultaneous equations, and to foster their abilities to use them.

(2) To help students deepen their understanding of the properties of the fundamental figures in a plane, and thereby understand the significance and methods of mathematical inference with reference to consideration of the properties of figures, and to foster their abilities to precisely represent the process of inference.

(3) To help students further deepen the way of viewing and thinking variation and correspondence and understand the characteristics of linear functions ,and foster their abilities to use them. Furthermore, to help students adequately represent numbers according to their purposes and develop their abilities to grasp the tendencies of statistical phenomena.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to carry out the four fundamental operations of simple algebraic expressions using letters .

a. Addition and subtraction of simple polynomials.

b. Multiplication and division of monomials.

(2) To enable students to develop their abilities to find the quantitative relationships in phenomena, and to represent such relationships in an algebraic expression by using letters and to utilize them.

a. To make use of algebraic expressions.

b. To transform simple equalities.

(3) To enable students to understand the meaning of inequality and to apply linear inequalities.

a. Inequality and the meaning of its solution.

b. The properties of inequality.

c. To solve linear inequalities.

(4) To enable students to understand the meaning of simultaneous linear equation and their solution, and thereby to apply them.

a. The meaning of linear equation with two variables and its solution.

b. To solve simple simultaneous linear equations.

【 Terms/Symbols 】

similar term

B. Geometrical Figures

(1) To enable students to find the properties of a figure in a plane, and confirm them by using the properties of parallel lines and the conditions for congruence of triangles.

a. The properties of parallel lines.

b. The conditions for congruence of triangles.

c. The properties of triangles and parallelograms.

(2) To enable students to clarify the concepts of similarity of figures, and develop their abilities to find the properties of figures by using the conditions for congruence or similarity of triangles and confirm them.

a. The meaning of similarity and the conditions for similarity of triangles.

b. The properties of the ratio of segments of parallel lines.

c. The applications of similarity.

【 Terms/Symbols 】

opposite angle, interior angle, exterior angle, definition, proof, center of gravity, $\equiv$, $\backsim$

C. Quantitative Relations

(1) To enable students to deepen their understanding of representation of numbers and to adequately use numbers in real situation.

(2) To enable students to further deepen their understanding of functional relations, understand the characteristics of linear functions and develop their abilities to make use of it.

a. Some phenomena may be represented by use of linear functions.

b. The ratio of changes in the values of linear function and characteristics of the graph.

c. A linear equation with two variables may be considered to represent the functional relationships between two variables.

(3) To enable students to collect data according to their purposes, arrange these data by using tables and graphs, and thereby to ascertain the tendencies of the data by paying attention to representative values and dispersion etc.

a. The meaning of frequency distribution and how to interpret of histogram.

b. The meaning of relative frequency.

c. The meaning of mean value and range.

d. How to interpret correlation diagrams and tables.

【 Terms/Symbols 】

significant figure, approximate value, error, frequency, class

3. Remarks concerning Content

(1) As for the content A-(3), representing procedure for computation such as flow chart should be also included.

(2) As for the content A-(4)-b, simultaneous linear equation with two variables should be taught.

(3) As for the content B-(2)-c, measurement of height and distance as applications of similarity should be taught.

(4) As for the content C-(1), numeration system such as binary system and expression in the form of $a \times 10^n$ should be taught.

(5) As for the content C-(3), attention should be paid to the teaching based on the real situation concerning daily-life phenomena.

[**3 rd Grade**]

1. Objectives

(1) To help students understand the square root of numbers, and thereby further deepen their understanding of the concept of numbers. Furthermore, to help students understand the transformation of algebraic expressions according to their purposes and quadratic equations, further deepen their understanding of algebraic expressions, and thereby efficiently deal with them.

(2) To help students deepen their understanding of the properties of right triangles and circles, and develop their abilities to use them in considering the properties of figures and in measuring them. Furthermore, to help them develop their abilities

to consider figures logically and insightfully.

(3) To help students further develop to represent or to use functional relations, and deepen their understanding of the functions through investigating the characteristics of functions. Furthermore, to help students understand the meaning of probability and the elementary concepts of sampling survey, and thereby deepen their views and way of statistical thinking.

2. Content

A. Numbers and Algebraic Expressions

(1) To enable students to understand the meaning and necessity of square root of the positive numbers, and use them.

a. The meaning of the square root of numbers.

b. Computation of simple algebraic expressions involving square roots.

(2) To enable students to expand and factor an expression with regard to simple polynomials using letters.

a. Multiplication of a monomial and a polynomial and division of a polynomial by a monomial.

b. Multiplication of simple linear expressions.

c. Expansion and factorization of an expression by using the formulae below :

$$(a+b)^2=a^2+2ab+b^2$$

$$(a-b)^2=a^2-2ab+b^2$$

$$(a+b)(a-b)=a^2-b^2$$

$$(x+a)(x+b)=x^2+(a+b)x+ab$$

(3) To enable students to understand quadratic equations and their solution, and apply them.

a. Quadratic equations and their solution.

b. To solve quadratic equations by using factorization and the formulae for solution, etc.

【 Terms/Symbols 】

radical sign, rational number, irrational number, prime number, factor, $\sqrt{\ }$

B. Geometrical Figures

(1) To enable students to deepen their understanding of the properties of circles and consider the properties of figures by using them.

a. The properties of a circle and a straight line and the properties of two circles.

b. Relationship between the angle of circumference and the central angle.

(2) To enable students to understand the measuring properties of figures and use them.

a. The Pythagorean theorem and its applications.

b. Length of an arc and area of a sector, and surface area and volume of a sphere.

c. Similarity of simple solid figures, and the relationships between the ratios of length, area, and volume in similar figures.

【 Terms/Symbols 】

tangential line, point of tangency

C. Quantitative Relations

(1) To enable students to develop their abilities to investigate the characteristics of change or correspondence by extracting two quantities in functional relations from a phenomena.

a. Various phenomena and their functions.

b. Function $y=ax^2$.

c. The ratio of change in the value of function.

(2) To enable students to understand the probability by paying attention to the frequency obtained through large numbers of observations or trials.

a. Stochastic events and the meaning of probability.

b. To compute probability in simple cases.

(3) To enable students to understand that the tendencies in a population can be estimated from a sample.

3. Remarks concerning Content

(1) As regards the content A-(2) etc., factorization of a natural number into prime factors should be also included.

(2) As for the content A-(3)-b, only quadratic equations having the real solution should be taught. And, in using factorization as a solving method, the available formulae should be limited to the ones indicated in A-(2)-c.

(3) As for the content C-(2)-b, events which may be easily classified by the aid of tree diagrams, etc. should be dealt with.

(4) As for the content C-(3), attention should be paid to dealing with it through experiments and observation.

III. THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT

1. Without disturbing to achieve the objectives of the each grade in II, the teachers may lightly refer to a part of the content for the proper grade and give full instruction to it in a succeeding grade. Whereas, without deviating from the objectives of the grade, the teachers may also include a part of the content assigned to a higher grade in their instruction.
2. In the 2nd and 3rd grades, problem situation learning should be included in a total teaching plan with an appropriate allotment and implement for the purpose of stimulating students' spontaneous learning activities and of fostering their views and ways of thinking mathematically. Here, 'problem situation learning' means the learning to cope with a problem situation, appropriately provided by the teacher so that the content of each domain may be integrated or related to daily affairs.
3. The items indicated in terms and symbols of the content for each grade in II are shown to clarify the extent and range of the content dealt with in each grade. In teaching them, the teachers should deal with them in close relation with those content.
4. In the teaching of each domain, computers should be efficiently utilized as an occasion demands. In particular, this matter need to be considered in the instruction by the experiment and observation etc. in "Quantitative Relations".
5. In the teaching of numerical computation, the teacher should give consideration to improve the effectiveness of learning by having the students use "soroban" (Japanese abacus), or hand-held calculators etc. as an occasion demands.
6. In "mathematics" as an optional subject in the 3rd grade, the learning activities such as problem situation learning, field or laboratory work, experiment, and investigation on the content should be appropriately designed and dealt with in school so as to develop various learning activities in accord with students' characteristics.

CURRICULUM OF MATHEMATICS FOR THE UPPER SECONDARY SCHOOL

Revised by the Ministry of Education in 1989, and to be put in force beginning in 1994.

Excerpt from the General Provision of the Course of Study for the Upper Secondary School

1. Mathematics in the upper secondary school is composed of several subjects whose titles and associated credits are shown in the following table.

Subject	Standard Number of Credits
Mathematics I	4
Mathematics II	3
Mathematics III	3
Mathematics A	2
Mathematics B	2
Mathematics C	2

2. Mathematics I is required for all students, but the other Mathematics subjects are optional.

Note:

1) One credit consists of 35 class hours and a class periods of 50 minutes is defined as one class hour.

MATHEMATICS

[I] OVERALL OBJECTIVES

To help students deepen their understanding of basic concepts, principles and laws of mathematics, and develop their abilities to think and cope with mathematically in dealing with various phenomena, and appreciate mathematical way of viewing and thinking, and thereby to foster their attitudes which encourage the use of such abilities.

[II] SUBJECTS

I. Mathematics I

1. Objectives

Through consideration of concrete phenomena, to help students understand quadratic functions, geometrical figures and mensuration, treatment of numbers of cases and probability, and to encourage them to master basic knowledge and skills, to develop their abilities to utilize them exactly and to deepen their appreciation of significance of mathematical way of viewing and thinking.

2. Content

(1) Quadratic Functions

a. Quadratic function and its graph

(i) function and its graph

(ii) quadratic function and its graph

b. Variation of values of quadratic function

(i) maximum and minimum of quadratic function

(ii) quadratic equation and quadratic inequality

(2) Geometrical Figures and Mensuration

a. Trigonometric ratios

(i) sine, cosine, tangent

(ii) mutual relations among trigonometric ratios

b. Trigonometric ratios and geometrical figures

(i) sine theorem and cosine theorem

(ii) mensuration of geometrical figures

【Terms/Symbols】 sin, cos, tan

(3) Treatment of Numbers of Cases

a. Rule of enumeration

b. Sequences of natural numbers

c. Numbers of cases

(i) permutation

(ii) combination

【Terms/Symbols】 ${}_nP_r$, ${}_nC_r$, factorial, $n!$

(4) Probability

a. Probability and its basic laws

b. Independent trial and probability

c. Expectation

【Terms/Symbols】 complementary event, exclusiveness

3. Remarks concerning Content

(1) As for the content (1)-b-(ii), quadratic equations should be limited to those with real solutions.

(2) As for the content (2), the range of angles should be from 0° to 180°.

(3) As for the content (2)-b-(ii), the teacher should give instruction to the mensuration of plane and space figures, but should not go too far to the calculation using Heron's formula for area of triangle.

(4) As regards the item indicated in content (3)-a, the teacher should give instruction to counting of number of elements of sets, but those treatments should be limited to simple cases.

(5) As regards the item indicated in content (3), the teacher should give instruction to the fundamental facts of sets.

(6) As for the content (4), the teacher should give instruction to those in relation to examples involving real situations.

(7) As for the content (4)-b, dependent and independent events are not included.

(8) Since "Mathematics I" is the subject for all students, the teachers should consider to treat the level and scope of content flexibly in accord with actual state of students as well as to devise their teaching methods.

II. Mathematics II

1. Objectives

As the content following to "Mathematics I", to help students understand exponential and trigonometric function, geometrical figures and equations, and variation of values of functions and to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Various Functions

a. Exponential function

(i) extention of exponent

(ii) exponential function

(iii) logarithmic function

b. Trigonometric function

(i) extention of angle

(ii) trigonometric function and its basic properties

(iii) addition theorems for trigonometric functions

【Terms/Symbols】 power root, $log_a x$

(2) Geometrical Figures and Equations

a. Points and lines

(i) coordinate of points

(ii) equations of straight lines

b. Circles

(i) equations of circles

(ii) circles and lines

(3) Variation of Values of Functions

a. Differential coefficient and derivatives

b. Applications of derivatives

c. Idea of integration

【Terms/Symbols】 limit value, *lim*, indefinite integral, definite integral

3. Remarks concerning Content

(1) As for the content (1)-a-(iii), computation by logarithms is not included. As for the content (1)-b-(iii), double angle formula and composition of simple harmonic motions are taken up, but should not go too far.

(2) As regards the item indicated in content (2), the teacher should give instruction to the geometric locus and the regions represented by inequalities in simple cases.

(3) As regards the item indicated in content (2)-b-(ii), the teacher should give instruction to the simultaneous equations with two variables of first and second degree.

(4) As for the content (3), the teacher should give instruction to the level of functions of third degree.

(5) As for the content (3)-c, the instruction should be limited to the level of finding areas in relation to graphs of functions.

III. Mathematics III

1. Objectives

To help students deepen their understanding of functions and limits, differential and integral calculus, and to encourage them to master knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Functions and Limits

a. Concept of function

(i) rational functions and irrational functions

(ii) composite functions and inverse functions

b. Limits

(i) limits of sequences $\{r^n\}$

(ii) sum of infinite geometrical series

(iii) limits of value of functions

【Terms/Symbols】 convergent, divergent, ∞

(2) Differential Calculus

a. Derivatives

(i) derivatives of sum, difference, product and quotient of functions

(ii) derivatives of composite functions

(iii) derivatives of trigonometric function, exponential function and logarithmic function

b. Applications of derivatives

tangent, increase and decrease of values of function, velocity, acceleration

【Terms/Symbols】 radian measure, natural logarithm, e, the second derivative, point of inflection

(3) Integral Calculus

a. Indefinite integral and definite integral

(i) meaning of integration

(ii) integrations by substitution and by part in simple cases

(iii) integrations of various functions

b. Applications of integration

area, volume and distance

3. Remarks concerning Content

(1) As for the content (1)-a-(i), functions such as $y=\frac{ax+b}{cx+d}$ and $y=\sqrt{ax+b}$ should be included.

(2) As regards the item indicated in content (2), though the mean value theorem may be allude, the instrnction should be limited to the level of understanding it intuitively.

(3) As for the content (2)-a-(ii), simple functions such as $y=x^k$(k is rational number), $y=\sqrt{ax+b}$ and $y=\sqrt{ax^2+b}$ should be included.

(4) As for the content (3)-a-(ii), integration by substitution should be limited such a level as substitution by $ax+b=t$ or $x=a\sin\theta$. Integration by part should be limited to those cases where only a single application is required concerning simple functions.

IV. Mathematics A

1. Objectives

As a broader content than "Mathematics I", to help students understand numbers and algebraic expressions, plane geometry, sequences or computation using computers, to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Numbers and Algebraic Expressions

a. Numbers

integers, rational numbers, real numbers

b. Algebraic Expressions

(i) polynomials

(ii) equalities and inequalities

(2) Plane Geometry

a. Properties of plane geometrical figures

(i) fundamental theorem of plane geometry

(ii) figures determined by conditions

b. Transformation on plane

(i) congruence transformation

(ii) similar transformation

(3) Sequences

a. Sequences and their summations

b. Recurring formula and mathematical induction

c. Binomial theorem

【Terms/Symbols】 Σ

(4) Computation and Computer

a: Operation of computer

b. Flow chart and programing

c. Calculation using computer

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subject, instruction should consist of sections appropriately chosen from content (1) to (4).

(2) As regards the item indicated in content (1)-b, the teacher should give instruction to the proof in algebraic expressions in simple cases.

(3) As regards the item indicated in content (1), content such as necessary condition, sufficient condition, contraposition and reductive absurdity should be included.

(4) As for the content (2)-a, the teaching should be at such a level as to develop their abilities to utilize what students have learned in lower secondary school by basing on and expanding them. As for the content (2)-b, teaching should be limited to the level of reviewing properties of geometrical figures by idea of transformation.

(5) As for the content (3)-a, the teachers should treat it to the level of arithmetic and geometric sequences, and sequences of $\{n^2\}$. As for the content (3)-b, recurring formulae should be limited to those for successive two terms, and the mathematical induction should be taught by putting emphasis on their understanding of its idea, without getting mixed up in its technical detail.

(6) As for the content (4)-b, the teachers should put their emphasis on helping students' understanding of structure of programing, but only short programs should be treated. As for the content (4)-c, use of computer should be at the level of using it for processing those computations which are concerning what students have learned in lower secondary level or "Mathematics I "

V. Mathematics B

1. Objectives

As more advanced content than "Mathematics I" and "Mathematics II", to help students understand vectors, complex numbers and complex number plane, probability distribution, or algorithm using computer, and to encourage them to master basic knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Vectors

a. Vectors on a plane

(i) vectors and their operations

(ii) inner product of vectors

b. Vectors in a space

(i) coordinate in space

(ii) vectors in space

(2) Complex Numbers and Complex Number Plane

a. Complex numbers and solutions of equation

(i) complex numbers and their operations

(ii) solutions of quadratic equation

(iii) simple equation of higher degree

b. Complex number plane

(i) geometric representation of complex number

(ii) De Moivre's theorem

【Terms/Symbols】 imaginary number, i, discriminant, argument, polar form

(3) Probability Distribution

a. Calculation of probability

b. Probability distribution

(i) random variable and probability distribution

(ii) binomial distribution

【Terms/Symbols】 conditional probability, mean, standard deviation

(4) Algorithm and Computer

a. Function of computer

b. Program of various algorithms

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subject, instruction should consist of sections appropriately chosen from content (1) to (4).

(2) As for the content (1)-b-(ii), the teacher should emphasize students' understanding that vectors in a space may be analogeously dealt with vectors on a plane, and should not get mixed up in detail of the equations of solid figures.

(3) As for the content (2)-a-(iii), teaching should be restricted to such level that students understand application of factor theorem to the equations of third order and fourth order with simple coefficient. As for the content (2)-b, teaching should be restricted to applications to simple binomial equations and to plane figures, and not get mixed up in its technical detail.

(4) As for the content (3)-a, calculation of probability should be restricted to the level of conditional probability, following to the content in "Mathematics I".

(5) As for the content (4)-b, programing should be restricted to the level of Euclidean algorithm and calculation of root by iteration.

VI. Mathematics C

1. Objectives

Through using computers from the viewpoint of applied mathematical science, to help students understand matrix and linear computation, various curves, numerical computation or statistics, and to encourage them to master knowledge and skills, and to develop their abilities to think and cope with mathematically in dealing with various phenomena.

2. Content

(1) Matrix and Linear Computation

a. Matrix

(i) matrices and their operations

sum, difference, multiplication by scalar

(ii) product of matrices and inverse matrix

b. Simultaneous linear equations

(i) representation by matrix

(ii) method of solution by elimination

【Terms/Symbols】 A^{-1}

(2) Various Curves

a. Algebraic expressions and geometrical figures

(i) curve represented by equation

(ii) ellipse and hyperbola

b. Parametric representation and polar coordinate

(i) parametric representation and polar coordinate

(ii) polar coordinate and polar equation

(iii) various curves

【Terms/Symbols】 focus, directrix

(3) Numerical Computation

a. Approximate solution of equation

b. Numerical integration

(i) mensuration by parts

(ii) approximate computation of area

(4) Statistics

a. Arrangement of statistical data

(i) representative values and measures of dispersion

(ii) correlation

b. Statistical inference

(i) population and sample

(ii) normal distribution

(iii) ideas of statistical inference

【Terms/Symbols】variance, standard deviation, coefficient of correlation, estimation

3. Remarks concerning Content

(1) In accord with the actual state of students taking this subjects, the teaching should consist of sections appropriately chosen from content (1) to (4)

(2) As for the content (1)-a, 3×3 matrices should be taught. However, regarding computing to inverse matrices, the extent should be limited to 2×2 matrices.

(3) As for the content (2), the teacher should help students observe and consider various curves by making use of computers and others, and become able to actually draw simple geometrical figures.

(4) As for the content (3)-a, the extent should be limited to the Newton's method or method of bisection. Furthermore, in relation to this, though it may be possible to

allude to approximate expressions, error and significant figures etc., only simple cases should be dealt with through actual examples in such teaching.

(5) As for the content (4)-b, the teacher should not go too far to the theoretical consideration.

【III】 THE CONSTRUCTION OF TEACHING PLANS AND REMARK CONCERNING CONTENT IN EACH SUBJECT

1. In designing teaching plans, the following points should be taken into consideration.

(1) When students take "Mathematics II" and "Mathematics III", they should follow the order of "Mathematics I", "Mathematics II" and "Mathematics III".

(2) "Mathematics A" should be taken in parallel with "Mathematics I" or following to "Mathematics I", and "Mathematics B" and "Mathematics C" should be taken following to "Mathematics I".

(3) In case where some of "mathematics" are taken in parallel, the teacher should devise a close mutual relation among content of each "mathematics" and pay attention to the systematic nature of the learning content.

2. In teaching the content shown in 【II】, the follwing points should be considered.

(1) Terms and symbols listed under the content of each subject are shown for the purposes of clarifying the extent and range which are to be treated in the subject. In the teaching of subject, it is necessary to relate these terms and symbols with the content of the subject.

(2) The teacher should make active use of educational media such as computers, so as to improve the effectiveness of teaching.

(3) In the teaching of computation, the teacher should have students use hand-held calculators and computers as an occasion demands, so as to improve the effectiveness of learning.

SCIENCE MATHEMATICS COURSE

1. The Science Mathematics Course is one of the Specialized Courses in the Upper Secondary School System which provides a curriculum based on the objectives mentioned below, and contains the following two subjects concerning mathematics:

   Mathematics I, Mathematics II,

   and

   Physics, Chemistry, Biology, Earth Science.

2. Credits given for completion of these courses are to be decided by each school authority.

SCIENCE MATHEMATICS

[I] OBJECTIVES OF THE COURSE

To help students deepen their systematic understanding of the fundamental concepts, principles and laws of natural science and mathematics through processes of investigating natural phenomena, and to foster their abilities and attitudes to think and cope with scientifically and mathematically.

[II] SUBJECTS OF THE COURSE

I. Mathematics I in the Course

1. Objectives of the Subject

Through students' formation of fundamental concepts of mathematics and their systematic understanding of principles and rules of mathematics, to help students appreciate mathematical way of viewing and thinking and to encourage them to master basic knowledge and skills, and to develop their abilities to utilize them exactly.

2. Content of the Subject

(1) Mathematics and Computer

(2) Treatment of Numbers of Cases and Probability

(3) Plane Geometry

(4) Geometrical Figures and Mensuration

(5) Algebraic Expressions and Functions

(6) Sequences

3. Remarks concerning Content of the Subject

(1) As for the content (1) to (6), the teacher should refer to "Content" and "Remarks concerning Content" in "Mathematics I" and "Mathematics A" and give instruction by developing or expanding the content of those subjects, as an occasion demands.

(2) As for the content (1), the teacher should give instruction to it by adding the content (4) in "Mathematics B".

(3) As for the content (5), the teacher should give instruction to computation of fractional expressions and simple fractional functions, and as regards this, the teacher should give instruction to solving simple equations and inequalities within the real number system.

(4) As for the content (6), the teacher should give instruction to the content (1)-b-(i) and -(ii) in "Mathematics III".

II. Mathematics II in the Course

1. Objectives of the Subject

To help students form concepts in each area of algebra•geometry, analysis and probability•statistics, deepen their understanding of principles and improve their abilities to express mathematically and to think logically, and to foster their inquisitive attitude and creative ability in considering phenomena.

2. Content of the Subject

A. Algebra • Geometry

(1) Curves and their Representation

(2) Vectors

(3) Complex Numbers and Complex Number Plane

(4) Matrix and Linear Computation

B. Analysis

(1) Various Functions

(2) Differential Calculus and its Applications

(3) Integral Calculus and its Applications

(4) Numerical Computation

C. Probability • Statistics

(1) Probability Distribution

(2) Statistical Processing

D. Project Study

3. Remarks conerning Content of the Subject

(1) As for the content A, B and C, the teacher should refer to "Content" and "Remarks concerning Content" in "Mathematics II", "Mathematics III", "Mathematics B" and "Mathematics C" and give instruction by developing or expanding the content of those subjects, as an occasion demands.

(2) As for the content B-(1), the teacher should give instruction to idea of inverse function, simple irrational functions and inverse trigonometric functions.

(3) As for the content B-(3), the teacher should give instruction to the meaning and solution method of such simple differential equations as $\frac{dy}{dx}=ky$ (k is a constant).

(4) As for the content D, the teacher should suitably set up project themes that were developed or expanded from the content A, B and C, and give consideration to use such appropriate methods in teaching as lectures, reading studies and exercises.

[Physics, Chemistry, Biology and Earth Science are omitted.]

[III] THE CONSTRUCTION OF TEACHING PLANS AND REMARKS CONCERNING CONTENT IN EACH SUBJECT

1. In designing teaching plans, the following points should be taken into consideration.

(1) "Mathematics II in the Course" should be taken following to "Mathematics I in the Course".

(2) In teaching "Mathematics I in the Course" and "Mathematics II in the Course", the teacher should make active use of computers so as to deepen students' visual understanding of mathematical · scientific phenomena and their recognition of rules through many computational trials.

【Points following these two are omitted, since those points have no relation with mathematics.】

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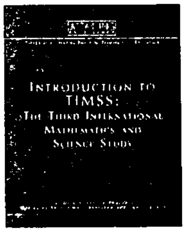

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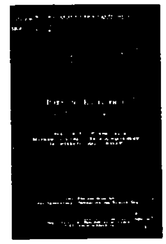

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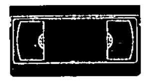

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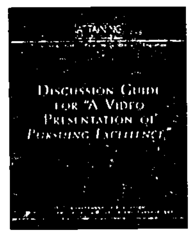

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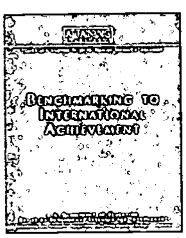

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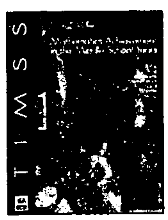

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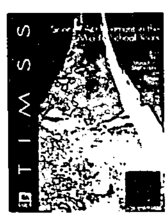

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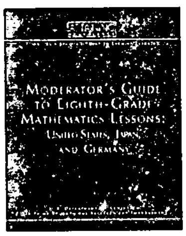

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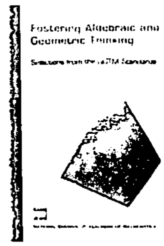

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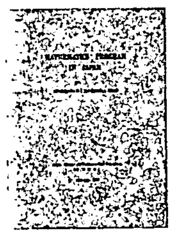

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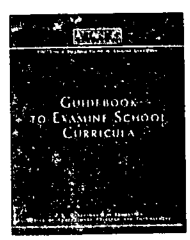
Guidebook to Examine School Curricula—A guidebook for use by school and district educators to evaluate and analyze curricula. It includes an overview of curriculum reform, a guide to using the module, the TIMSS curriculum analysis methodology, and other models for analyzing curricula from several sources: the National Science Foundation, the American Association for the Advancement of Science's Project 2061, the State of California, and the Council of Chief State School Officers. The executive summary of the TIMSS report on mathematics and science curricula, *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, and an annotated bibliography are included. (Not sold separately.)



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The kit—based on the world's largest, most comprehensive, and most rigorous international comparison of mathematics and science education—will help state and local policymakers, educators, and citizens compare their education systems with those of other countries. This represents the most comprehensive effort to date by the U.S. Department of Education to assemble significant research findings and present them in a format that can be used by educators for discussion.

TIMSS was funded by the National Center for Education Statistics of the U.S. Department of Education and the National Science Foundation. The study tested the mathematics and science knowledge of students in 41 countries during the 1995 school year.

To order *Attaining Excellence: A TIMSS Resource Kit*, contact the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250-7954; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: orders@gpo.gov; World Wide Web: http://www.access.gpo.gov/su_docs. Also may be downloaded from: http://www.ed.gov/NCES/timss

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William Schmidt

The *Guidebook to Examine School Curricula* is based on years of effort at the national, state, and local levels. The groundbreaking work done by the National Science Foundation to create high-quality mathematics and science materials, along with the efforts of hundreds of teachers to test not only those materials but also ways to evaluate the material, form the core of this module.

We relied on the work of the Expert Panel on Mathematics and Science Education sponsored by our colleagues in the Office of Reform Assistance and Dissemination to provide a first look at curriculum analysis methodologies linked to standards and frameworks. Their work in identifying analysis methods linked to standards and frameworks made this module possible.

The members of the working team for this module were Janice Earle of the National Science Foundation, Jo Ellen Roseman of the American Association for the Advancement of Science, Barbara Kapinus and Rolf Blank of the Council of Chief State School Officers, and Patricia O'Connell Ross and Margaret E. McNeely of the Office of Educational Research and Improvement. Lois Peak and Eugene Owen of the National Center for Education Statistics guided our efforts to look closely and accurately at the TIMSS findings. Cynthia Hearn Dorfman and colleagues in Media and Information Services guided the production of the *Guidebook*. Rima Azzam and staff at the Pelavin Research Institute and the Education Statistics Services Institute, Ruth Chacon and staff at The Widmeyer-Baker Group, and Axis Communications managed the editing and design of this *Guidebook*. All contributed their valuable time and effort, beyond their already burdened schedules, to make this module better and more useful.

Contents

Overview of Curriculum Analysis

Of the many lessons we can learn from the Third International Mathematics and Science Study (TIMSS), one of the most compelling is the variation in what is taught to and expected of students. Mathematics and science curriculum standards, frameworks, and instructional materials are quite different in the countries participating in TIMSS. The conventional wisdom holds that mathematics and science are subjects without national boundaries. However, TIMSS shows the differences in how mathematics is taught and the disparities in expectations for students.

The TIMSS curriculum study, which is discussed in greater detail later in this *Guidebook*, analyzed the scope and sequence of mathematics and science frameworks, standards, and textbooks at every grade level tested in the participating countries. The variation is startling, especially at the middle to high school years. In addition to the international perspective, an in-depth analysis was done for the United States. The report on the United States, titled *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education* and summarized at the end of this volume, states, "[S]plintered visions produce unfocused curricula and textbooks that fail to define clearly what is intended to be taught." (Schmidt 1996)

The relationship between curriculum offerings and student achievement will be studied as more of the TIMSS data are released. The comparisons that can be made now among the findings of the curriculum study, the teacher questionnaires, the teacher video study, and the achievement tests lead to the following insights about the curricula offered to our nation's students:

- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries.
- Topic coverage is not as focused in U.S. eighth-grade mathematics classes as in the classrooms of other countries. (National Center for Education Statistics 1996)

While the TIMSS studies do not yet draw a conclusive link between curriculum and achievement, they reinforce what researchers, policymakers, and teachers have long believed about the variable quality and lack of coherence in U.S. mathematics and science curricula.

Analyzing Frameworks and Textbooks

How decisions are made to purchase materials and the criteria used to select one set over another have a major impact on what students are expected to learn and what teachers teach over many years. While some school districts may use a thoughtful approach to match curricular aims and goals to instructional materials and textbook series, far too many have neither the resources nor the time to make deliberative decisions. The selection of a textbook, or any kind of instructional material, needs to be based on a clear set of instructional principles and learning goals. Without an in-depth analytic review, there is no way of knowing whether the material will actually help students learn what is expected.

In school year 1993-1994, almost $5.5 billion was spent on instructional materials by public schools in the United States. The decisions on what to purchase were probably made by curriculum committees comprising teachers, administrators, central office personnel, and community members. In some states, selections were made from a list of materials approved by a state-level agency or commission. Most states, however, leave these decisions to local decision-making bodies who select from the broad marketplace.

We know from TIMSS and other research the importance of aligning all aspects of the education process to ensure that students are provided with the best opportunities to achieve to high standards and meet high expectations. The interactions among instructional materials, pedagogy, assessment, teacher preparation, school capacity, and expectations determine what and how much students learn.

A school's curriculum is made up of many different parts. It includes textbooks, workbooks, independent assignments, teacher-developed materials, and state and district frameworks. The most common and recognizable piece, however, is the textbook. While there is much debate over how much control textbooks have over instruction, we do know that they focus the instructional scope and sequence for most teachers and students.

Most school districts also have curriculum guides or frameworks that articulate expectations for what is taught. Recently, many districts also have developed standards aligned with state standards or modeled after those developed by professional organizations and groups, such as the National Council of Teachers of Mathematics, the American Association for the Advancement of Science's Project 2061, and the National Research Council's

National Science Education Standards (NSES). These documents add another level of expectations, yet textbooks and other instructional materials are rarely aligned with them.

Given the variety of documents, each articulating its own view of mathematics and science curricula, a systematic approach to analysis becomes even more important.

Using the Guidebook

This *Guidebook* sets forth five different methods of analyzing curricula. It is designed to be used primarily by teachers, curriculum supervisors, and administrators, and may also be used by parents, students, and community members as they select materials to use in classrooms. The analytic methods are as follows:

- TIMSS Curriculum and Textbook Analysis,
- National Science Foundation (NSF) Instructional Materials and Review Process,
- American Association for the Advancement of Science's (AAAS) Project 2061 Curriculum-Analysis Procedure,
- California Department of Education Instructional Resources Evaluation, and
- Council of Chief State School Officers (CCSSO) State Curriculum Frameworks and Standards Map.

These five methods were selected for inclusion in the *Guidebook* because each of them is tied to a framework and/or set of standards. This alignment was an important criterion for inclusion in the *Guidebook.* The methods selected vary in their depth of analysis, the time and resources necessary, their potential uses, and the type of information and conclusions that can be gleaned from each. All of the methods pay particular attention to how instructional materials address the needs of diverse learners, including students with disabilities and second-language learners.

Selecting a Method of Analysis

The section **Guide to Using the Methods of Analysis** includes more information on suggested ways of using each method and brief profiles that will help you select the most appropriate method(s) for your purposes. The following questions may help you evaluate each of the analytic methods:

- Will the results of this analysis be used to select new instructional materials or assessments, evaluate the scope and sequence of current materials, and/or determine the alignment between state frameworks and instructional materials?
- Will the evaluation be done by teachers or broad-based community groups?
- Will the results be used by curriculum committees, members of the public, and/or administrators?

It needs to be noted that this *Guidebook* does not examine the role of teachers and the efficacy of different instructional practices. While most of the methods of analysis do include pedagogy and ease of use as aspects to be examined, the focus is not on teaching per se. The capacity of the school system, including teachers' instructional approaches and professional preparation, influences how instructional materials come alive in the classroom.

Regardless of which analytic methods are used, every school or district needs to ask itself what students are expected to know, when they are expected to know it, and what materials are used. The TIMSS results have shown that U.S. curricula are generally not as rigorous as those in Germany and Japan. All eighth graders in these countries spend most of the year studying algebra and geometry, while most U.S. students study these subjects later. Only by looking deeply and systematically at what is expected and taught will we be able to raise student achievement.

Reviewing curricula as a whole needs to be part of every school's decision-making portfolio. These procedures inform important decisions that are made regularly in schools throughout the country.

Guide to Using the Methods of Analysis

Purpose

The purpose of this *Guidebook* is to present different ways of analyzing instructional materials for mathematics and science, including curricula, curriculum frameworks, textbooks, instructional modules, classroom activities, or teachers' guides. Each of these methods of analysis provides different sets of information about instructional materials, ranging from descriptions and analyses of content and structure, to evaluations of their potential for leading to specific learning goals. Thus, whether you are designing, reviewing, or selecting materials, some components of this module are relevant.

Uses of the Analysis Methods

As you develop, review, or select your instructional materials, there are several ways you might use these different methods:

- **As a general reference**—Each of these methods emphasizes certain qualities, such as balance of topics, student skills and behaviors encouraged, or connection to specific curriculum frameworks. These qualities should be kept in mind as you conduct your own curriculum development and review processes.
- **Adapted to local needs**—These methods have two components, a methodology (process of analyzing curriculum materials) and a frame of reference (frameworks or standards to which they are compared). Even if you have a different frame of reference (such as your own state's curriculum framework), you will be able to adapt the methodology to your own needs.
- **As presented**—If the frame of reference is relevant to your needs, you may wish to use a particular method as presented. In some cases, the material included in this *Guidebook* is sufficient for you to conduct the analysis yourself, while in other cases you may need additional resources or assistance from an outside organization.

The methods of analysis in this *Guidebook* examine instructional materials before they are put into use by schools and teachers. They examine the content and quality of the materials as a set of documents that articulate a course of study and an instructional approach. In fact, the primary goal of one of the methods, the AAAS Project 2061 Curriculum-Analysis Procedure, is to judge the materials in terms of the likelihood that they would contribute to the attainment of specific learning goals. If questions of implementation and impact are also among your concerns, you should consider additional, more direct methods of assessing these factors.

As you decide which methods to use, you must be sure that they are appropriate to your needs. Individual methods examine particular aspects of instructional materials. For example, the TIMSS Curriculum and Textbook Analysis looks at the topics to be presented but does not examine the accuracy of the material. The CCSSO Curriculum Frameworks and Standards Map looks at broad frameworks and standards but not at instructional materials.

Each of the analytic models should be reviewed carefully before any decisions are made to use one instead of another. Each reflects a different perspective on curriculum materials, requires different amounts of time to complete, and may require training or additional assistance.

Guide to Contents

This section provides a matrix of the five analytic methods presented in this *Guidebook* and a brief description of each. The brief descriptions answer key questions about each method and should be used as an overview and to compare the methods.

The section **TIMSS Curriculum and Textbook Analysis** includes a background and overview of the process and how it was used.

The **Other Curriculum-Analysis Methods** section presents four additional methods of analysis for examining instructional materials:

NSF Review of Instructional Materials—Developed by the National Science Foundation to review its funded comprehensive middle-school science and mathematics projects.

AAAS Project 2061 Curriculum-Analysis Procedure—Developed by Project 2061 at the American Association for the Advancement of Science for reviewing a variety of prepared curriculum materials.

California Instructional Resources Evaluation—Developed by the California Department of Education for its Instructional Resources Adoption Process.

CCSSO Curriculum Frameworks and Standards Analysis—Developed by the Council of Chief State School Officers to describe state mathematics and science standards and curriculum frameworks.

For each method of analysis, the *Guidebook* contains background information, a description of the analysis process, and, in some cases, forms or other instruments for conducting the analysis. There is also an overview for each method of analysis that summarizes it in terms of several key questions. The methods of analysis are outlined in the matrix that follows on page 9.

KEY MATRIX AND OVERVIEW HEADINGS INCLUDE:

- **What issues does it address?** Not all of the methods look at the same issues or answer the same questions. Some of the methods review only content and seek to answer fairly focused questions, such as "Which curriculum topics are addressed, and how much attention is devoted to each?" Others are more in depth, looking at issues of pedagogical approach and answering such questions as "Is this material acceptable for use?"
- **What materials does it examine?** Some methods are designed to look only at topics and subtopics to be addressed. Others look at textbooks and teachers' guides, which, in addition to an outline of topics, provide student activities and instructional strategies. Some are designed to look at any of these individually or as sets.
- **What is the frame of reference?** All methods involve comparisons to a particular framework or set of standards for mathematics and science, such as a state framework or the National Council of Teachers of Mathematics' (NCTM) *Curriculum and Evaluation Standards for School Mathematics,* the *National Science Education Standards (NSES),* or the *Benchmarks for Science Literacy* from the AAAS Project 2061. Although you may base your curriculum on another framework, the method of analysis will still prove useful.

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- **What is the analysis process?** Most methods involve the use of review forms or protocols. The processes differ, however, in the level of detail at which materials must be examined and whether they require teams of reviewers.
- **What resources does this type of analysis require?** The process of materials analysis may be a major undertaking, requiring large amounts of staff time and special funds. In some cases, the people performing the analysis should possess particular backgrounds, such as in teaching science, or familiarity with a particular framework. Also, using a specific method may require the purchase of additional resources, such as training materials, guidebooks, or evaluation forms.
- **Does this analysis require outside assistance or special training?** To use some of the methods, it may be necessary to send materials to an outside organization for analysis or to consult with the developers. In some cases, special training for using the method is available.
- **What are the potential uses at the local level?** Each of the methods will provide different types of information and assist the user in drawing different types of conclusions.
- **Contact information.** The people listed are available to answer more detailed questions about the methods and about using them in your school or district.

Overview of Methods of Analysis

	TIMSS Curriculum and Textbook Analysis	NSF Instructional Materials Review Process	AAAS Project 2061	California Instructional Resources Evaluation	CCSSO Frameworks Map
Issues Addressed	Topics covered, total number of topics, sequencing, comparison to international benchmarks, performance expectations	Alignment with *National Science Education Standards (NSES)* and NCTM standards, content quality, pedagogical design, assessment methods, support for implementation, equity	Alignment of content coverage with *Benchmarks for Science Literacy*, *NSES*, NCTM standards, or similar learning goals; effectiveness of instructional strategies aimed at learning goals	Content, organization and structure, work required of students, attention to student diversity, integration of assessment and instruction, support for teachers	Development of standards, content, pedagogy, materials, and assessment policies
Materials Examined	Curriculum guides, textbooks	Sets of instructional materials (e.g., teachers' guides, student books, multimedia material)	Instructional materials, including textbooks and teachers' guides	Textbooks, other instructional resources	Curriculum frameworks, content standards
Frame of Reference	TIMSS Curriculum Frameworks, profiles of other countries	*NSES* and NCTM standards	*Benchmarks for Science Literacy*; national standards in science, mathematics, and technology	California State Frameworks	Set of elements developed by CCSSO expert panel
Process	Classify each topic and subtopic, analyze distribution	Review teams rate using specified criteria and forms	Review teams evaluate using specified learning goals and sets of criteria	Review teams rate using specified criteria and forms	Categorize and codify
Resources Needed	Fee determined by extent of analysis	Five working days for each team member (4-5 people per team)	At least 2 people per material, 3 to 5 days of training, several days per unit, various materials (see Project 2061 section)	Five working days for each team member (4 to 5 people per team)	Two staff members per document
Outside Assistance	Analysis conducted by U.S. TIMSS staff	Available through NSF	Customized training programs available through Project 2061	Consultation with framework experts recommended	Available through CCSSO

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Overview of TIMSS Curriculum and Textbook Analysis

Background

The TIMSS project provides a comprehensive look at mathematics and science education in different countries. It focuses on three areas: intended curricula (what is supposed to be taught), implemented curricula (what is actually taught and how), and achieved curricula (what is learned). The curriculum and textbook analysis process presented in this module was designed to address the first and second areas, intended curricula and implemented curricula. TIMSS researchers used this process to compare curriculum documents across almost 50 countries. Prior to TIMSS, international comparisons of curricula relied primarily on the opinions of experts. The TIMSS curriculum and textbook analysis provides a systematic method of analyzing and comparing original curriculum documents using an international framework. It should be emphasized that it is an analytic tool, meaning that it does not make judgments regarding what is good or bad, but rather seeks to illustrate the similarities and differences between mathematics and science curricula in different countries.

What issues does it address?

Breadth and depth of content (topics, e.g., relationships of common decimal fractions) and performance expectations (thinking skills, e.g., formulating and clarifying problems and situations). Within a grade, it can help you determine whether you are covering many topics, but with brief attention to each, or if your curriculum is more focused, and whether the performance expectations are balanced. You can also see how the sets of topics and performance expectations change from grade to grade. You can compare your curriculum "profile" to those of schools in other countries.

What materials does it examine?

Curriculum guides and textbooks.

What is the frame of reference?

The TIMSS Curriculum Framework and curriculum profiles of other countries.

What is the analysis process?

Items in the materials to be examined are placed into frameworks of categories and subcategories of content topics and performance expectations. The results are then analyzed to show which topics and performance expectations are addressed, under which broad areas they fall, the amount of time devoted to each, and the total number of topics and performance expectations.

What are the potential uses at the local level?

Although the analysis methods presented here were developed to compare curricula across countries, they have several potential uses for local schools and districts, for example:

- **Benchmarking to a country involved in the TIMSS study, a group of countries, or an international composite.** This is useful to schools, districts, and communities interested in knowing how their curricula compare with those of a country, or set of countries, with high levels of student mathematics and science achievement, or with countries they see as having high standards.
- **Comparisons of topic coverage profiles with local goals and priorities.** While the TIMSS analysis did not make judgments about whether a curriculum was good or bad, these may be the types of judgments schools and districts would like to make. With a TIMSS-style profile of topic coverage and performance expectations, schools and districts can determine where there are undesirable gaps/overlaps in their science and mathematics curricula across grade levels. The results would help them see if they have too many topics at a given grade level and if they are not giving enough attention to a particular topic.
- **Substitution of another framework for the TIMSS framework.** Schools and districts may use similar methods of Topic Trace Mapping and Document Analysis, but with a different curriculum framework, such as a state framework or the *NSES* or NCTM standards. Only when the TIMSS framework is used, however, can districts compare themselves to other countries or international benchmarks.

Does this analysis require outside assistance or special training?

Performing this analysis as was done for the TIMSS project requires the assistance of the TIMSS staff at Michigan State University. Contact information is provided below.

What resources does this type of analysis require?

The TIMSS staff charges a fee for conducting the analysis. The fee depends on the extent of analysis, including such variables as district or school size, number of textbooks, and curriculum documents to be analyzed.

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Overview of National Science Foundation Review of Instructional Materials for Middle School Science and Mathematics and Framework for Review: Instructional Materials for Middle School Mathematics

Background

In 1996, the National Science Foundation (NSF) undertook a study of comprehensive (at least one year) instructional materials for science in the NSF portfolio encompassing the middle-school years. This middle-school review was the first effort to examine a range of projects for a particular set of grades.

The major goals of NSF are to (1) provide the field with high-quality instructional materials that incorporate the best research on teaching and learning; (2) include accurate science and the active participation of scientists in the development process; and (3) have undergone an extensive pilot and field-test process. Support of such materials enables teachers, schools, and districts to have access to materials that provide students with experiences that lead to an understanding and mastery of scientific concepts and processes.

What issues does it address?

Alignment of materials with *NSES* and NCTM standards. Criteria include accuracy of the material presented, coverage of topics, pedagogical design (e.g., Do the materials provide for conceptual growth? How do they engage students?), assessment methods, support for implementation (e.g., Do the materials provide information on available resources and necessary support structures?), and equity (e.g., Are the materials likely to be interesting, engaging, and effective for underrepresented and underserved students?).

What materials does it examine?

Comprehensive sets of instructional materials—for example, a coordinated package of student books, hands-on materials, multimedia materials, assessments, and a teacher's guide designed to cover one or more years of instruction.

What is the frame of reference?

The *NSES* and NCTM standards.

What is the analysis process?

Teams of practicing scientists or mathematicians, educators, and assessment and implementation specialists review materials using a common review framework (included in this module). Team members assigned with specific portions of the materials review them individually, assign scores using the forms, and then meet to discuss their individual evaluations and develop a consensus assessment.

What are the potential uses at the local level?

The analytic method developed by NSF reflects three recognized dimensions of good instructional materials:

- **Alignment with *National Science Education Standards* or National Council of Teachers of Mathematics Standards.** This is useful to schools as they examine the coherence and alignment of their curricula with recognized national standards. Where local standards and frameworks are unique, schools and districts may wish to use the NSF review process but link it to their own standards. It provides valuable information on the rigor of their curricula and instructional materials.
- **Sound pedagogical design and logical development of conceptual understanding.** The NSF model asks evaluative questions that relate content and design and focuses on whether instructional materials reflect conceptual growth and provide students with opportunities to gain a better understanding of the information.
- **Provision for ongoing student assessment.** Materials that embed assessments within the instructional approach provide both students and teachers with a better picture of how well students are learning.

Does this analysis require outside assistance or special training?

Training is highly recommended to familiarize participants with the process and review criteria.

What resources does this type of analysis require?

For each team member involved, approximately five working days, broken down as follows:

1 day Team training

2 days Individual review of materials (can be spread over a longer period of time)

2 days Team discussion of individual reviews and consensus assessment

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OVERVIEW OF AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS) PROJECT 2061 CURRICULUM-ANALYSIS PROCEDURE

Background

With the growing consensus on what all students should know and be able to do in science, mathematics, and technology, educators now need a reliable method for identifying curriculum materials that will help students achieve those learning goals. Working with hundreds of K-12 teachers, materials developers, cognitive researchers, and scientists, Project 2061 has developed a systematic procedure for analyzing curriculum materials for alignment to specific learning goals. This procedure was created under a grant from the National Science Foundation and has been tested under field conditions by teachers at six sites around the country.

What issues does it address?

The Project 2061 Curriculum-Analysis Procedure focuses on three central concerns: What content does the curriculum material target? How well does that content align with specific learning goals such as benchmarks or standards? Does the material provide appropriate instructional strategies to help students learn the intended content? Project 2061's procedure offers a systematic approach to answering these questions.

The Project 2061 procedure identifies which specific learning goals the content of the material addresses, and estimates the effectiveness of its explicit instructional approaches for those specific learning goals. This is in contrast to procedures that make separate judgments about general topic coverage and general instructional quality.

What materials does it examine?

K-12 curriculum materials—ranging from short units to multiyear programs, including textbooks and their accompanying teachers' guides—that deal with the natural and social sciences, mathematics, and technology.

What is the frame of reference?

Project 2061's *Benchmarks for Science Literacy*, the National Research Council's *National Science Education Standards,* the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics,* and, when they become available, ITEA Standards (*Technology for All Americans*). States can use their own frameworks or standards as the frame of reference, provided the learning goals are specific.

What is the analysis process?

Working as a team, reviewers first identify a sample of plausible specific learning goals against which to compare curriculum material. Next, they apply sets of analytical criteria to judge how well the material is aligned to the learning goals. This includes judgments about (1) how well the material's content matches the *specific* learning goals and (2) the extent to which the material's instructional strategy promotes student learning of the content. In a final report, reviewers summarize their findings, develop profiles for the materials, and present their conclusions.

What are the potential uses at the local level?

The AAAS Project 2061 Curriculum-Analysis Procedure provides districts/schools with a standards-based approach to evaluating instructional materials. For example, a school or district can use the procedure to consider the following:

- **Appropriateness of the content.** When selecting new materials or examining current offerings, a district will want to evaluate the extent to which textbooks and other curriculum materials are consistent with national, state, or local standards/frameworks and in line with learning goals for students at specific grade levels.
- **Utility of the instructional design.** Paying attention to the underlying instructional strategy of curriculum materials will help the district or school decide whether the materials will help students meet its expectations.

Does this analysis require outside assistance or special training?

Depending on audience and purpose, at least three to five days of training are recommended, which includes practice analyzing actual materials. Some groups might want additional time to familiarize themselves with *Bench-*

marks for Science Literacy or other standards documents to which they want materials to align. Project 2061 will publish a training manual in 1998 ("Resources for Science Literacy: Curriculum Evaluation") as part of a CD-ROM/ print tool, which will provide step-by-step instructions for the procedure, along with case studies of analyzed materials. In the meantime, interested educators can contact Project 2061 for information about training opportunities.

What resources does this type of analysis require?

Personnel—At least two individuals should review the material independently so that they can compare and reconcile results. The number of reviewers required naturally depends on the magnitude and scope of what is being reviewed. For looking at units, two individuals might suffice, but for looking at larger curriculum components, across grades or disciplines, teams that collectively have the necessary subject-matter and grade-level expertise are needed.

Materials—In addition to the curriculum material under consideration, reviewers will need Project 2061's *Resources for Science Literacy: Curriculum Evaluation* (available in 1998). *Resources* will also provide detailed comparisons of *Benchmarks for Science Literacy* and national standards in science, mathematics, and technology. Reviewers will also need copies of *Benchmarks for Science Literacy, Technology for All Americans,* and the relevant set of national (or local) standards against which they want to evaluate materials. Many reviewers will also find *Benchmarks for Science Literacy on Disc* very useful, with its search feature and sample growth-of-understanding maps.

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OVERVIEW OF CALIFORNIA DEPARTMENT OF EDUCATION CURRICULUM FRAMEWORKS AND INSTRUCTIONAL RESOURCES: MATHEMATICS INSTRUCTIONAL MATERIALS EVALUATION INSTRUMENT AND RATING FORM

Background

For use in grades one through eight, the California State Board of Education has the constitutional authority to adopt textbooks, based on their consistency with the State Board's curriculum frameworks. The state's Curriculum Commission recommends and the State Board appoints a panel of individuals to conduct an in-depth review of the textbooks. After reviewing the textbooks, the panel makes recommendations to the Curriculum Commission. This *Guidebook* contains the evaluation form for use by panels when evaluating mathematics textbooks in grades K-8.

What issues does it address?

Alignment of instructional resources with California state standards for mathematics. Criteria for mathematics include: mathematical content, program organization and structure, the work students do, student diversity (how the program deals with diversity in backgrounds, abilities, and interests), integration of assessment and instruction, and support for the teacher.

What materials does it examine?

Designed for textbooks, it can also be used for other instructional resources, such as technology-based resources or manipulative kits.

What is the frame of reference?

Mathematics Frameworks for California Public Schools, Kindergarten Through Grade Twelve.

What is the analysis process?

Panels of reviewers evaluate materials using a common form (included in this *Guidebook*). Team members review materials, assign scores individually using the forms, and then meet to discuss their individual evaluations and develop a consensus assessment.

What are the potential uses at the local level?

The methods developed for the state of California provide a technique for rating different sets of materials with a numeric score. By using this technique, a school or district can:

- **Compare different sets of instructional materials to a scoring rubric.** When examining different textbook series, a school or district will be able to compare and contrast the materials using a standard weighted rubric.
- **Establish different weights for review criteria.** This method of analysis provides weighted criteria across six areas. The relative percentages can be changed to emphasize different perspectives.
- **Substitute another framework.** The areas of emphasis and relative weights were determined by the California mathematics framework. If another framework is used, it should be closely examined and the relative weights aligned to the emphasis of the other framework.

Does this analysis require outside assistance or special training?

Experts on the California frameworks (or on those frameworks used in place of them) should meet with panel members to familiarize them with the frameworks.

What resources does this type of analysis require?

For each team member involved, approximately five working days, broken down as follows:

1 day Team training

3 days Individual review of materials
(can be spread over a longer period of time)

1 day Team discussion of individual reviews and consensus assessment

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Overview of Council of Chief State School Officers (CCSSO) State Curriculum Frameworks and Standards Map: Definitions of Categories and Concepts

Background

The Council of Chief State School Officers (CCSSO) conducted a comprehensive study of the status, characteristics, and quality of state curriculum frameworks and standards in mathematics and science. An initial report in 1995 described the process of development of state frameworks and standards in the 1990s. In 1997, CCSSO released a second report addressing new frameworks and standards completed by the end of 1996, which included a total of 32 states. A key component of the study was a "Conceptual Map of State Frameworks and Standards." The map categorized and described state frameworks and standards documents across 14 concepts or "elements."

What issues does it address?

The findings are intended for use in identifying states (or districts) with specific standards in mathematics and science, in finding information in the documents on how standards can be applied and used with schools, and in providing examples of the different ways states have addressed development of frameworks and standards.

The mapping elements include sources of information; development process; funding; pages; year; number and types of content standards; number and types of benchmarks/indicators; related state documents; communication methods; equity and inclusion; pedagogy; assessment; professional development; and the use of technology, materials, and texts.

What materials does it examine?

Curriculum frameworks, content standards, other state and district guidance on curriculum development.

What is the frame of reference?

A set of elements developed by the CCSSO expert panel, based on national professional standards publications, international frameworks, and a reading of a sample of state frameworks and standards.

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What is the analysis process?

Definitions and categories are specified for each element. Documents are thoroughly read by two trained research staff who code the documents against the analysis categories. Codes, examples, brief descriptions, and state definitions are entered into a database.

What are the potential uses at the local level?

This method of analysis was created to look across frameworks and develop a comprehensive model of state frameworks and standards. At the school or district level, potential uses include:

- **Comparison of local standards/frameworks with state standards.** This is useful to local communities developing their own frameworks or standards for seeing how they compare within their own states or to other neighboring states.
- **Analysis of state standards and frameworks.** A school, district, or consortium of districts may need to analyze the state standards prior to evaluating a set of instructional materials. This will be particularly important if a state assessment is in progress.

Does the analysis require outside assistance or special training?

Training for two to three days is needed. Research staff should have expertise in mathematics and/or science education. For assistance, see contact information.

What resources does this type of analysis require?

The analysis of each state document requires, on average, about three days. This assumes the staff has been trained, has been oriented to the task, and has done a pilot analysis. Two staff analyze the same document, and another staff person monitors any differences in categorization and coding.

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TIMSS Curriculum and Textbook Analysis

Introduction

"International achievement tests tell us what and how well students in the United States have learned compared to students in other countries, but are all U.S. students expected to learn the same things? Are our students expected to learn more or less material than other students, and when are they expected to learn it?"

These are the types of questions the TIMSS curriculum analysis attempted to answer. TIMSS is the third large-scale international study of mathematics and science education conducted by the International Association for the Evaluation of Educational Achievement (IEA). The first two studies focus almost exclusively on comparing student achievement. While the achievement data indicate how students compare to each other on a common examination, they leave unanswered whether all students study the same material or are taught in similar settings with similar techniques. Therefore, TIMSS took a broader look at the factors contributing to achievement, particularly curriculum, instruction, and the environments of students and teachers. One purpose was to shed more light on achievement data, but the study also was designed to provide a much more sophisticated understanding of educational practices. The goal was not to judge which countries had "good" or "bad" curricula and instructional practices, but rather to analyze and compare them.

The TIMSS Curriculum Frameworks

The first step in comparing mathematics and science education across countries was to develop a common, international frame of reference for talking about learning goals. The results are the TIMSS curriculum frameworks for mathematics and science (see Figure 1 on page 29). These frameworks cover all of the years of schooling. They consider three aspects of curricula: (1) content—subject matter topics, (2) performance expectations—what students are expected to do with particular content, and (3) perspectives—overarching themes connecting subject matter to its place among the disciplines and the everyday world. By using this classification

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system, any curriculum component can be described by a "signature" consisting of categories and subcategories from each of the three aspects. Again, the frameworks are not meant to serve as statements regarding what a curriculum *should* include, but to help describe what a curriculum *does* include.

Content

The most immediate questions regarding curriculum center around whether students from different countries are studying similar material and, if not, how the curricula differ. Figure 1 lists the content categories for both mathematics and science. In science, the eight content categories are further divided into 47 subcategories with 66 subordinate subcategories. In mathematics, the 10 categories are further divided into 29 subcategories and 20 subordinate subcategories. The complete content frameworks for mathematics and science can be found in Figures 6 and 7 on pages 35 and 38, respectively. Comparisons using the content frameworks help identify whether students in different countries are expected to study similar material.

Performance Expectations

In addition to the topics covered, TIMSS researchers investigated expectations of what students are to do with the knowledge they acquire. As the framework indicates, performance expectations range from understanding information to applying it in theorizing, problem solving, and investigation. Comparing different curricula to the performance expectations framework can help identify which curricula place greater emphasis on understanding and which tend to emphasize application.

Perspectives

The goal of the perspectives framework is to identify broader goals for teaching mathematics and science than either acquisition of knowledge or development of skills. These goals include developing positive attitudes toward the subject matter and careers in the field. The materials in this module focus primarily upon content and performance expectations.

FIGURE 1. THE TIMSS SCIENCE AND MATHEMATICS CURRICULUM FRAMEWORKS

Science	Mathematics
Content Categories	
1.1 Earth Sciences 1.2 Life Sciences 1.3 Physical Sciences 1.4 Science, Technology, and Mathematics 1.5 History of Science and Technology 1.6 Environmental and Resource issues related to science 1.7 Nature of Science 1.8 Science and other disciplines	1.1 Numbers 1.2 Measurement 1.3 Geometry: Position, Visualization, and Shape 1.4 Geometry: Symmetry, Congruence, and Similarity 1.5 Proportionality 1.6 Functions, Relations, and Equations 1.7 Data Representation, Probability, and Statistics 1.8 Elementary Analysis 1.9 Validation and Structure 1.10 Other content
Performance Expectations Categories	
2.1 Understanding 2.2 Theorizing, analyzing, and solving problems 2.3 Using tools, routine procedures, and science processes 2.4 Investigating the natural world 2.5 Communicating	2.1 Knowing 2.2 Using routine procedures 2.3 Investigating and problem solving 2.4 Mathematical reasoning 2.5 Communicating
Perspectives Categories	
3.1 Attitudes toward science, mathematics, and technology 3.2 Careers in science, mathematics, and technology 3.3 Participation in science and mathematics by underrepresented groups 3.4 Science, mathematics, and technology to increase interest 3.5 Safety in science performance 3.6 Scientific habits of mind	3.1 Attitudes toward science, mathematics, and technology 3.2 Careers in science, mathematics, and technology 3.3 Participation in science and mathematics by underrepresented groups 3.4 Science, mathematics, and technology to increase interest 3.5 Scientific and mathematical habits of mind

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Analyses Performed and Examples of Questions They Answer

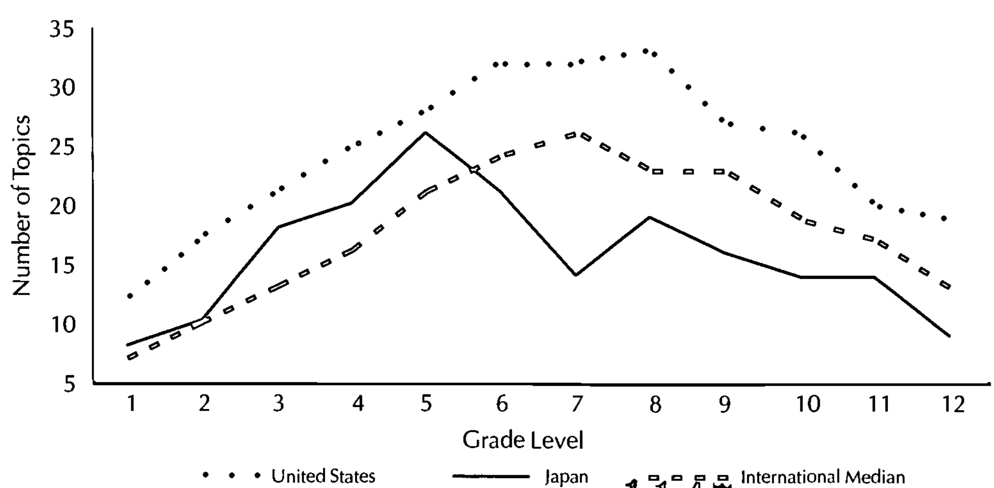
Using this framework, TIMSS researchers conducted two types of analyses to compare mathematics and science curricula. These analyses were intended to answer questions about topic inclusion, curriculum depth and breadth, and relative emphasis placed on various topics. TIMSS researchers also conducted a survey of seventh- and eighth-grade teachers in Japan, Germany, and the United States.

Topic Trace Mapping (of content)

In this procedure, a panel of curriculum experts in each country identified the grade levels at which particular topics from the TIMSS framework are included in their country's curriculum frameworks. (It should be noted that, unlike the United States, most countries have national curriculum guidelines.) Doing so allowed researchers to draw a "map" of all grade levels showing when each topic enters and leaves the curriculum and how long it stays. It also allowed comparisons of the total number of topics included in the curriculum at each grade level. The data can be used to answer a large number of research questions regarding both the "life" of topics in the curriculum over all years of schooling and topic "profiles" of each grade level. Comparisons can be made with specific countries or as an international composite. Following are three questions addressed in the study and the results.

(1) How many topics do we plan to cover at each grade level?

Figure 2. Number of Mathematics Topics Intended



(2) What is the number of topics added and dropped at each grade level?

FIGURE 3. NUMBER OF SCIENCE TOPICS ADDED AND DROPPED AT EACH GRADE LEVEL

Grade Level	Country	Topics Added	Topics Dropped	Net Gain (or Loss)	Cumulative Number of Topics
1	United States	21	0	21	21
	Germany	4	0	4	4
	Japan	0	0	0	0
2	United States	0	0	0	21
	Germany	0	0	0	4
	Japan	0	0	0	0
3	United States	1	0	1	22
	Germany	5	0	5	9
	Japan	15	0	15	15
4	United States	1	0	1	23
	Germany	32	0	32	41
	Japan	2	0	2	17
5	United States	15	0	15	38
	Germany	1	0	1	42
	Japan	5	0	5	22
6	United States	5	0	5	43
	Germany	15	1	14	56
	Japan	7	0	7	29
7	United States	7	0	7	50
	Germany	9	3	6	62
	Japan	3	0	3	32
8	United States	2	0	2	52
	Germany	1	7	-4	58
	Japan	10	0	10	42
9	United States	2	0	2	54
	Germany	2	15	-13	45
	Japan	11	0	11	53
10	United States	1	10	-9	45
	Germany	3	8	-5	40
	Japan	6	5	1	54
11	United States	0	16	-16	29
	Germany	3	5	-2	38
	Japan	9	6	3	57
12	United States	2	12	-10	19
	Germany	0	11	-11	27
	Japan	0	1	-1	56

(3) How long do we plan to continue study of a topic? (In how many grades is it addressed?)

FIGURE 4. AVERAGE MATHEMATICS TOPIC DURATION

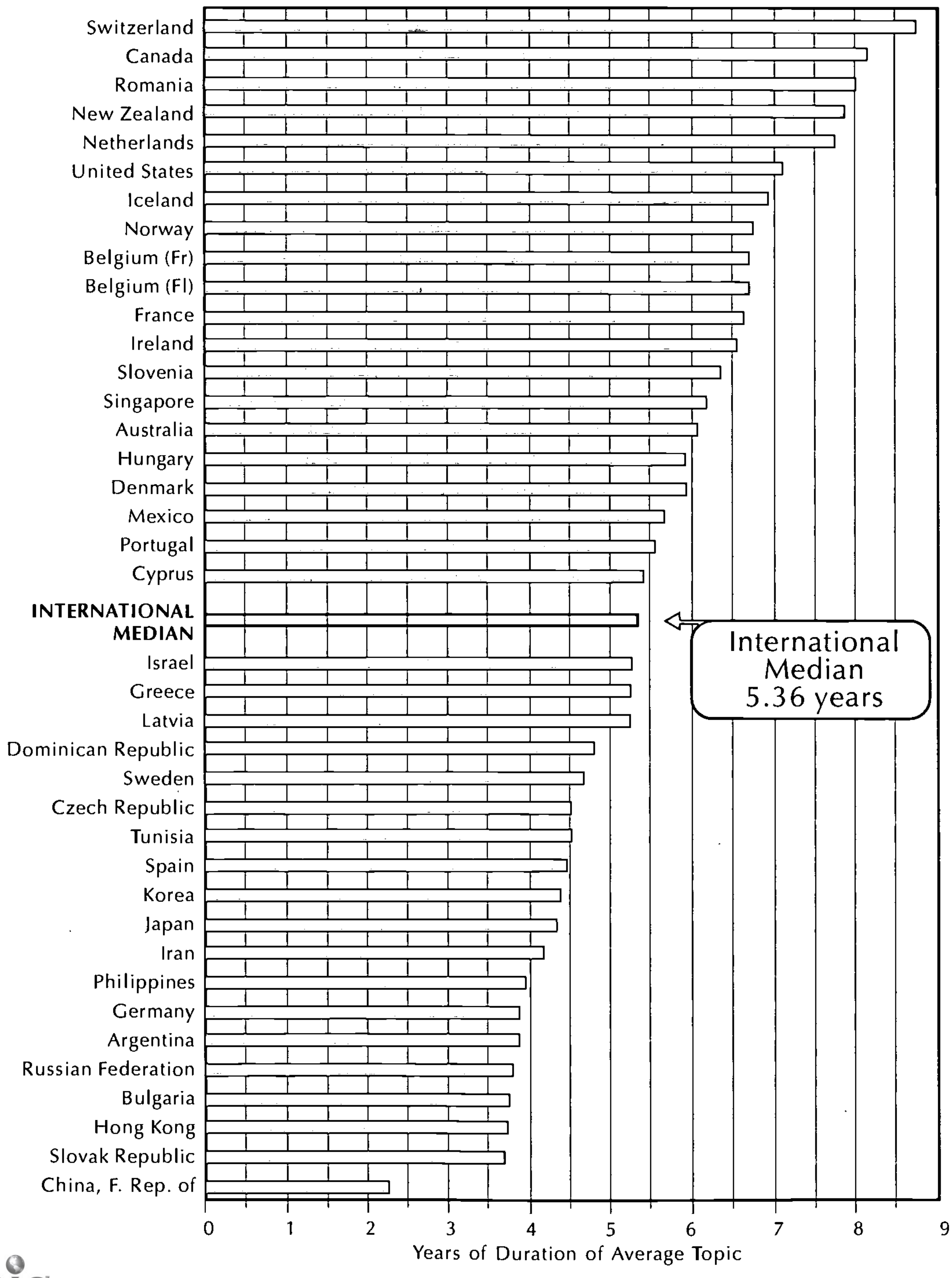


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Figure 5. Curriculum Coverage for Selected Science Topics Across Student Ages

○ topic covered in curriculum □ topic emphasized in curriculum

Example 1: Earth Building & Breaking Processes

Country	6	7	8	9	10	11	12	13	14	15	16	17	18
France			○	○	○	○	○	□	○	○	□	○	
Japan								○	□	□	○	○	
Norway					○	○	○	○	○	○	○		
Spain						○	○	○	□	○	□	□	
Switzerland								○	○	□	□	○	
United States	○	○	○	○	○	○	○	○	□				

Example 2: Organs & Tissues

Country	6	7	8	9	10	11	12	13	14	15	16	17	18
France				○	○	□	□	□	□	□	□	□	
Japan			○	○	○	○	□	□	○	○	□	□	
Norway					○	○	○	○	○	○	○	○	
Spain			○	○	□	□	○	○	○	○	□	□	
Switzerland								○	○	□	□	○	
United States	○	○	○	○	○	○	○	○	□				

Example 3: Reproduction of Organisms

Country	6	7	8	9	10	11	12	13	14	15	16	17	18
France		○	○	○	○	□	□	□	○	○	□	□	
Japan					□				□	□			
Norway		○	○	○	○	○	○	□	○	□	○		
Spain				○	□	○	○	○	□	○	□	○	
Switzerland			○	○	○	○	○	○	□	□	○	○	
United States	○	○	○	○	○	○	○	○	□				

Example 4: Chemical Properties of Matter

Country	6	7	8	9	10	11	12	13	14	15	16	17	18
France								○	○	□	□	□	
Japan					○	□	○	□	□	○	□	□	
Norway					○	○	○	○	○	○	○	○	○
Spain						○	○	□	○	□	○	□	
Switzerland							○	○	○	□	□		
United States						○	○	○	○	○	□		

Note: Ages 9 and 13 are TIMSS Student Populations 1 and 2.

Document Analysis

The TIMSS study focuses on three different student populations: Population 1, students in the two consecutive grades with the majority of 9-year-olds; Population 2, students in the two consecutive grades with the majority of 13-year-olds; and Population 3, students in the final year of secondary school. For Populations 1 and 2, and for students in Population 3 specializing in mathematics and physics, researchers conducted an in-depth analysis of curriculum guides and textbooks using a two-step process:

(1) Researchers divided each document into *units*—major structural components—and *blocks*—smaller segments within units.

(2) Each of these units and blocks was then assigned content, performance expectation, and perspective category codes from the frameworks.

Several measures were taken to ensure uniformity and reliability across the large number of teams involved in the coding process. These included the development of detailed manuals on the procedures, intensive training sessions, and an initial quality-assurance phase in which teams were not allowed to begin their coding until they had been evaluated satisfactorily in a trial coding exercise by an international panel of referees.

With the documents fully coded, researchers were then able to describe and compare the science and mathematics curricula of different countries in terms of the topics and performance expectations included, their relative emphases, and the total number of content topics. Following are two questions addressed in the study and the results.

Which topics do we plan to cover?

Figures 6 and 7 show the topics from the TIMSS frameworks included in the curriculum guides and textbooks of the United States and a composite of the other participating countries. A "✓" means that the topic was listed in at least 70 percent of the curriculum guides or textbooks.

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FIGURE 6. TOPICS COVERED IN MATHEMATICS CURRICULUM GUIDES AND TEXTBOOKS

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2					
	International Composite		United States		International Composite		United States			
							Non-Algebra		Algebra	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.1 Numbers **1.1.1 Whole numbers**										
1.1.1.1 Meaning	✓	✓	✓	✓				✓		✓
1.1.1.2 Operations	✓	✓	✓	✓			✓	✓	✓	✓
1.1.1.3 Properties of operations	✓	✓		✓		✓		✓		✓
1.1.2 Fractions and decimals										
1.1.2.1 Common fractions	✓	✓	✓	✓		✓	✓	✓	✓	✓
1.1.2.2 Decimal fractions	✓		✓	✓		✓		✓		✓
1.1.2.3 Relationships of common and decimal fractions				✓		✓	✓	✓	✓	✓
1.1.2.4 Percentages						✓	✓	✓	✓	✓
1.1.2.5 Properties of common and decimal fractions										
1.1.3 Integer, rational, and real numbers										
1.1.3.1 Negative numbers, integers, and their properties				✓	✓	✓	✓	✓	✓	✓
1.1.3.2 Rational numbers and their properties					✓	✓		✓		✓
1.1.3.3 Real numbers, their subsets, and their properties					✓			✓		✓
1.1.4 Other numbers and number concepts										
1.1.4.1 Binary arithmetic and/or other number bases								✓		
1.1.4.2 Exponents, roots, and radicals					✓	✓		✓		✓
1.1.4.3 Complex numbers and their properties									✓	✓
1.1.4.4 Number theory				✓				✓		✓
1.1.4.5 Counting				✓				✓		

FIGURE 6. TOPICS COVERED IN MATHEMATICS CURRICULUM GUIDES AND TEXTBOOKS (CONTINUED)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2					
	International Composite		United States		International Composite		United States			
							Non-Algebra		Algebra	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.1.5 Estimation and number sense										
1.1.5.1 Estimating quantity and size				✓			✓	✓	✓	
1.1.5.2 Rounding and significant figures				✓			✓	✓	✓	
1.1.5.3 Estimating computations			✓	✓			✓	✓	✓	
1.1.5.4 Exponents and orders of magnitude							✓		✓	
1.2 Measurement										
1.2.1 Units	✓	✓	✓	✓		✓	✓	✓	✓	
1.2.2 Perimeter, area, and volume	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.2.3 Estimation and error			✓	✓			✓	✓	✓	
1.3 Geometry: position, visualization, and shape										
1.3.1 Two-dimensional geometry: coordinate geometry	✓		✓	✓	✓	✓	✓	✓	✓	✓
1.3.2 Two-dimensional geometry: basics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.3.3 Two-dimensional geometry: polygons and circles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.3.4 Three-dimensional geometry			✓	✓	✓	✓	✓	✓	✓	
1.3.5 Vectors							✓		✓	
1.4 Geometry: symmetry, congruence, and similarity										
1.4.1 Transformation	✓		✓	✓	✓	✓	✓	✓	✓	✓
1.4.2 Congruence and similarity			✓	✓	✓		✓	✓	✓	✓
1.4.3 Constructions using										

Figure 6. Topics Covered in Mathematics Curriculum Guides and Textbooks (continued)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2					
	International Composite		United States		International Composite		United States			
							Non-Algebra		Algebra	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.5 Proportionality										
1.5.1 Proportionality concepts				✓	✓		✓	✓	✓	✓
1.5.2 Proportionality problems					✓	✓		✓		✓
1.5.3 Slope and trigonometry								✓		✓
1.5.4 Linear interpolation and extrapolation										
1.6 Functions, relations, and equations										
1.6.1 Patterns, relations, and functions			✓	✓	✓	✓	✓	✓	✓	✓
1.6.2 Equations and formulas			✓	✓	✓	✓	✓	✓	✓	✓
1.7 Data representation, probability, and statistics										
1.7.1 Data representation and analysis		✓	✓	✓			✓	✓	✓	
1.7.2 Uncertainty and probability			✓	✓			✓	✓	✓	
1.8 Elementary analysis										
1.8.1 Infinite processes										
1.8.2 Change										
1.9 Validation and structure										
1.9.1 Validation and justification				✓				✓		✓
1.9.2 Structuring and abstracting				✓				✓		✓
1.10 Other content				✓				✓		✓
1.10.1 Informatics										
Total number of topics	11	9	18	29	16	18	24	37	24	27

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Figure 7. Topics Covered in Science Curriculum Guides and Textbooks

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2			
	International Composite		United States		International Composite		United States	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.1 Earth Sciences **1.1.1 Earth features**								
1.1.1.1 Composition								
1.1.1.2 Land forms				✓				✓
1.1.1.3 Bodies of water	✓			✓				✓
1.1.1.4 Atmosphere								✓
1.1.1.5 Rocks, soil					✓	✓		
1.1.1.4 Ice forms								✓
1.1.2 Earth processes								
1.1.2.1 Weather and climate	✓	✓		✓	✓	✓		✓
1.1.2.2 Physical cycles				✓				✓
1.1.2.3 Building and breaking								
1.1.2.4 Earth's history								✓
1.1.3 Earth in the universe								
1.1.3.1 Earth in the solar system	✓	✓		✓				✓
1.1.3.2 Planets in the solar system				✓				✓
1.1.3.3 Beyond the solar system								
1.1.3.4 Evolution of the universe								
1.2 Life Sciences **1.2.1 Diversity, organization, and structure of living things**								
1.2.1.1 Plants, fungi	✓	✓	✓	✓	✓	✓	✓	✓
1.2.12 Animals	✓	✓	✓	✓	✓	✓		✓
1.2.1.3 Other organisms				✓	✓			✓
1.2.1.4 Organs, tissues	✓	✓	✓	✓	✓	✓	✓	✓
1.2.1.5 Cells				✓	✓			✓

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Figure 7. Topics Covered in Science Curriculum Guides and Textbooks (continued)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2			
	International Composite		United States		International Composite		United States	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.2.2 Life processes and systems enabling life functions								
1.2.2.1 Energy handling				✓	✓	✓		✓
1.2.2.2 Sensing and responding				✓	✓	✓		✓
1.2.2.3 Biochemical processes in cells								
1.2.3 Life spirals, genetic continuity, and diversity								
1.2.3.1 Life cycles				✓	✓	✓		✓
1.2.3.2 Reproduction				✓	✓	✓		✓
1.2.3.3 Variation and inheritance								
1.2.3.4 Evolution, speciation, and diversity				✓	✓			✓
1.2.3.5 Biochemistry of genetics								
1.2.4 Interactions of living things								
1.2.4.1 Biomes and ecosystems			✓	✓	✓			✓
1.2.4.2 Habitats and niches				✓	✓			
1.2.4.3 Interdependence of life	✓	✓	✓	✓	✓	✓	✓	✓
1.2.4.4 Animal behavior				✓	✓			
1.2.5 Human biology and health	✓				✓			
1.2.5.1 Nutrition				✓				✓
1.2.5.2 Disease					✓	✓		✓
1.3 Physical Sciences								
1.3.1 Matter								
1.3.1.1 Classification of matter				✓	✓	✓		✓
1.3.1.2 Physical properties	✓	✓	✓	✓	✓	✓	✓	✓
1.3.1.3 Chemical properties				✓	✓	✓	✓	✓

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FIGURE 7. TOPICS COVERED IN SCIENCE CURRICULUM GUIDES AND TEXTBOOKS (CONTINUED)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2			
	International Composite		United States		International Composite		United States	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.3.2 Structure of matter								
1.3.2.1 Atoms, ions, and molecules				✓	✓	✓		✓
1.3.2.2 Macromolecules, crystals								
1.3.2.3 Subatomic particles					✓			✓
1.3.3 Energy and physical properties								
1.3.3.1 Energy types, sources, conversions	✓	✓	✓	✓	✓	✓	✓	✓
1.3.3.2 Heat and temperature					✓	✓		✓
1.3.3.3 Wave phenomena								
1.3.3.4 Sound and vibration				✓				✓
1.3.3.5 Light			✓	✓	✓	✓		
1.3.3.6 Electricity			✓	✓	✓	✓	✓	✓
1.3.3.7 Magnetism					✓			
1.3.4 Physical transformations								
1.3.4.1 Physical changes						✓		✓
1.3.4.2 Explanations of physical changes								
1.3.4.3 Kinetic theory								
1.3.4.4 Quantum theory and fundamental particles								
1.3.5 Chemical transformations								
1.3.5.1 Chemical changes								✓
1.3.5.2 Explanations of chemical changes					✓	✓		
1.3.5.3 Rate of change and equilibria								
1.3.5.4 Energy and chemical change								

FIGURE 7. TOPICS COVERED IN SCIENCE CURRICULUM GUIDES AND TEXTBOOKS (CONTINUED)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2			
	International Composite		United States		International Composite		United States	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.3.5.5 Organic and biochemical changes								
1.3.5.6 Nuclear chemistry								✓
1.3.5.7 Electrochemistry								
1.3.6 Forces and motion								
1.3.6.1 Types of forces				✓	✓	✓		✓
1.3.6.2 Time, space, and motion						✓	✓	✓
1.3.6.3 Dynamics of motion								
1.3.6.4 Relativity theory								
1.3.6.5 Fluid behavior								
1.4 Science, technology, and mathematics								
1.4.1 Nature or conceptions of technology								✓
1.4.2 Interactions of science, mathematics, and technology								
1.4.2.1 Influence of mathematics and technology on science								
1.4.2.2 Applications of science in mathematics and technology				✓	✓	✓		✓
1.4.3 Interactions of science, technology, and society								
1.4.3.1 Influence of science and technology on society				✓	✓	✓		✓
1.4.3.2 Influence of society on science and technology								
1.5 History of science and technology				✓		✓		✓

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FIGURE 7. TOPICS COVERED IN SCIENCE CURRICULUM GUIDES AND TEXTBOOKS (CONTINUED)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2			
	International Composite		United States		International Composite		United States	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
1.6 Environmental and resource issues related to science								
1.6.1 Pollution	✓				✓	✓	✓	✓
1.6.2 Conservation of land, water, and sea resources	✓	✓		✓	✓	✓		✓
1.6.3 Conservation of material and energy resources	✓			✓	✓	✓		✓
1.6.4 World population	✓				✓			
1.6.5 Food production and storage	✓			✓	✓			✓
1.6.6 Effects of natural disasters					✓			✓
1.7 Nature of science								
1.7.1 Nature of scientific knowledge				✓	✓		✓	✓
1.7.2 The scientific enterprise				✓				✓
1.8 Science and other disciplines								
1.8.1 Science and mathematics				✓				✓
1.8.2 Science and other disciplines				✓				✓
Total number of topics	15	9	9	40	39	29	10	50

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What do we expect students to do with the content we plan to cover?

Figure 8 below indicates the performance expectations from the TIMSS mathematics framework included in the curriculum guides and textbooks in the United States and a composite of other participating countries. A "✓" means that the performance expectation was listed in at least 70 percent of the curriculum guides or textbooks.

FIGURE 8. PERFORMACE EXPECTATIONS INCLUDED IN MATHEMATICS CURRICULUM GUIDES AND TEXTBOOKS

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2					
	International Composite		United States		International Composite		United States			
							Non-Algebra		Algebra	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
2.1 Knowing										
2.1.1 Representing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.1.2 Recognizing equivalents	✓	✓		✓	✓	✓		✓		✓
2.1.3 Recalling mathematical objects and properties	✓	✓	✓	✓	✓	✓		✓		✓
2.2 Using routine procedures										
2.2.1 Using equipment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.2.2 Performing routine procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.2.3 Using more complex procedures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.3 Investigating and problem solving										
2.3.1 Formulating and clarifying problems and situations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.3.2 Developing strategies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.3.3 Solving	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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FIGURE 8. PERFORMACE EXPECTATIONS INCLUDED IN MATHEMATICS CURRICULUM GUIDES AND TEXTBOOKS (CONTINUED)

TIMSS Framework of Content Categories and Subcategories	Population 1				Population 2					
	International Composite		United States		International Composite		United States			
							Non-Algebra		Algebra	
Curric. = Curriculum	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books	Curric. Guides	Text-books
2.3.4 Predicting	✓		✓	✓	✓	✓	✓	✓	✓	✓
2.3.5 Verifying	✓		✓	✓	✓	✓	✓	✓	✓	✓
2.4 Mathematical reasoning										
2.4.1 Developing notation and vocabulary	✓			✓	✓		✓	✓	✓	
2.4.2 Developing algorithms	✓			✓				✓		✓
2.4.3 Generalizing			✓	✓	✓	✓	✓	✓	✓	✓
2.4.4 Conjecturing			✓	✓	✓	✓	✓	✓	✓	✓
2.4.5 Justifying and proving			✓	✓	✓	✓	✓	✓	✓	✓
2.4.6 Axiomatizing										
2.5 Communication										
2.5.1 Using vocabulary and notation			✓	✓	✓	✓	✓	✓	✓	✓
2.5.2 Relating representations			✓	✓	✓	✓	✓	✓	✓	✓
2.5.3 Describing and discussing			✓	✓	✓	✓	✓	✓	✓	✓
2.5.4 Critiquing				✓				✓		✓
Total number of topics	**13**	**9**	**16**	**20**	**18**	**17**	**16**	**20**	**16**	**19**

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FIGURE 9. PERCENT OF TEXTBOOK SPACE DEVOTED TO MAJOR POPULATION 2 SCIENCE PERFORMACE EXPECTATIONS

	Understanding	Theorizing, Analyzing, and Solving Problems	Using Tools, Routine Procedures, and Science Processes	Investigating the Natural World	Communicating
Argentina	71.0	11.0	12.0	0.0	1.0
Australia	79.0	7.0	8.0	7.0	7.0
Austria	80.0	8.0	2.0	7.0	2.0
Belgium (Fl)	47.0	11.0	34.0	10.0	5.0
Belgium (Fr)	15.0	3.0	9.0	10.0	6.0
Bulgaria	48.0	15.0	4.0	0.0	3.0
Canada	71.0	8.0	17.0	11.0	4.0
China, People's Rep. of	73.0	13.0	6.0	2.0	0.0
Colombia	98.0	3.0	0.0	0.0	0.0
Cyprus	70.0	12.0	10.0	8.0	0.0
Czech Republic	95.0	6.0	6.0	1.0	1.0
Denmark	73.0	3.0	18.0	10.0	0.0
Dominican Republic	29.0	16.0	2.0	19.0	1.0
France	68.0	16.0	16.0	1.0	1.0
Germany	55.0	15.0	30.0	0.0	0.0
Greece	90.0	6.0	1.0	0.0	0.0
Hong Kong	74.0	2.0	23.0	0.0	0.0
Hungary	87.0	2.0	8.0	2.0	0.0
Iceland	94.0	2.0	4.0	2.0	6.0
Iran	100.0	0.0	0.0	0.0	0.0
Ireland	85.0	2.0	4.0	6.0	1.0
Israel	77.0	3.0	10.0	1.0	0.0
Italy	85.0	8.0	5.0	3.0	1.0
Japan	82.0	7.0	13.0	10.0	2.0
Korea75.0	19.0	8.0	2.0	0.0	
Latvia	52.0	4.0	13.0	7.0	0.0
Lithuania	87.0	12.0	6.0	1.0	1.0
Mexico	92.0	3.0	9.0	2.0	3.0
Netherlands	58.0	16.0	10.0	4.0	1.0
New Zealand	56.0	4.0	26.0	21.0	8.0
Norway	72.0	4.0	5.0	14.0	3.0
Portugal	89.0	9.0	13.0	2.0	2.0
Romania	83.0	9.0	6.0	1.0	0.0
Russian Federation	88.0	15.0	7.0	1.0	1.0
Scotland	90.0	0.0	2.0	1.0	7.0
Singapore	76.0	3.0	3.0	19.0	0.0
Slovak Republic	86.0	12.0	9.0	2.0	1.0
Slovenia	85.0	14.0	5.0	2.0	0.0
South Africa	86.0	1.0	14.0	8.0	0.0
Spain	62.0	19.0	4.0	5.0	3.0
Sweden	72.0	7.0	2.0	8.0	3.0
Switzerland	79.0	7.0	1.0	5.0	1.0
Tunisia	93.0	3.0	1.0	2.0	0.0
United States	88.0	4.0	7.0	2.0	1.0

Teacher Survey

TIMSS researchers also surveyed seventh- and eighth-grade teachers in Japan, Germany, and the United States regarding the topics they actually cover in class, how much time they devote to each (using the TIMSS frameworks as references), their beliefs about pedagogical strategies, and the hours spent teaching each week. An example of the kind of question the survey answers is, "What are the topics most commonly taught?" Figure 10 presents the 10 topics most commonly taught in eighth-grade mathematics and science in the United States, Japan, and Germany, as reported by eighth-grade teachers.

Figure 10. The 10 Most Commonly Taught Topics in Eighth-Grade Mathematics and Science

United States	Japan	Germany
Mathematics		
Other Numbers and Number Concepts	Geometry: Congruence and Similarity	Equations and Formulas
Number Theory and Counting	Data Representation and Analysis	Perimeter, Area, and Volume
Perimeter, Area, and Volume	Patterns, Relations, and Functions	Two-Dimensional Geometry
Estimation and Number Sense	Two-Dimensional Geometry	Three-Dimensional Geometry and Vectors
Percentages	Proportionality Problems	Measurement: Units
Two-Dimensional Geometry	Other Content	Geometry: Congruence and Similarity
Proportionality Concepts	Estimation and Number Sense	Proportionality Problems
Proportionality Problems	Proportionality Concepts	Percentages
Properties of Common and Decimal Fractions	Measurement: Estimation and Error	Patterns, Relations, and Functions
Relationships of Common and Decimal Fractions	Equations and Formulas	Other Numbers and Number Concepts
Science		
Nature of Science	Human Diversity	Environmental and Resource Issues
Structure of Matter	Human Life Processes and Systems	Nature of Science
Matter	Chemical Transformations	Energy and Physical Processes
Science and Technology Mathematics	Structure of Matter	History of Science and Technology
Physical Transformations	Life Processes and Systems	Heat, Temperature, Wave, and Sound
Environmental and Resource Issues	Matter	Interactions of Living Things
Energy and Physical Processes	Energy and Physical Processes	Structure of Matter
Chemical Transformations	Earth Processes	Diversity, Organization, and Structure of Living Things
Heat, Temperature, Wave, and Sound	Atmosphere	Life Processes and Systems
History of Science and Technology	Environmental and Resource Issues	Matter

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Other Curriculum-Analysis Methods

A. National Science Foundation (NSF) Review of Instructional Materials for Middle School Science and Framework for Review: Instructional Materials for Middle School Mathematics

B. American Association for the Advancement of Science (AAAS) Project 2061 Curriculum-Analysis Procedure

C. California Department of Education Curriculum Frameworks and Instructional Resources: Mathematics Instructional Materials Evaluation Instrument and Rating Form

D. Council of Chief State School Officers (CCSSO) State Curriculum Frameworks and Standards Map: Definitions of Categories and Concepts

National Science Foundation Review of Instructional Materials for Middle School Science

In 1996, the National Science Foundation (NSF) undertook a review of comprehensive curriculum projects in middle-school science. As work on the study progressed, it became clear that the framework for review developed to examine middle-school materials and the results of the panel's findings might be helpful beyond NSF and that they could be useful to those in the field working to improve science education in schools, districts, and states. The purpose of this paper is to make such information available to this broader audience.

Introduction

Unlike earlier school reforms, current reforms focus on identifying what all students should know and be able to do. Efforts such as NSF's Systemic Initiatives aim to create bold new visions of curriculum, assessment, and pedagogy to improve education for all children. The frameworks for these reforms are often found in national standards, such as those from the National Council of Teachers of Mathematics (NCTM) and the National Academy of Sciences' *National Science Education Standards (NSES).* These national frameworks were largely grassroots efforts with contributions from teachers, parents, school administrators, and scientists and mathematicians. They provide consensus views on what content is most important to teach, suggestions for teachers about effective instructional strategies, suggestions for how to assess student learning, and, in the case of the *NSES*, suggestions for implementation. In addition, the American Association for the Advancement of Science (AAAS) has developed *Benchmarks for Science Literacy*, a compendium of specific science literacy goals developed by scientists and educators that states, districts, and schools can use as a guide for a science curriculum.

Many states and districts have developed curriculum frameworks in mathematics and science that build on or adapt these standards efforts. The question now is, Do we have the tools required to successfully transverse the current educational terrain? The national and state frameworks perhaps set the compass and provide a large-scale map, but it falls on districts, schools, and teachers to identify the best materials and programs to make reform a reality. Without quality instructional materials, even the best teachers can make little headway.

To investigate the current status of instructional materials, NSF conducted a review of its portfolio of comprehensive curricula for middle-school science (grades 5 to 9) in early 1996. The justifications for starting with middle-level science included the following:

- Earlier NSF-funded projects had resulted in several sets of comprehensive materials at the elementary level.
- There were questions both in the field and at NSF about the availability of quality comprehensive materials for middle-school students.
- There were several sets of middle-school materials at or near completion and, therefore, ready for review.

The purpose of the Middle School Science Study was to answer the following questions:

1. What are the characteristics of the portfolio of comprehensive instructional materials for middle-school science developed with NSF funds?
2. How sufficiently do these materials provide for a comprehensive program for middle-school science consistent with the national standards for science education?

The study included a review of comprehensive curricula, those that equal a year or more of course material, produced during the past decade or that were currently under development. The central criteria used in reviewing the instructional materials were as follows:

1. Is the science content correct?
2. How well do the materials provide for conceptual growth in science?
3. How well do the materials align with the *National Science Education Standards*?

Rationale and Background—Overview and History of NSF's Instructional Materials Development Program (IMD)

It is NSF's goal to "achieve excellence in U.S. science, mathematics, engineering, and technology education at all levels."[1] One of the strategies for meeting this goal is to fund development of high-quality instructional materials with potential for national impact that are consistent with state and national standards. NSF, through the IMD Program, supports the development of new comprehensive materials and new instructional units and the revision of existing high-quality materials.

Developing high-quality instructional materials is an expensive and long-term process, requiring contributions from numerous teachers, scientists, and mathematicians to ensure that the content and pedagogy are current and correct. Materials should contain activities that are engaging for and relevant to students and should provide sufficient guidance for teachers so that they can successfully implement them in their classrooms. Materials must provide for extensive pilot and field testing with diverse student populations, and this often means time-consuming revisions. Materials supported by NSF are often under development for five years or longer before they are ready for publication. High-quality instructional materials are a critical component of the reform effort. Reform is not possible without materials that contain cutting-edge science; provide for students' conceptual growth over time; and contain engaging reading, experiments, and opportunities for teacher-directed student inquiry.

In sum, the IMD Program seeks projects that:

- Involve collaboration of scientists, mathematicians, teachers, and educators;
- Apply current research in teaching and learning;
- Align with standards;
- Contain embedded student assessments that help inform instruction and use a variety of strategies to assess student learning;
- Field-test materials in diverse settings; and
- Employ formative and summative evaluations that include student outcome data from field-test sites.[2]

Overview of Science Materials Reform

For mathematics, NSF funded a portfolio of projects to develop comprehensive instructional materials following the release of the National Council of Teachers of Mathematics *Standards for Content and Evaluation* in 1989[3]; however, NSF began funding the development of innovative comprehensive instructional materials in science a decade prior to the release of the science standards. The American Association for the Advancement of Science (AAAS) released *Benchmarks for Science Literacy*[4] in 1993, and the National Academy of Sciences/National Research Council published the *National Science Education Standards (NSES)*[5] in December 1995. Therefore, many of the middle-school projects reviewed in this study predate these standards. Many curriculum developers, however, served on the working groups that developed the *Benchmarks* and standards, participated in the extensive review and critique of the science standards, and incorporated ideas emerging from these standards-based projects in their materials.

The current cycle of development of instructional science materials, dating from the mid-1980s, is driven by (1) the need to ensure that there are effective materials available, particularly at the elementary level, where science is frequently relegated to "the last 20 minutes on Friday afternoon"; (2) the need to develop materials that provide more "hands-on" opportunities in which students can actively conduct their own observations and experiments and generate their own questions under teacher guidance; and (3) the need to incorporate new research findings in teaching and learning into science instructional materials.

In the mid-1980s, NSF funded hands-on materials at the elementary level, through the TRIAD projects. These projects formed partnerships among three critical groups—publishers, developers, and school districts—and operated on the assumption that the availability of high-quality elementary science materials would motivate teachers to teach science using a hands-on and inquiry-based approach. Shortly thereafter, work began on developing middle school materials, and this was followed by work on high school materials, many of which are now nearing completion.[6]

NSF has refined its ideas about what constitutes good instructional materials. NSF increasingly is concerned that materials provide appropriate guidance for teachers, suggest appropriate instructional strategies, contain a variety of assessment activities, accommodate the diversity of students, and contain suggestions for implementation. The review instrument developed by Inverness Research and modified by NSF for use in the Middle School Study reflects the Foundation's concern with assessing a wide range of features in addition to a high-quality content.

Procedures of the Middle School Science Study

The Middle School Science Study adapted NSF's peer review process to critique the portfolio of comprehensive curricula, using a method similar to that used by the IMD program for reviewing proposals for new projects. In this peer review process, panels of outstanding scientists, mathematicians, and educators critique proposals submitted for funding and make recommendations to the NSF about each proposal's quality, funding priority, and potential impact. Typically, reviewers provide individually written reviews, discuss the proposals in panel meetings, and develop a panel summary for each proposal. This study followed a four-step process in completing the review of materials: (1) training, (2) independent review, (3) summary and consensus, and (4) synthesis.

Training

A review panel of 20 experts comprising scientists, science and technology educators, and science teachers participated in the peer review process. For the peer review, program directors from the Division of Elementary, Secondary, and Informal Education (ESIE) met with the panel of experts to agree on the process and criteria for reviewing the materials. The panel used an instrument developed by Inverness Research to review one instructional module as a trial run in calibrating the review process. Following the trial review, the panel critiqued and revised the instrument to develop a common understanding for each item and to agree on the review process. Appendix A on page 61 includes a copy of the final review instrument, called the *Framework for Review.*

Independent Review

Following the panel meeting, panel members formed small working groups, comprising a scientist, science educator, practitioner, and individuals

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with expertise in assessment and implementation. Panel members read their assigned portions of the curriculum materials at home and prepared in-depth analyses of the materials using the review instrument as a framework for guiding their critiques. The panel members were asked to provide detailed justifications for their ratings for each item of the instrument.

Panel Summary

The panel members returned to NSF and exchanged results in their working groups. Each group prepared a written summary for each program representing a consensus of their reviews. The panel provided feedback on the review instrument and the review process, which NSF staff used to revise the instrument for future use. New summary groups were formed to discuss cross-cutting issues: (1) treatment of science content, (2) approach to teaching, (3) approach to assessment and equity, and (4) strategies for implementation. Each summary group reported to the whole panel and, through a large-group discussion, developed the major summary findings of the overall peer review.

Synthesis

A second panel of experts convened to review the process and findings of the peer review, to develop strategies for disseminating the findings, and to recommend future directions. The synthesis panel constituted 14 members, including four from the peer review panel. The synthesis panel included scientists, teachers, curriculum developers, and national and state leaders in the reform of science, mathematics, and technology education. The synthesis panel carefully reviewed the panel summaries and summary recommendations from the peer review process and developed an overall synthesis of findings that are the basis for this report.

Constraints

The review procedures were designed to provide a broad-brush assessment of the status of the portfolio of NSF-funded comprehensive instructional materials for middle school science. The purpose of the activity was to identify strengths and weaknesses in the portfolio, as well as gaps requiring the development or revision of projects. The intent of the study was to provide feedback to program officers who review proposals.

The study was *not* designed to (1) provide the NSF vision of a national curriculum, (2) thoroughly evaluate the individual projects, (3) offer a "consumer report" on quality of curricula, or (4) survey the needs of teachers and schools.

The study had several constraints:

- In most cases, the complete set of materials for one comprehensive program was not reviewed by all members of the panel. Therefore, each panel member completed the individual review based on only a subset of the full package of materials.
- No materials were reviewed by more than one panel; thus, it was not possible to equate a particular value on an item for one set of materials given by one panel with a value for the same item given by a different panel to another set of materials.
- Panel members analyzed, in general terms, the degree to which a set of materials addressed content standards within particular science disciplines, but did not do a fine-grained analysis of specific concepts and the amount of time allocated to the mastery of those specific concepts.

While the results of the study have shed light on the current status of middle-school science instructional materials developed with NSF funding, they do not serve as a detailed evaluation of the individual projects. It is hoped that the results of the study will be used to inform state and local administrators, curriculum developers, principal investigators of systemic reform and teacher enhancement projects, and NSF program officers about quality, standards-based instructional materials for middle school science. The review instrument developed as part of this study is an important product for use by those who select materials or school science programs.

Results—Overall

Thirteen of the 19 projects examined as part of NSF's Middle School Review had panel ratings of 3 or higher on a 1-5 point scale of the Inverness Research *Framework for Review,* with 1 as "low" and 5 as "high" on overall quality. Eight of these—*Prime Science* (6-10); *Science 2000* (6-8); *Science and Technology: Investigating Human Dimensions* (*BSCS,* 6-8); *Full Option Science*

System (*FOSS* 5-6); *Science and Technology for Children* (5-6); *Improving Urban Elementary Science* (*Insights* 5-6); *Elementary School Science and Health Materials* (*BSCS* 5-6); and *Integrated Mathematics, Science, and Technology* (*IMaST* 7-8)—are multiyear comprehensive programs. *Event-Based Science* and *Junior High/Middle School Life Science Program (Jeffco)* comprise materials for one year. *Science Education for Public Understanding Program (SEPUP)* and its predecessor, *Chemical Education for Public Understanding Project (CEPUP),* cover non-sequential multiple single years of material, and a third set of materials, *Life Science for Public Understanding Project,* is currently under development in order to complete a comprehensive grade 7-10 series. *National Geographic Kids Network* (4-6) covers multiple grade levels but is not designed to cover a full year of science at any grade level. Therefore, the answer to the question regarding the availability of high-quality, standards-based middle-school science materials is that there are some good, comprehensive programs. Also, one-year programs can form important components of a total middle-school program. (See Appendix B for brief descriptions of these projects on page 97.)

CONTENT

Science content in middle schools includes important scientific concepts in earth, biological, and physical sciences; opportunities for inquiry; and information on the history and processes of science. Particular programs stand out as having strengths in particular areas. These programs have the potential to serve as exemplars for curriculum developers who are designing new materials and for school districts that are forming school science programs.

Projects vary in their approach to content. A few developers have produced multiyear comprehensive programs designed to achieve all of the content standards for the middle level. These programs have been forced to face the challenge of finding the best balance between breadth and depth of science content. One example, *PRIME Science,* provides a balanced curriculum covering biological, earth, and physical sciences for grades 6 to 10 and revisits important concepts so students can deepen their understanding of key ideas. Another example, *Science 2000,* is rated high for its alignment with the *National Science Education Standards* content standards and its development of key science concepts. *Science 2000* is unique in that it is organized around a few major conceptual themes, and it has separate units on science and technology. *Integrated Mathematics, Science, and Technology (IMaST)* stands alone as a program that is designed to integrate the teaching of science and mathematics with technology. *IMaST* is designed to be taught by a team of mathematics, science, and technology teachers in a three-hour block and enables students to achieve the content standards in science and mathematics for the middle grades, with a grounding in technology education as well.

Single-year programs for the middle grades do not propose to meet all of the content standards for grades 5 to 9. Programs of this type either have developed materials aligned with a discipline-based approach (e.g., *Junior High/Middle School Life Science*, or *Event-Based Science: Earth Science)* or they have taken a problem/issue-centered approach that may transcend science disciplines (*CEPUP* and *SEPUP*). *Event-Based Science: Earth Science* takes both approaches in that it is a problem-centered program designed to teach the traditional content of earth science. *Event-Based Science* is rated high in its presentation of science content, and it is one of the few programs that addresses earth science. It effectively uses video footage of natural disasters (e.g., earthquakes, tornadoes, floods) to engage students in investigating the content and processes of earth science. The strength of the single-year approach is that a school district can build its own multiyear program by selecting single-year programs that fit their curriculum framework.

Comprehensive programs for grades 5 to 6 that are part of a K-6 program are challenged with the need to be both scientifically meaningful and developmentally appropriate for young students. *The Full Option Science System (FOSS)* for grades 5 to 6 is an example of the effective treatment of science content at this level. *FOSS* strikes a good balance between an emphasis on the major conceptual themes, such as systems, and an emphasis on science concepts, such as an electrical circuit. The reviewers felt that *FOSS* presents important current science content accurately, at a developmentally appropriate level, and covers appropriate breadth of science and depth of understanding.

Pedagogy

Good materials contain suggestions for teachers, such as sequencing activities to achieve desired learning results, and hints on working with groups of students. Particular programs have the potential to serve as exemplars for particular areas related to pedagogy. From the category of multiyear comprehensive programs, *PRIME Science* was rated highly by the panel for overall quality of pedagogical design. The panel members were especially impressed with the manner in which *PRIME Science* presents a logical progression of the development of conceptual understanding that reflects researchers' current understanding of the teaching and learning of science. *Science and Technology for Children* is a K-6 program that received high marks for engaging students in science inquiry and technology problem solving. *CEPUP* was recognized as providing a good model for using personal and social issues as the pedagogical driver for engaging students in learning and applying important science concepts. *National Geographic Kids Network* is unique in its effective use of telecommunications for engaging students in collaborative science investigations, and *Science 2000* provides a model for using interactive videodisc technology to engage students in learning science content.

Assessment

While classroom assessment is an important component of instructional materials, some of the materials (particularly those funded before the early 1990s) contained limited assessment activities. Other projects appear to include assessment as an afterthought. It is now believed that assessments should be developed concurrently with, and embedded in, the instructional materials. Some materials, such as *Junior High/Middle School Life Science Program (Jeffco)*, contain traditional assessments (paper-and-pencil tests), but they are well done. Others have greatly expanded on this traditional base by including assessments in which students demonstrate through performance or extended response questions what they know and are able to do. *Event-Based Science*, for example, is regarded as being very user-friendly for teachers and has excellent scoring rubrics that are related to the ongoing instructional themes. At the elementary level, *FOSS*, *Insights*, and *Science and Technology for Children* include embedded assessments that are integral to instruction and use a variety of approaches to test student understanding. *SEPUP* was cited as an outstanding example of embedded assessment at the middle-school level. *National Geographic Kids Network* also includes innovative uses of performance assessment linked to computer network communications.

Equity

Panel members described the approaches to equity in these materials as more likely to commit sins of omission than commission. Many of the materials simply do not address equity issues in any explicit way, although there is no obvious bias in the materials. Panel members felt that almost all of the materials would benefit from an explicit focus on equity issues and concrete suggestions for how teachers can gain access to needed materials and supplies, with an understanding that programs that rely on complex technologies may be expensive and thereby excluded in many schools and districts at the current time. Supplemental materials are needed that address the effective use of heterogeneous student groups and the importance of accommodating various learning styles. These materials may be produced by others than the curriculum developers.

Panel members lauded materials that focused on societal issues, such as *Event-Based Science, SEPUP,* and *Middle School Science and Technology* (*BSCS* 6-8), as having an inclusionary effect, because they address many issues using events and materials familiar and relevant to students. These integrated approaches provide access to important scientific ideas. Both sets of materials also discuss student learning styles and suggest cooperative learning strategies.

Implementation

Most of the materials packages in review do not address dissemination or implementation issues, and this is critical in focusing schools and districts on strategies for scaling up projects, exerting quality control, aligning curriculum, professional development and assessment, working effectively with parents and other community members, and so forth. Notable exceptions in this regard are the implementation guides including *Middle School Science and Technology* (*BSCS* 6-8) and *Junior High/Middle School Life Science Program (Jeffco).* Specific suggestions and strategies are provided for adopting new approaches to appropriate professional development, for scope and sequence of content, and for evaluating the effectiveness of implementing the materials. None of the materials packages mentions how to work with parents or the public.

Conclusions

There are a number of high-quality middle-school science curricula available, and some are comprehensive. With care and these materials, schools and districts can create good middle-school science programs.

A few key findings are:

- Most of the 13 sets of materials that rated 3 or higher on the 5-point scale are generally consistent with the national science content standards.
- The emphasis on science literacy for all students points to the importance of applying equity principles, but most materials do not explicitly address strategies for improving the performance of a diverse set of students through attention to differences in ability, learning style, and so on. Additional supplemental materials may be needed to provide good strategies.
- Among the content areas, earth science appears least frequently.
- Connections between science and mathematics are not developed in most of the materials.
- The greatest weakness in the set of materials relative to the science standards is the lack of sufficient focus on the history and nature of science.
- Too few materials incorporate significant and appropriate use of instructional technologies, such as ensuring that materials are presented in a variety of formats.

NOTES

[1]National Science Foundation, *NSF in a Changing World*, Arlington, VA (NSF95-24).
[2]National Science Foundation, *Elementary, Secondary, and Informal Education, Program Announcement and Guidelines*, 97-20.
[3]National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards*, Reston, VA, 1989.
[4]American Association for the Advancement of Science, Project 2061, *Benchmarks for Science Literacy*, Oxford University Press, New York, 1993.
[5]National Research Council of the National Academy of Science, *National Science Education Standards*, Academy Press, 1995.
[6]Cozzens, Margaret, "Instructional Materials Development (IMD): A Review of the IMD Program, Past, Present, and Future," unpublished paper, National Science Foundation.

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APPENDIX A

Framework for Review: Instructional Materials for Middle School Science

Title: ____________________

Author(s): ____________________

Publisher: ____________________ Copyright date: ____________

Reviewed by: ____________________ Date: ____________

I. Descriptors

a. Write a brief description of the components of the curriculum upon which this review is based (e.g., teacher's guide, student books, hands-on materials, multimedia material). That is, what materials did you receive and include in your review?

____

____

____

b. Write a brief description of the purpose and broad goals of these materials. That is, what were the stated purposes, and what were the actual results of the materials?

____

____

____

c. What grade levels do the materials serve?

____5 ____6 ____7 ____8

1177

d. Are the instructional materials designed to

- ___ provide a complete multiyear program for middle school science.
- ___ provide a complete one-year course for middle school science.
- ___ provide multiple modules or units that could be used to supplement other course materials for middle school science.
- ___ provide a single module or collection of activities that could be used to supplement other course materials for middle school science.
- ___ other (explain): ______________________________

e. What are the major domains/topics of the content covered by these materials?

II. Quality of the Science

Directions: For each item, circle the number corresponding with your response to the question.
Write an explanation for your rating of each item below the item.

a. Does the content in the instructional materials align well with all eight areas of the Content Standards as described in the *National Science Education Standards (NSES)*? (See attached guidelines.)

1	2	3	4	5
Omits substantial content included in *NSES* and/or includes substantial content not recommended in *NSES*		Some misalignment of content with recommendations in *NSES*		The curriculum aligns well with content recommendations in *NSES*

1178

b. Are the science concepts presented in the instructional materials accurate and correct? (Provide examples of major errors where they are evident. Attach extra page if necessary.)

1	2	3	4	5
Substantial, major errors		Mostly correct, with some minor errors		Scientifically accurate and correct

____

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____

c. Do the instructional materials adequately present the major concepts in the standards and adequately demonstrate and model the processes of science?

1	2	3	4	5
Major concepts and processes not addressed		Major concepts and processes somewhat addressed		Major concepts and processes addressed well

____

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d. Does the science presented in the instructional materials reflect current disciplinary knowledge?

1	2	3	4	5
The ideas are out of date		Somewhat current		Current

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1179

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e. Do the instructional materials accurately represent views of science as inquiry as described in the *National Science Education Standards*?

1	2	3	4	5
Poor examples of inquiry		Mixed quality		Rich and accurate examples of inquiry

f. Do the instructional materials accurately present the history of science?

1	2	3	4	5
Poor portrayal of history of science		Mixed quality		Rich and accurate portrayal of history of science

g. Do the materials emphasize technology as an area of study?

1	2	3	4	5
Little or no emphasis		Some emphasis		Rich and well-designed emphasis

1180

h. Do the materials emphasize the personal and societal dimensions of science?

1	2	3	4	5
Little or no emphasis		Some emphasis		Rich and well-designed emphasis

i. Do the materials emphasize the content of life science?

1	2	3	4	5
Little or no emphasis		Some emphasis		Rich and well-designed emphasis

j. Do the materials emphasize the content of earth science?

1	2	3	4	5
Little or no emphasis		Some emphasis		Rich and well-designed emphasis

1181

k. Do the materials emphasize the content of physical science?

1	2	3	4	5
Little or no emphasis		Some emphasis		Rich and well-designed emphasis

l. Do the instructional materials provide sufficient activities for students to develop a good understanding of key science concepts?

1	2	3	4	5
Too few learning activities		Activities provide some opportunity for students to learn some important concepts		Activities provide many rich opportunities to learn key science concepts

m. Do the instructional materials provide sufficient opportunities for students to apply their understanding of the concepts (i.e., designing of solutions to problems or issues)?

1	2	3	4	5
Very few application activities		Some application activities		Very rich in application activities

1182

n. Do the instructional materials present an accurate picture of the nature of science as a dynamic endeavor?

1	2	3	4	5
The image of science is out-of-date, inaccurate, or non-existent		The image of science is of mixed quality		The image of science is current and accurate

o. Do the materials develop an appropriate breadth and depth of science content?

1	2	3	4	5
Too narrow or too broad		Somewhat balanced		Good balance of breadth and depth

p. What is the overall quality of the science presented in the instructional materials?

1	2	3	4	5
Low		Medium		High

1183

III. The Pedagogical Design

a. Do the instructional materials provide a logical progression for developing conceptual understanding in science?

1	2	3	4	5
No logical progression of ideas		Somewhat logical progression of ideas		Logical progression of ideas that builds conceptual understanding

b. Do the instructional materials provide students with the opportunity to make conjectures, gather evidence, and develop arguments to support, reject, and revise their preconceptions and explanations for natural phenomena?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

c. To what extent do the instructional materials engage students in doing science inquiry?

1	2	3	4	5
Very few or very contrived activities for students to do science inquiry		Some good activities for students to do science inquiry		Many rich and authentic opportunities for students to do science inquiry

1184

d. To what extent do the instructional materials engage students in doing technology problem solving?

1	2	3	4	5
Very few or very contrived activities for students to do technology problem solving		Some good activities for students to do technology problem solving		Many rich and authentic opportunities for students to do technology problem solving

e. To what extent does the curriculum engage students in activities that help them connect science to everyday issues and events?

1	2	3	4	5
Very few or very contrived activities for students to make connections		Some good activities for students to make connections		Many rich and authentic opportunities for students to make connections

f. How would you rate the overall developmental appropriateness of the instructional materials, given their intended audience of ALL students at the targeted level(s)?

1	2	3	4	5
Not developmentally appropriate		Somewhat developmentally appropriate		Developmentally appropriate

1185

g. Do the materials reflect current knowledge about effective teaching and learning practices (e.g., active learning, inquiry, community of learners) based on research related to science education?

1	2	3	4	5
Do not reflect current knowledge about teaching and learning		Somewhat reflective of current knowledge about teaching and learning		Reflect well current knowledge about teaching and learning

h. Do the instructional materials provide students with the opportunity to clarify, refine, and consolidate their ideas, and to communicate them through multiple modes?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

i. Do the instructional materials provide students with the opportunity to think and communicate scientifically?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

j. Do the instructional materials provide students with activities connecting science with other subject areas?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

k. Are the instructional materials likely to be interesting, engaging, and effective for students?

1	2	3	4	5
Not at all interesting		Somewhat interesting		Interesting and engaging

l. Are the instructional materials likely to be interesting, engaging, and effective for girls and for boys?

1	2	3	4	5
Gender biased		Some sensitivity to gender issues		Equally interesting, engaging, and effective for girls and for boys

1187

m. Are the instructional materials likely to be interesting, engaging, and effective for underrepresented and underserved students (e.g., ethnic, urban, rural, with disabilities)?

1	2	3	4	5
Biased		Some sensitivity to underrepresented and underserved students		Equally interesting, engaging, and effective for underrepresented and underserved students

n. Does assessment have explicit purposes connected with decisions to be made by teachers (e.g., prior knowledge, conceptual understanding, grades)?

1	2	3	4	5
Unclear purposes		Somewhat clear purposes		Clear statement of purposes

o. Do assessments focus on the curriculum's important content and skills?

1	2	3	4	5
Poor correspondence		Fair correspondence		Full correspondence

1188

p. Do the instructional materials include multiple kinds of assessments (e.g., performance, paper/pencil, portfolios, student interviews, embedded, projects)?

1	2	3	4	5
Little or no student assessment provided		Some variety of student assessment		Complete student assessment package

q. Are the assessment practices fair to all students?

1	2	3	4	5
Fair to a few		Fair to most		Fair to all

r. Do the instructional materials include adequate and appropriate uses of a variety of educational technologies (e.g., video, computers, telecommunications)?

1	2	3	4	5
Little or no educational technology included		Some educational technology included		Many appropriate rich and useful applications of educational technology included

1189

s. What is the overall quality of the pedagogical design of these instructional materials?

1	2	3	4	5
Low		Medium		High

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____

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____

IV. Implementation and System Support

a. Will the teachers find the materials interesting and engaging?

1	2	3	4	5
Dry and boring		Somewhat interesting and engaging		Interesting and engaging

____

____

____

____

b. Do the instructional materials include information and guidance to assist the teacher in implementing the lessons?

1	2	3	4	5
No teacher support		Some teacher support		Rich and useful teacher support

____

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1190

c. Do the instructional materials provide information about the kind of resources and support system required to facilitate the district implementation of the required science materials?

1	2	3	4	5
No materials support		Some materials support		Rich and useful materials support

d. Do the instructional materials provide information about how to establish a safe science learning environment?

1	2	3	4	5
No safety information		Some safety information		Rich and useful safety information

e. Do the instructional materials provide information about the kinds of professional development experience needed by teachers to implement the materials?

1	2	3	4	5
Little or no information provided		Partial information provided		Rich and useful information provided

f. Do the materials provide guidance in how to link the materials with the district and state assessment frameworks and programs?

1	2	3	4	5
No guidance		Some guidance		Rich and useful guidance

g. Do the materials provide guidance and assistance for actively involving administrators, parents, and the community-at-large in supporting school science?

1	2	3	4	5
No guidance		Some guidance		Rich and useful guidance

h. Overall, are the materials usable by, realistic in expectations of, and supportive of teachers?

1	2	3	4	5
Teacher-unfriendly		Somewhat teacher-friendly		Teacher-friendly

V. Major Strengths and Weaknesses

a. In your opinion, what are the three major strengths of this curriculum?

____

____

b. In your opinion, what are the three major weaknesses of this curriculum?

____

____

VI. Overall Quality, Value, and Contribution

a. In your opinion, what is the overall quality of these materials relative to:

		Low				High
☐	turning students on to science?	1	2	3	4	5
☐	making students think?	1	2	3	4	5
☐	quality of science content?	1	2	3	4	5
☐	quality of pedagogy?	1	2	3	4	5
☐	quality of classroom assessments?	1	2	3	4	5
☐	encouraging teachers to teach differently?	1	2	3	4	5

b. In your opinion, what is the overall quality of these instructional materials?

1	2	3	4	5
Low		Medium		High

c. To what extent would you encourage the dissemination, adoption, and implementation of this curriculum?

1	2	3	4	5
Not worthy of dissemination, adoption, or implementation		OK to disseminate, adopt, and implement if revised		OK to disseminate, adopt, and implement as is

1193

Framework for Review: Instructional Materials for Middle School Mathematics

Title: ______________________________

Author(s): ______________________________

Publisher: ______________ Copyright date: __________

Reviewed by: ______________ Date: ______________

I. Descriptors

a. Write a brief description of the components of the curriculum upon which this review is based (e.g., teachers' guide, student books, hands-on materials, multimedia material). That is, what materials did you receive and include in your review?

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____

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b. Write a brief description of the purpose and broad goals of these materials. That is, what were the stated purposes, and what were the actual results of the materials?

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____

c. What grade levels do the materials serve?

____5 ____6 ____7 ____8

1194

d. Are the instructional materials designed to

___ provide a complete multiyear program for middle school mathematics?

___ provide a complete one-year course for middle school mathematics?

___ provide multiple modules or units that could be used to supplement other course materials for middle school mathematics?

___ provide a single module or collection of activities that could be used to supplement other course materials for middle school mathematics?

___ other (explain): ____

____

e. What are the major domains/topics of the content covered by these materials?

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II. Quality of the Mathematics

Directions: For each item, circle the number corresponding with your response to the question. ***Write an explanation for your rating of each item below the item.***

a. Does the content in the instructional materials align well with all 13 areas of the Curriculum Standards as described in the National Council of Teachers of Mathematics' (NCTM) *Curriculum and Evaluation Standards for School Mathematics*? (See attached guidelines.)

1	2	3	4	5
Omits substantial content included in NCTM and/or includes substantial content not recommended in NCTM in NCTM		Some misalignment of content with recommendations		The curriculum aligns well with content recommendations in NCTM

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____

b. Are the mathematics concepts presented in the instructional materials accurate and correct? (Provide examples of major errors where they are evident. Attach extra page if necessary.)

1	2	3	4	5
Substantial, major errors		Mostly correct, with some minor errors		Mathematically accurate and correct

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1196

c. Do the instructional materials adequately present the major concepts and adequately demonstrate and model the processes of mathematics?

1	2	3	4	5
Major concepts and processes not addressed		Major concepts and processes somewhat addressed		Major concepts and processes addressed well

d. Do the instructional materials accurately represent views of mathematical problem solving as described in the NCTM *Curriculum and Evaluation Standards for School Mathematics*?

1	2	3	4	5
Poor portrayal of problem solving		Mixed quality		Rich and accurate portrayal of problem solving

e. Do the materials use technology as a tool for learning mathematics?

1	2	3	4	5
Little or no use		Some emphasis		Rich and well-designed use

1197

f. Do the materials emphasize communication about mathematics through a variety of modalities?

1	2	3	4	5
Little or no emphasis, few modalities		Some emphasis, some modalities		Rich and well-designed emphasis, varied modalities

g. Do the materials appropriately address mathematical reasoning?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

h. Do the materials appropriately address computation?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

1198

i. Do the materials appropriately address estimation?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

j. Do the materials appropriately address numbers and number relationships?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

k. Do the materials appropriately address number systems and number theory?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

1199

l. Do the materials appropriately address patterns?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

m. Do the materials appropriately address functions?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

n. Do the materials appropriately address algebra?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

1200

o. Do the materials appropriately address geometry?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

p. Do the materials appropriately address measurement?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

q. Do the materials appropriately address statistics?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

r. Do the materials appropriately address probability?

1	2	3	4	5
Not appropriately addressed		Somewhat appropriately addressed		Appropriately addressed

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s. Do the instructional materials provide sufficient activities for students to develop a good understanding of key mathematics concepts?

1	2	3	4	5
Too few learning activities		Activities provide some opportunity for students to learn some important concepts		Activities provide many rich opportunities to learn key mathematics concepts

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t. Do the instructional materials provide sufficient opportunities for students to apply their understanding of the concepts (i.e., designing of solutions to problems or issues)?

1	2	3	4	5
Very few application activities		Some application activities		Very rich in application activities

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u. Do the materials develop an appropriate breadth and depth of mathematics content?

1	2	3	4	5
Too narrow or too broad		Somewhat balanced		Good balance of breadth and depth

v. What is the overall quality of the mathematics presented in the instructional materials?

1	2	3	4	5
Low		Medium		High

III. The Pedagogical Design

a. Do the instructional materials provide a logical progression for developing conceptual understanding in mathematics?

1	2	3	4	5
No logical progression of ideas		Somewhat logical progression of ideas		Logical progression of ideas that builds conceptual understanding

1203

b. Do the instructional materials provide students the opportunity to formulate, solve, and reflect critically on problems?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

c. To what extent are the mathematical concepts embedded in learner-appropriate contexts?

1	2	3	4	5
Very few or very contrived activities for students to do mathematical problem solving		Some good activities for students to do mathematical problem solving		Many rich and authentic opportunities for students to do mathematical problem solving

d. How would you rate the overall developmental appropriateness of the instructional materials, given their intended audience of ALL students at the targeted level(s)?

1	2	3	4	5
Not developmentally appropriate		Somewhat developmentally appropriate		Developmentally appropriate

e. Do the materials reflect current knowledge (that is, in the last 5 years) about effective teaching and learning practices (e.g., active learning, inquiry, community of learners) based on research related to mathematics education?

1	2	3	4	5
Do not reflect current knowledge about teaching and learning		Somewhat reflective of current knowledge about teaching and learning		Reflect well current knowledge about teaching and learning

f. Do the instructional materials provide students the opportunity to clarify, refine, and consolidate their ideas?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well-designed opportunity

g. Do the instructional materials provide students with activities connecting mathematics with other subject areas?

1	2	3	4	5
No opportunity		Some opportunity		Rich and well designed opportunity

h. Are the instructional materials likely to be interesting, engaging, and effective for girls and for boys?

1	2	3	4	5
No sensitivity to gender issues		Some sensitivity to gender issues		Sensitive to gender issues

i. Are the instructional materials likely to be interesting, engaging, and effective for underrepresented and underserved students (e.g., ethnic, urban, rural, with disabilities)?

1	2	3	4	5
No sensitivity to underrepresented and underserved students		Some sensitivity to underrepresented and underserved students		Sensitive to underrepresented and underserved students

j. Does assessment have explicit purposes connected with decisions to be made by teachers (e.g., prior knowledge, conceptual understanding, grades)?

1	2	3	4	5
Unclear purposes		Somewhat clear purposes		Clear statement of purposes

1206

k. Do assessments focus on the curriculum's important content and skills?

1	2	3	4	5
Poor correspondence		Fair correspondence		Full correspondence

l. Do the instructional materials include multiple kinds of assessments (e.g., performance, paper/pencil, portfolios, student interviews, embedded, projects)?

1	2	3	4	5
Little or no student assessment provided		Some variety of student assessment		Complete student assessment package

m. Are the assessment practices fair to all students?

1	2	3	4	5
Fair to a few		Fair to most		Fair to all

1207

n. Do the instructional materials include adequate and appropriate uses of a variety of educational technologies (e.g., video, computers, telecommunications)?

1	2	3	4	5
Little or no educational technology included		Some appropriate educational technology included		Many rich and useful applications of educational technology included

o. What is the overall quality of the pedagogical design of these instructional materials?

1	2	3	4	5
Low		Medium		High

IV. Implementation and System Support

a. Will the teachers find the materials interesting and engaging?

1	2	3	4	5
Dry and boring		Somewhat interesting and engaging		Interesting and engaging

b. Do the instructional materials include information and guidance to assist the teacher in implementing the lessons?

1	2	3	4	5
No teacher support		Some teacher support		Rich and useful teacher support

c. Do the instructional materials provide information about the kind of resources and support system required to facilitate the district implementation of the required mathematics materials?

1	2	3	4	5
No materials support		Some materials support		Rich and useful materials support

d. Do the instructional materials provide information about the kinds of professional development experience needed by teachers to implement the materials?

1	2	3	4	5
Little or no information provided		Partial information provided		Rich and useful information provided

1209

e. Do the materials provide guidance in how to link the materials with the district and state assessment frameworks and programs?

1	2	3	4	5
No guidance		Some guidance		Rich and useful guidance

f. Do the materials provide guidance and assistance for actively involving administrators, parents, and the community-at-large in supporting school mathematics?

1	2	3	4	5
No guidance		Some guidance		Rich and useful guidance

g. Overall, are the materials usable by, realistic in expectations of, and supportive of teachers?

1	2	3	4	5
Teacher-unfriendly		Somewhat teacher-friendly		Teacher-friendly

V. Major Strengths and Weaknesses

a. In your opinion, what are the three major strengths of this curriculum?

b. In your opinion, what are the three major weaknesses of this curriculum?

VI. Overall Quality, Value, and Contribution

a. In your opinion, what is the overall quality of these materials relative to:

	Low				High
☐ turning students on to mathematics?	1	2	3	4	5
☐ making students think?	1	2	3	4	5
☐ quality of mathematics content?	1	2	3	4	5
☐ quality of pedagogy?	1	2	3	4	5
☐ quality of classroom assessments?	1	2	3	4	5
☐ encouraging teachers to teach differently?	1	2	3	4	5

1211

b. In your opinion, what is the overall quality of these instructional materials?

1	2	3	4	5
Low		Medium		High

c. To what extent would you encourage the dissemination, adoption, and implementation of this curriculum?

1	2	3	4	5
Not worthy of dissemination, adoption, nor implementation		OK to disseminate, adopt, and implement if revised		OK to disseminate, adopt, and implement as is

1212

APPENDIX B

This appendix contains a brief description of each set of instructional materials from the Middle School Science Study that are discussed in this report. The materials are grouped as follows:

- Comprehensive, multiple continuous years, grade 6 and beyond;
- Comprehensive, multiple continuous years, grades K-6;
- Comprehensive, integrated mathematics, science, and technology, grades 7-8;
- Single-year comprehensive; and
- Technology-driven supplemental, but material for at least a full year.

Comprehensive 6-10

Title: *PRIME Science*
Contact: Richard Saykally, University of California, Berkeley
Publisher: Kendall/Hunt Publishing Co.
4050 Westmark Drive
P.O. Box 1840
Dubuque, IA 52004
1 (800) 258-5622

PRIME Science provides a U.S. adaptation of "Salter's Science"—a well-tested British multidisciplinary science program for middle grades. The science is balanced—not integrated—between life, earth, and physical science, developing conceptual understanding and integrating mathematics, technology, and decision making. The science is rigorous, interesting, and useful to the student. Among the major integrative themes that provide structure for grades six through 10 are the earth in space, properties of matter, and so forth. Each unit begins with an application. The teachers' guides are directed at first-year teachers, not teaching in their major discipline. Included are student preconceptions, safety, background, and ways of introducing the content and assessment items. The visually stimulating, attractively designed student supplements for each of the 40 units contain the application, a summary of what students should know, what they need to learn, and the activities they can do. The materials were tested and rewritten by teachers and science educators at several sites throughout the United States. Professors at the University of California, Berkeley, reviewed the materials for content accuracy. The British developers were part of the design team. Not only does the adaptation involve language translation, but also changing data to interest U.S. audiences and adding units to meet local interests and frameworks.

Materials Reviewed: Sixth-grade materials developmental form were reviewed.

1214

Strengths:

1. The program is planned to introduce science content at various grade levels and to revisit it as students advance to later grade levels. Content introduced in the sixth grade might be revisited several times in later grades, giving students opportunities to further develop their own understanding as they mature.
2. The activity-based approach gives students experiences with numerous science concepts in a way they will more likely remember and understand.
3. The teacher materials provide support for both the experienced teachers and those unfamiliar with the content being taught. It is flexible enough to allow teachers to supplement the curriculum with their own experiences and to integrate current events.

General Concerns:

1. Efforts should include more of the emerging technologies (e.g., CD-ROM).
2. More of the student challenges should be open ended to develop inquiry skills.
3. The program should include a greater variety of assessment items.

Comprehensive 6-8

Title: *Science 2000*
A Middle School Technology Based
Curriculum Management Tool

Contact: Ellen M. Nelson

Publisher: Decision Development Corp.
2680 Bishop Drive
Suite 122
San Ramon, CA 94583
(510) 830-8894

Science 2000 is a multimedia science curriculum for grades 5 to 8 that uses a constructive pedagogy, a thematic approach, and a multidisciplinary organization of science. At the sixth- to eighth-grade levels, four different thematic units integrate materials from earth, life, and physical science leading to a decision-making situation in which students apply knowledge to solve an STS-type problem. Grade six units are: Earth's Changing Environments, Growth and Development, Physics of Building, and Chemistry of Food. Eighth-grade units are: Genetics and Heredity, Sun and Global Climate Change, Ears to the Sky, and Natural Disasters. The large ideas of science and science as a method of knowing are stressed. Each unit includes teacher lessons, student activities, and bibliographic resources stored in software; a learning resource management tool compatible with either IBM or Macintosh computers, which allows teachers to choose, write, and edit lessons, as well as assign student activities, access videodiscs, and review supplemental material; four videodiscs; eight hands-on activities; and models for pre- and in-service teacher education. *Science 2000* correlates to the standards and has been adopted as a textbook alternative in Alabama, Florida, Georgia, Kentucky, Louisiana, Texas, Utah, and West Virginia.

Materials Reviewed: Units in grades 6 and 8 were reviewed.

1216

Strengths:

1. The professional quality of the programs and the software are high, video clips and databases are current, and themes and story lines are engaging and appropriate.
2. The materials are diverse enough to support a variety of uses by both inquisitive students and creative teachers.
3. There is very good alignment with standards, and the focus on four major questions per year allows in-depth study. The thematic, problem-solving approach is question driven, and there are some open-ended questions.

General Concerns:

1. The actual assessment pieces are vague.
2. The program's complexity (extensions and flexibility) make the program difficult to use. The technology was very difficult to set up. Teachers will need considerable in-service training to use this program effectively.
3. The lack of text may cause problems with parents, and there are no materials for communicating with them.

Comprehensive 6-8

Title: *Middle School Science and Technology*
Contact: Michael Doherty, Biological Sciences Curriculum Study
Publisher: Kendall/Hunt Publishing Co.
4050 Westmark Drive
P.O. Box 1840
Dubuque, IA 52004
1 (800) 258-5622

Middle School Science and Technology is a three-year, activity-based, middle school program for grades 6 to 8 as a continuation of the Biological Sciences Curriculum Study (BSCS) K-6 program. It focuses on the development of the early adolescent, illustrates careers in science, and emphasizes reasoning and critical thinking. The content is structured around major themes of patterns of change, diversity and limits, and systems and change, with emphasis on personal dimensions of science and technology, science and technology in society, technological problem solving, and the nature of scientific explanation. The content is strongest in the life sciences, but generally aligns well with the content recommendations in the *National Science Education Standards (NSES).*

Materials Reviewed: Sixth-, seventh-, and eighth-grade materials were reviewed.

Strengths:

1. Emphasis is on development and use of good pedagogy; for example, the philosophy and approach to cooperative learning is thoroughly explained and consistently used.
2. There is excellent attention to professional development, teaching, program, system, assessment, as well as content; there is a high level of consistency with the standards.
3. The "less is more" approach is used to build an accurate understanding of overriding concepts and related subconcepts.

1218

General Concerns:

1. The eighth-grade materials are not consistent with the format and approach so effectively used for grades six and seven. The quality of the introductory units is not equivalent to the other units.
2. The teacher support materials tend to be wordy to the detriment of easy understanding.
3. There is limited opportunity for students to develop and pursue questions of their own.

Comprehensive K-6

Title: *Science for Life and Living*
Contact: Catherine Monson, Biological Sciences Curriculum Study
Publisher: Kendall/Hunt Publishing Co.
4050 Westmark Drive
P.O. Box 1840
Dubuque, IA 52004
1 (800) 258-5622

Science for Life and Living is a K-6 elementary science program that encourages students to make decisions and take actions that will improve the quality of their lives. At each grade level, one major concept and one major skill integrate the disciplines, so that students can make meaningful connections between areas of study. For example, Level 1 ideas and concepts including the following: Introduction to Order and Organization—Objects and Properties (science), Materials and Structures (technology), Safety and Security (health). Major ideas in Levels 2-6 include the following: Level 2—Introduction to Change and Measurement; Level 3—Introduction to Patterns and Predictions; Level 4—Introduction to Systems and Analysis; Level 5—Introduction to Energy and Investigation; Level 6—Introduction to Balance and Decisions. The curriculum uses the Biological Sciences Curriculum Study instructional model, is based on constructivist learning theory, integrates cooperative learning, and includes kits of hands-on materials and an implementation guide for use by personnel in school districts and school buildings. The components of the program consist of: (1) two teachers' guides in three-ring binders for each level, K-6; (2) student materials for each level; (3) kits of hands-on materials for each level; and (4) an implementation guide for administrators and leadership teams within schools.

Materials Reviewed: Two levels, grades five (Energy and Investigation) and six (Balance and Decisions), of the curriculum were reviewed. Each level consisted of a teacher guide in the form of a notebook plus a student text. The *Implementation Guide* was also reviewed.

1220

Strengths:

1. Teacher guide takes the teacher step-by-step through the curriculum—valuable for the science-timid teacher.
2. The materials utilize inexpensive supplies.
3. Team skills are taught.
4. The *Implementation Guide* for use by districts, principals, and schools is excellent.

General Concerns:

1. At times the content appears to be very thin.
2. There is too much focus on terms, and the content diagrams are somewhat unfriendly.
3. Hands-on, active learning is not always present; activities are more like demonstrations; mostly pencil-and-paper activities are used.

Comprehensive K-6

Title: *Full Option Science System (FOSS)*
Contact: Lawrence F. Lowry, Lawrence Hall of Science
Publisher: EBEC
310 South Michigan Avenue
Chicago, IL 60604
1 (800) 554-9862

The Full Option Science System (FOSS) for grades K-6 is offered to schools as a collection of standalone modules on different topics appropriate for students in grades K-6. The module consists of a kit of student materials, a detailed teacher's guide, and a teacher's preparation video. The activities are organized into four strands: Life Science, Physical Science, Earth Science, and Scientific Reasoning and Technology. Five unifying themes weave through the modules of the program: Pattern, Structure, Interaction, Change, and System. Student assessment suggestions are included. Four modules in any academic year would easily constitute a complete curriculum. Eight modules (two in each strand) have been developed to be appropriate for students in sets of grades K-2, 3-4, and 5-6. There are two language versions of all student materials packaged in each guide, Spanish and English. There are also suggestions for cultural enrichment, sensitivity to cultural difference, and sheltered instruction. *FOSS* employs cognitive and constructivist approaches to science instruction. Students work in collaborative groups of four to maximize effective use of materials and promote student-student interactions. Fundamental academic skills of language and mathematics are integrated into all activities, and guidance is provided to help teachers lead productive discussions.

Materials Reviewed: Units reviewed were Life Science: Food and Nutrition, and Environments; Physical Science: Levers and Pulleys, and Mixtures and Solutions; Earth Science: Solar Energy, and Landforms.

Strengths:

1. Materials are user friendly, clear, and clean; teachers' guides and videos are excellent.
2. Modules are built on a strong psychological and teaching research foundation.
3. There is strong science content with a good balance of depth and breadth.
4. Children will enjoy the cleverly designed activities and materials.
5. Assessments are strong; questioning approaches direct teachers regarding the types of questions to ask.

General Concerns:

1. Many of the hands-on science activities are excellent, but materials do not encourage students to ask their own questions.
2. Materials provide guided inquiry, but little open-ended inquiry.
3. Bibliography and history of science are thin.

Comprehensive K-6

Title: *Insights: A Hands-On Inquiry Science Curriculum*
Contact: Karen Worth, Education Development Center
Publisher: Optical Data Corporation
30 Technology Drive
Warren, NJ 07059
1 (800) 248-8478

The Education Development Center's *Insights* is a hands-on, inquiry-oriented science program designed for self-contained elementary classrooms. The science is appropriate and current, and the supplies required are inexpensive and easy to obtain. These materials are designed to improve students' abilities to think critically, use language, and solve problems using the natural world as an experimental base. Since urban systems face extremely complex problems, the science materials are specifically aimed at these systems. There is a balance of life, physical, and earth sciences, tying the experimental base to the urban setting where appropriate. The materials integrate science with the rest of the elementary curriculum, particularly language arts and mathematics.

Materials Reviewed: Six units were reviewed: Changes of State, grades 4-5; The Mysterious Powder, grades 4-5; Reading the Environment, grades 4-5; Structures, grade 6; There Is No Away, grade 6; and Human Body Systems, grade 6.

Strengths:

1. The topics are important for the age levels, with appropriate and current science.
2. The supplies called for are inexpensive.
3. Activities stretch over a period of time and allow exploration on the part of students.
4. Effective sequencing of the curriculum within the units (i.e., activities) provides good guidance for teachers; assessments are also good.

1224

General Concerns:

1. Minor errors and inconsistencies exist and should be edited out.
2. The amount of information provided to teachers in the background text appears insufficient.
3. Assessment questions need to focus on topics that are familiar/ accessible to all students (an example of a bicycle activity would leave those without bicycles at a disadvantage).

Comprehensive K-6

Title: *Science and Technology for Children*
Contact: Douglas M. Lapp, National Science Resource Center, Smithsonian Institution, and National Academy of Sciences
Publisher: Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215
1 (800) 227-1150

The National Science Resource Center (NSRC) joined with the National Academy of Sciences and the Smithsonian Institution to bring together teachers, educators, and scientists with a great diversity and richness of experience to create and disseminate an innovative elementary science program for grades one through six called *Science and Technology for Children (STC)*. Twenty-four hands-on, inquiry-centered units constitute a complete elementary science program for grades one through six. In addition, there are 16 science readers to complement the 16 *STC* units for grades three through six. Each *STC* unit provides children with the opportunity for in-depth learning about topics in the physical, life, or earth sciences and technology through direct observation and experimentation. The units invite children first to develop hypotheses and then to test their ideas just as professional scientists do. Along the way, children develop patience, persistence, and confidence in their own ability to tackle and solve real problems. The teachers act as guides to the hands-on learning, encouraging students to explore new ideas for themselves and expand their understanding of the world around them. School districts are able to use these materials either collectively, as a complete elementary science program, or individually, as a supplement to an existing science program. These materials are designed to meet the needs of elementary school children from diverse cultural and ethnic backgrounds.

Materials Reviewed: Of the 24 units, those considered appropriate for fifth and sixth grades were Food Chemistry, Electric Circuits, Ecosystems, Animal Studies, Microworlds, Experiments with Plants, Measuring Time, and Floating and Sinking.

Strengths:

1. The program presents carefully sequenced, hands-on activities designed to lead to conceptual development.
2. Rich, strong, and accurate science content is a real strength.
3. The program is positively aligned with standards, including technology content and assessment.

General Concerns:

1. The materials are very teacher directed, with insufficient opportunity for students to ask and answer their own questions.
2. The teachers' guide has too much information that is hard to locate and use.

Integrated Comprehensive 7-8

Title: *Integrated Mathematics, Science and Technology*
Contact: Francie Loepp, Illinois State University
Publisher: Glen Co. Macmillan
3008 West Willow Knolls Drive
Peoria, IL 61614
(309) 438-3089

The *Integrated Mathematics, Science and Technology (IMaST)* program is centered around the topics of biotechnology, manufacturing, and forecasting. Each unit includes objectives, experiential learning, appropriate use of multimedia, and appropriate technology and evaluation instruments. The materials motivate students, especially those from groups underrepresented in technological careers, to learn the foundation concepts of mathematics, science, and technology by involving them in enriched learning experiences relevant to their daily lives. The materials are designed to be used by mathematics, science, and technology teachers concurrently over a nine-week school session. Assessment activities designed for mathematics, science, and technology are included. Though some content areas are not addressed, there is generally excellent content alignment with the *National Science Education Standards (NSES).*

Materials Reviewed: Seventh-grade materials were reviewed. The eighth-grade materials are under development.

Strengths:

1. The materials and activities apply a hands-on approach.
2. The content and activities in science, mathematics, and technology are integrated and there is a well-represented progression of ideas and skills. The technology and science content is current.
3. The program provides teacher materials and activities as a basis for an integrative approach to learning.

1228

General Concerns:

1. The program's activities and approaches are somewhat prescriptive.
2. It is not clear that there is sufficient attention to activities for students with high potential in science, mathematics, and/or technology.
3. The format of the program is not teacher friendly.
4. Implementation of the program may be difficult. The design of the program—three teachers teaching the program concurrently—may not fit into the schedule of some schools.

Single-Year Comprehensive

Title: *Event-Based Science: Earth Science*
Contact: Russell Wright
Montgomery County Public Schools
850 Hungerford Drive
Rockville, MD 20850
Publisher: Addison-Wesley Publishing Co.
Route 128
Reading, MA 01867
1 (800) 552-2259

The materials in *Event-Based Science: Earth Science* (EBS) provide a yearlong, event-based science curriculum for heterogeneously grouped middle school students in grades 6-9 for use primarily in departmentalized earth science classes. *EBS* is different from other approaches to science instruction and curriculum writing. The event focus (e.g., earthquakes, volcanoes, tornadoes) makes each unit topical and relevant to early adolescents. It allows science to become less compartmentalized. It allows for a natural highlighting of non-traditional roles filled by women and minorities. High-interest activities are models for other activities. The approach taken by *EBS* requires students to explore other sources of information (biographies, newspapers) in order to complete class assignments. *EBS* stresses alternative assessment techniques and grading strategies that reward success and downplay failure. Nationally disseminated products include a textbook, a teacher's resource notebook, and videotape and/or videodisc support.

Materials Reviewed: All current modules and two pilot test modules were reviewed.

Strengths:

1. The materials have a strong inquiry focus.
2. The materials are highly student centered with relevant tasks.
3. There are good uses of authentic assessment.
4. The modules are interchangeable.

1230

General Concerns:

1. There are a limited number of science activities.
2. The content of the videos could be more content-rich, but the current "hook" they provide is well done.
3. Some pilot test modules contain content errors and are not generally as engaging as the earlier work.

Single-Year Comprehensive

Title: *Science Education for Public Understanding Program (SEPUP): Issues-Oriented Science for Secondary Schools*
Contact: Herbert D. Their, University of California, Berkeley
Publisher: LAB-AIDS, Inc.
17 Colt Court
Ronkonkoma, NY 11779
(516) 737-1133

The *Science Education for Public Understanding Program (SEPUP)* materials support two one- year courses of study: a concrete course for middle school and a course emphasizing global issues for high school. The courses stress issue-oriented science and the use of scientific evidence and risk-benefit analysis in making decisions. These courses continue the emphasis of the *Chemical Education for Public Understanding Program (CEPUP),* societal issues involving the use of chemicals, and expand the scope of dealing with other issues of life, earth and physical sciences, and technology. Eight modules cover many of the large themes of science proposed in The American Association for the Advancement of Science's Project 2061 along with issue-oriented themes such as evidence-based decision making, uncertainty and controversy, and science and societal systems. Materials include a teacher's resource book, a student text, projects and extension activities, kits, videotapes, and software. Assessment of student learning is built into these materials. Note: A set of life science modules for *SEPUP* is now under development.

Materials Reviewed: All four sections of *Issues, Evidence, and You* were reviewed.

Strengths:

1. The materials are engaging, provide good activities for student decision making, and offer opportunities for student-designed inquiry.
2. The scope and sequence allow for conceptual growth.
3. There is an excellent assessment component.

1232

General Concerns:

1. Materials cannot be used as a "full" curriculum; additions are needed in the areas of life and earth science.
2. There is limited use of educational technology.

1233

Single-Year Comprehensive

Title: *Chemical Education for Public Understanding Project*
Contact: Herbert D. Their, University of California, Berkeley
Publisher: LAB-AIDS, Inc.
17 Colt Court
Ronkonkoma, NY 11779
(516) 737-1133

The *Chemical Education for Public Understanding Project (CEPUP)* at the Lawrence Hall of Science has developed 12 modular sets of interdisciplinary materials for use at the middle/junior high school level that can comprise a one-year course. The content is up-to-date, is accurate, and gives students opportunities to study materials in depth through active application of concepts. The materials introduce students to scientific concepts in chemistry and their interaction with people and the environment. *CEPUP* materials highlight areas of direct societal concerns associated with science and technology. Students are given chemistry-based laboratory investigations and experiments that focus on the environment, biotechnologies, industrial processes, agricultural practices, alternative energy sources, and health science.

Materials Reviewed: The *Teacher's Guide,* including student sheets, and *Guide for Implementation* were reviewed. All 12 of the modules were examined.

Strengths:

1. The materials address real-life issues and give students multiple opportunities to apply chemistry.
2. The focus on interdisciplinary topics is one that many middle school teachers and students will find appealing.
3. The modular format is a strength.
4. These materials help students to develop good data skills.

1234

General Concerns:

1. The classroom assessments emphasize written tests; many potential alternative assessments are not developed.
4. The materials emphasize scientific processes and do not sufficiently emphasize scientific theory and models.

1235

Single-Year Comprehensive

Title: *Junior High/Middle School Life Science Program*
Contact: Harold Pratt, Jefferson County Public Schools
Publisher: Kendall/Hunt Publishing Co.
4050 Westmark Drive
P.O. Box 1840
Dubuque, IA 52004
1 (800) 258-5622

The Jefferson County, Colorado Public School System developed materials that constitute a year-long junior high/middle school program in life science that emphasizes the understanding and care of the human body. The development was done in close cooperation with the University of Colorado Health Sciences Center and with the support of local physicians and university-level scientists and science educators. The program provides an alternative for teachers and schools seeking materials to improve their life science curriculum and serves as a resource for schools seeking to integrate health topics with their existing life science course. General topics included in the materials are life science, human biology and reproduction, ecology, cells, and genetics. The life science section, although only in the context of human biology, aligns well with the *National Science Education Standards (NSES).* Part of the program directs students toward an ability to make decisions in and about their local environment. Materials include student text and investigations, an extensive *Teachers' Guide,* the *Teachers' Resource Book* (which includes transparency masters, worksheets, etc.), and the *Guide for Implementation.*

Materials Reviewed: The student text and investigations, *Teacher's Guide, Teacher's Resource Book,* and the *Guide for Implementation* were reviewed.

Strengths:

1. The materials contain a strong activity orientation, and many students will find them engaging.
2. The materials explicitly help students move from the big picture to smaller ideas.
3. The materials provide good teacher support.
4. The health-related topics contain sensitive treatment of key issues in language appropriate for middle school students.

General Concerns:

1. The materials are weak in the area of student assessments.
2. Students are not encouraged to design their own investigations.
3. This curriculum is overstuffed—there is more material presented than students can reasonably learn, and much of it focuses on facts and vocabulary.

1237

Supplemental Technology Driven

Title: *National Geographic Kids Network*
Contact: Daniel Barstow, TERC, Inc.
Publisher: National Geographic Society
Educational Services
Department 89
Washington, DC 20036
1 (800) 368-2728

These materials extend those developed for grades 4-6 with nine units (or approximately 90 weeks) of supplementary science material targeted for grades 7-9 and organized around telecommunications-based collaborative student research. The materials contain coordinated curriculum and software and were designed by TERC in collaboration with the National Geographic Society (NGS). Each unit requires students to gather data, share these data with students in other school districts over a telecommunications network, and analyze the collected data. This approach allows students to perform like scientists. Before gathering the data, students study the underlying science content and learn the experimental skills required to perform appropriate measurements. Following data collection, students apply data analysis techniques and reflect on the social significance of the problem addressed in the study. Study areas proposed include Conditions for Growth, Trees, Student Fitness, Acid Deposition, Recycling and Composting, Radon, Alternative Energy Sources, Automobile Accidents, and Greenhouse Gases. The materials include a teacher's guide, readings, student lab sheets, assessments, overhead transparencies, posters, works and reference disks, and a *Quick Guide to Using NGS Works.*

Materials Reviewed: The unit "What Is Our Soil Good For?" was reviewed.

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Strengths:

1. Technology is used well as a tool in these materials.
2. There is good focus on science as inquiry.
3. The data collection/analysis activities are strong.
4. The materials permit students to explore science experiences in depth.

General Concerns:

1. The materials are expensive, the software is complicated, and difficulties can be anticipated in its use.
2. The technology is not used to its full potential. There is a lack of graphics, the menus are tedious, and data analysis tools are weak.
3. These materials do not compose a full-year program.

The Project 2061 Curriculum-Analysis Procedure

Introduction

Deciding which curriculum materials to use is one of the most important professional judgments that educators make. Textbook adoption committees make recommendations that influence instruction for years to come, and the daily decisions teachers make about which teaching units or chapters to use—and how to use them—largely determine what and how students will be expected to learn.

Such important decisions require a valid and reliable method for evaluating the quality of curriculum materials. Even an in-depth review of the topics covered by a textbook or a teaching unit may not be sufficient to determine whether the material will actually help students learn that content. What is needed is a manageable process for examining curriculum materials that gets below the surface by focusing intensely on the *appropriateness of content* and the *utility of instructional design.*

With funding from the National Science Foundation and in collaboration with hundreds of K-12 teachers, curriculum specialists, teacher educators, scientists, and materials developers, Project 2061 of the American Association for the Advancement of Science (AAAS) has been developing a process for analyzing curriculum materials. Field tests suggest that Project 2061's curriculum-analysis procedure will not only serve the materials adoption needs of the schools but also help teachers revise existing materials to increase their effectiveness, guide developers in the creation of new materials, and contribute to the professional development of those who use it.

Specific Learning Goals Are Key

Until recently, there was nothing against which to judge appropriateness of content and utility of instructional design. Now, as a result of the standards-based reform movement in education, these judgments can be made with a high degree of confidence. In science and mathematics, for example, the appearance of *Science for All Americans* (AAAS, 1989), *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), *Benchmarks for Science Literacy* (AAAS, 1993), and *National*

Science Education Standards (National Research Council, 1996) has made it possible to make more thoughtful decisions about curriculum materials than ever before.

Although the Project 2061 curriculum-analysis procedure was developed using the learning goals in *Benchmarks* and the mathematics and science standards, subsequent work has indicated that some state education frameworks also can be used. Indeed, the process would seem to apply to any K-12 school subject for which specific learning goals have been agreed upon. These goals must be explicit statements of what knowledge and skills students are expected to learn, and they must be precise. Vague statements such as "students should understand energy" are not adequate. Instead, consider this benchmark dealing with energy-related concepts that students should know by the end of the eighth grade:

> *Most of what goes on in the universe—from exploding stars and biological growth to the operation of machines and the motion of people—involves some form of energy being transformed into another. Energy in the form of heat is almost always one of the products of an energy transformation.*

Similar explicit statements can be found in the fundamental concepts of the National Research Council's *National Science Education Standards (NSES).*

At its simplest level, the Project 2061 curriculum-analysis procedure involves the following five steps:

- **Identify specific learning goals to serve as the intellectual basis for the analysis**. This is done before beginning to examine any curriculum materials. The source for appropriate goals can be national standards or benchmark documents such as those mentioned above, state or local standards and curriculum frameworks, or sources like them. To be useful, the goals must be precise in describing the knowledge or skills they intend students to have. If the set of goals is large, a representative sample of them should be selected for purposes of analysis.
- **Make a preliminary inspection of the curriculum materials to see whether they are likely to address the targeted learning goals**. If there appears to be little or no correspondence, the materials can be rejected without further analysis. If the outlook is more positive, go on to a content analysis.

- **Analyze the curriculum materials for alignment between content and the selected learning goals.** The purpose here is to determine, citing evidence from the materials, whether the content in the material matches specific learning goals—not just whether the topic headings are similar. At the topic level, alignment is never difficult, since most topics—heredity, weather, magnetism, and so forth—lack specificity, making them easy to match. If the results of this analysis are positive, then reviewers can take the next step.
- **Analyze the curriculum materials for alignment between instruction and the selected learning goals.** This involves estimating the degree to which the materials (including their accompanying teacher's guides) reflect what is known generally about student learning and effective teaching and, more important, the degree to which they support student learning of the *specific knowledge and skills for which a content match has been found.* Again, evidence from the materials must be shown.
- **Summarize the relationship between the curriculum materials being evaluated and the selected learning goals.** The summary can take the form of a profile of the selected goals in terms of the content and instruction criteria, or a profile of the criteria in terms of the selected goals. In either case, a statement of strengths and weaknesses should be included. With this information in hand, reviewers can make more knowledgeable adoption decisions and suggest ways for improving the examined materials.

In addition to its careful focus on matching content and instruction to very specific learning goals, the Project 2061 procedure has other features that set it apart. For example, its emphasis on collecting explicit evidence (citing page numbers and other references) of a material's alignment with learning goals adds rigor and reliability to decisions about curriculum materials. Similarly, the Project 2061 procedure calls for a team approach to the analytical task, thus providing opportunities for reviewers to defend their own judgments about materials and to question those of other reviewers. These and other characteristics help make participation in the analytical process itself a powerful professional development experience.

THE PROJECT 2061 CURRICULUM-ANALYSIS PROCEDURE IN DETAIL

To provide a better sense of how the procedure works, the following describes in more detail each step in the procedure, using learning goals from Project 2061's *Benchmarks for Science Literacy* as an illustrative frame of reference. The description pays particular attention to the various criteria used to evaluate the instructional effectiveness of materials.

Identify specific learning goals to serve as the intellectual basis for the analysis. After reviewers have agreed upon a set of learning goals as a framework for the analysis (in this case, the benchmarks in *Benchmarks for Science Literacy*), the task is then to choose specific benchmarks that will serve as the focus of further study.

When evaluating standalone curriculum units that cover a relatively short period of time, it might be possible and worthwhile to analyze *all* of the benchmarks that appear to be targeted by the material. However, in the evaluation of year-long courses or multiyear programs, this becomes impractical. Therefore, a crucial step in the analysis procedure is the sampling of a few benchmarks that will lead to valid and reliable generalizations about the material.

Sampling of benchmarks should be representative of the whole set of goals specified in *Benchmarks for Science Literacy* and should reflect the reviewers' needs. For example, if the review committee's task is to select a course in high school Biology that is aligned with *Benchmarks,* it might identify a sample of benchmarks from life science sections in *Benchmarks* (e.g., cells, heredity, and evolution) and from other sections (e.g., nature of scientific inquiry, models, and communication skills). When examining middle-school science materials, one would probably want to broaden the range of benchmarks examined to include some from physical and earth science topics (e.g., energy, forces, and processes that shape the earth).

Make a preliminary inspection of the curriculum materials to see whether they are likely to address the targeted learning goals. Once benchmarks have been selected, the next step is to make a first pass at the materials to identify those whose content appears to correspond reasonably well to *Benchmarks.* Materials that do not meet these initial criteria are not analyzed further.

Reviewers then examine materials on the shortened list more carefully to locate and record places where each selected benchmark seems to be targeted (e.g., particular readings, experiments, discussion questions). If several sightings are found for some or all of the sample benchmarks in the material, then these sightings will be looked at more carefully in subsequent steps of the analysis. If, on the other hand, sightings cannot be found for a significant number of the sample benchmarks, then the material is dropped from the list.

Analyze the curriculum materials for alignment between content and the selected learning goals. This analysis is a more rigorous examination of the link between the subject material and the selected learning goals and involves giving precise attention to both ends of the match—the precise meaning of the benchmark on one end and the precise intention of the material on the other.

With respect to each of the sampled benchmarks, the material is examined using such questions as:

- Does the content called for in the material address the substance of a specific benchmark or only the benchmark's general "topic"?
- Does the content reflect the level of sophistication of the specific benchmark, or are the activities more appropriate for targeting benchmarks at an earlier or later grade level?
- Does the content address all parts of a specific benchmark or only some? (While it is not necessary that any particular unit would address all of the ideas in a benchmark or standard, the K-12 curriculum as a whole should do so. The purpose of this question is to provide an account of precisely what ideas are treated.)

In addition, an attempt is made to estimate the degree of overlap between the material's content and the set of benchmarks of interest. Thus, this step in the analysis is designed to answer questions regarding the material's inclusion of content that is not required for reaching science literacy and the extent to which the material distinguishes between essential and non-essential content. (While distinguishing content essential for literacy from non-essential content in material might seem to be a luxury, it assists teachers in determining the range of students for which the material can be used. Identifying the non-essential material makes it easier for the teacher to direct better students to enrichment activities and allows students themselves to avoid overload from ideas that go beyond what is vital.)

Analyze the curriculum materials for alignment between instruction and the selected learning goals. The purpose here is to estimate how well material addresses targeted benchmarks from the perspective of what is known about student learning and effective teaching. The criteria for making the judgments in the instructional analysis are derived from research on learning and teaching and on the craft knowledge of experienced educators. In the context of science literacy, these are summarized in Chapter 13, "Effective Learning and Teaching," of *Science for All Americans*; in Chapter 15, "The Research Base," of *Benchmarks for Science Literacy*; and in Chapter 3, "Science Teaching Standards," of *National Science Education Standards*.

From these sources, seven criteria clusters (shown below) have been identified to serve as a basis for the instructional analysis (for the specific questions within each cluster, see Appendix on page 137). The proposition here is that (1) the analysis would tie the instruction to each one of the sample benchmarks rather than look at instructional strategies globally and (2) in the ideal, *all* questions within each cluster would be well-addressed in any material—they are not alternatives.

Cluster I. Providing a Sense of Purpose: Part of planning a coherent curriculum involves deciding on its purposes and on which learning experiences will likely contribute to those purposes. But while coherence from the curriculum designers' point of view is important, it may not give students an adequate sense of what they are doing and why. This cluster includes criteria to determine whether the material attempts to make its purposes explicit and meaningful to students, either by itself or by instructions to the teacher.

Cluster II. Taking Account of Student Ideas: Fostering better understanding in students requires taking time to attend to the ideas they already have, both ideas that are incorrect and ideas that can serve as a foundation for subsequent learning. Such attention requires that teachers be informed about prerequisite ideas/skills needed for understanding a benchmark and what their students' initial ideas are—in particular, the ideas that may interfere with learning the scientific information. Moreover, teachers can help address students' ideas if they know what is likely to work. This cluster examines whether the material contains specific suggestions for identifying and relating to student ideas.

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Cluster III. Engaging Students with Phenomena: Much of the point of science is explaining phenomena in terms of a small number of principles or ideas. For students to appreciate this explanatory power, they need to have a sense of the range of phenomena that science can explain. "Students need to get acquainted with the things around them—including devices, organisms, materials, shapes, and numbers—and to observe them, collect them, handle them, describe them, become puzzled by them, ask questions about them, argue about them, and then try to find answers to their questions." (*Science for All Americans*, p. 201) Furthermore, students should see that the need to explain comes up in a variety of contexts.

Cluster IV. Developing and Using Scientific Ideas: *Science for All Americans* includes in its definition of science literacy a number of important yet quite abstract ideas (e.g., atomic structure, natural selection, modifiability of science, interacting systems, common laws of motion for earth and heavens). Such ideas cannot be inferred directly from phenomena, and the ideas themselves were developed over many hundreds of years as a result of considerable discussion and debate about the cogency of theory and its relationship to collected evidence. Science literacy requires that students see the link between phenomena and ideas and see the ideas themselves as useful. This cluster includes criteria to determine whether the material attempts to provide links between phenomena and ideas and to demonstrate the usefulness of the ideas in varied contexts.

Cluster V. Promoting Student Reflection: No matter how clearly materials may present ideas, students (like all people) will assign their own meanings to them. Constructing meaning well is aided by having students (1) make their ideas and reasoning explicit, (2) hold them up to scrutiny, and (3) recast them as needed. This cluster includes criteria for determining whether the material suggests how to help students express, think about, and reshape their ideas to make better sense of the world.

Cluster VI. Assessing Progress: There are several important reasons for monitoring student progress toward specific learning goals. Having a collection of alternatives can ease the creative burden on teachers and increase the time available to analyze student responses and make adjustments in instruction based on those responses. This cluster includes criteria for evaluating whether the material includes a variety of goal-relevant assessments.

Cluster VII. Enhancing the Learning Environment: Many other important considerations are involved in the selection of curriculum materials—for example, the help they provide to teachers in encouraging student curiosity and creating a classroom community where all can succeed, or the material's scientific accuracy or attractiveness. The criteria listed in this cluster provide reviewers with the opportunity to comment on these and other important features.

Summarize the relationship between the curriculum materials being evaluated and the selected learning goals. In the preliminary inspection, a few benchmarks were selected as representative of the set of goals that the material appears to target. Having analyzed whether the content in the material matches these specific benchmarks and how well the instructional strategies in the material support students learning these benchmarks, the final step in the process is to provide a profile of the material based on this analysis.

The analysis makes it possible to produce two sets of profiles. The first illustrates how well the material treats *each* benchmark (for which a content match was found) across all criteria examined in the instructional analysis. Based on these profiles, conclusions can be made about what the material under consideration can be expected to accomplish in terms of benchmarks. For example, the profiles may indicate that the material treats one of the examined benchmarks well and the rest only moderately or poorly.

The second set of profiles illustrates how well the material meets each *criterion* in the instructional analysis tool across all benchmarks examined. These profiles point to major strengths and weaknesses in the instructional design of the material. For example, the profiles may indicate that the material consistently includes appropriate experiences with phenomena relevant to the benchmarks but only occasionally provides students with opportunities to reflect on these experiences. Depending on the time available and their interests, a review committee could decide to produce either one or both sets of profiles. Profiles of different materials provide the basis for selection decisions.

Support for Users

Project 2061 is in the process of developing "Resources for Science Literacy: Curriculum Evaluation," a CD-ROM that will offer full instruction in using the procedure. The CD-ROM and its print companion volume will contain (1) detailed instructions for evaluating curriculum materials in light of *Benchmarks*, national standards, or other learning goals of comparable specificity; (2) case-study reports illustrating the application of the analysis procedure to a variety of curriculum materials; (3) a utility for relating findings in the case-study reports to state and district learning goals; and (4) a discussion of issues and implications of using the procedure.

Project 2061 also offers introductory workshops and longer training institutes to groups of educators. Typically three to six days long, the training institutes can be adapted to suit a variety of needs and time constraints. The project has offered customized workshops for K-12 science and mathematics teachers, teacher educators, school and university administrators, developers of curriculum materials, and policy makers. Depending on the interests of participants, the workshops can focus on understanding learning goals, selecting materials, revising existing materials, or evaluating curriculum frameworks, among other possibilities.

For information on Project 2061's workshops and institutes (or any aspects of Project 2061's work) contact Mary Koppal, Project 2061, American Association for the Advancement of Science (see the Guide to Using the Methods of Analysis section of this *Guidebook* for contact information).

Putting the Project 2061 Curriculum-Analysis Procedure to Work

Many of the educators involved in developing and field testing the Project 2061 procedure have begun to use it to decide on materials for their classrooms, school districts, or states; to identify shortcomings in materials they are using; and to suggest ways to improve them. Here are a few examples of how educators have adapted the procedure to their local needs and time constraints:

San Antonio. Faced with the task of selecting a new high-school physical science textbook from five possible choices, a San Antonio school district committee requested training in the Project 2061 curriculum-analysis procedure. Already familiar with *Benchmarks for Science Literacy* and *Science for All Americans*, these 12 educators spent two days studying Project 2061's analytical criteria, as well as some additional criteria decided locally. Committee members then evaluated one material apiece, with at least two committee members independently evaluating each material. When finished with their independent evaluations, those educators reviewing the same material met to compare their results and to come to an agreement about the value of the material. Then, about three weeks after the initial training, the whole group reconvened to share their results and settle on the material. Because the evaluation procedure requires reviewers to cite evidence for judgments made, the reviewers were prepared to justify their recommendations, pointing to specific instructional strategies for particular learning goals in physical science.

After much discussion, the reviewers reached agreement on one material for the district. Throughout the process, the reviewers were very reflective and motivated by the work at hand. In fact, because the evaluation procedure had revealed some weaknesses even in the material they agreed to select, they decided to write a supplemental unit on one topic.

Philadelphia. The Philadelphia school district was already committed to teaching toward specific learning goals derived from *Benchmarks* and *National Science Education Standards* when it set out to identify materials that are aligned with those goals. Their list of possibilities included some materials developed through National Science Foundation funding and some materials that had been favorably evaluated by the Project 2061 pilot and field test participants. The district held training institutes to introduce teachers to the evaluation procedure and to develop evaluation skills that they would use to select materials from the list of possibilities. More than 200 teachers participated in the institutes, giving the district a cadre of leaders who could assist in the school-based selection of curriculum materials.

After employing the procedure to select materials for use in their classrooms, teachers planned to make a more thorough evaluation of the materials when they eventually put them to use. Findings from the procedure also will be used to improve materials currently being implemented in district classrooms. Such remedies might include developing questions to focus students' reflection on benchmark ideas, adding activities to address student learning difficulties, or demonstrating how benchmark ideas are useful for making sense of the students' world outside the classroom.

Through its work with the Project 2061 procedure, Philadelphia has developed a group of educators who are becoming more knowledgeable about specific learning goals in *Benchmarks* and the *National Science Education Standards* and about the analysis criteria used to judge materials in light of these goals. As new, better aligned materials become available, the district will have a cadre of informed consumers who can recognize them and put them to work. Most important, district classrooms will reflect teaching and learning that engage all students in achieving science literacy goals essential for the 21st century.

Kentucky. In the fall of 1996, Project 2061 began to work with the director of the Kentucky Middle Grades Mathematics Teacher Network to adapt the project's curriculum analysis procedure to mathematics. The Kentucky Network, which already reaches some

2,000 teachers, aims to align the state's mathematics content and teaching practices in fifth through eighth grades with the recommendations of the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics.* In particular, the network helps to train teachers in reviewing and analyzing curriculum materials so that they can (1) discriminate between materials that only claim to align with the mathematics standards and those that actually do and (2) recognize standards in the newer, integrated mathematics curricula.

As the criterion for alignment, Project 2061 has used Kentucky's *Mathematics Core Content for Assessment* (which elaborates the national mathematics standards into more specific goal statements) to analyze five middle-school curriculum projects funded by the National Science Foundation (NSF). While developing the analysis procedure and applying it to the materials, Project 2061 received continual feedback from Kentucky teachers and from a national advisory committee that included the developers of the NSF-funded curricula.

During a 1997 two-week summer workshop, 32 Kentucky teachers used the analysis procedure and case-study reports to examine middle-grade mathematics materials and develop workshops for teachers throughout the state. In doing so they (1) gained a better understanding of integrated, problem-based mathematics curricula; (2) developed the skills necessary to evaluate mathematics curricula in light of specific learning goals; and (3) developed skills necessary to effectively share what they have learned throughout their regions. The workshop participants worked during the 1997-1998 school year with teachers, schools, and districts in their regions to assist in analyzing and evaluating mathematics curriculum materials.

APPENDIX
Criteria for Instructional Analysis

Project 2061's curriculum-analysis procedure uses the following questions, grouped within seven criteria clusters, to determine the extent to which the material's instructional strategy is likely to help students learn the content.

Cluster I. Providing a Sense of Purpose:

Framing. Does the material begin with important focus problems, issues, or questions about phenomena that are interesting and/or familiar to students?

Connected sequence. Does the material involve students in a connected sequence of activities (vs. a collection of activities) that build toward understanding of the benchmark(s)?

Fit of frame and sequence. If there is both a frame and a connected sequence, does the sequence follow well from the frame?

Activity purpose. Does the material prompt *teachers* to convey the purpose of an activity and its relationship to the benchmarks? Does each activity encourage *each student* to think about the purpose of the activity and its relationship to specific learning goals?

Cluster II. Taking Account of Student Ideas:

Identifying prerequisite knowledge/skills. Does the material specify prerequisite knowledge/skills that are necessary to learn the benchmark(s)?

Alerting to commonly held ideas. Does the material alert teachers to commonly held student ideas (both troublesome and helpful) such as those described in *Benchmarks,* Chapter 15, "The Research Base"?

Assisting the teacher in identifying students' ideas. Does the material include suggestions for teachers to find out what *their* students think about familiar phenomena related to a benchmark before the scientific ideas are introduced?

Addressing commonly held ideas. Does the material explicitly address commonly held student ideas?

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Assisting the teacher in addressing identified students' ideas. Does the material include suggestions for teachers on how to address ideas that their students hold?

Cluster III. Engaging Students with Phenomena:

Firsthand experiences. Does the material include activities that provide firsthand experiences with phenomena relevant to the benchmark when practical and, when not practical, make use of videos, pictures, models, simulations, and so forth?

Variety of contexts. Does the material promote experiences in multiple contexts so as to support the formation of generalizations?

Questions before answers. Does the material link problems or questions about phenomena to solutions or ideas?

Cluster IV. Developing and Using Scientific Ideas:

Building a case. Does the material suggest ways to help students draw from their experiences with phenomena, readings, activities, and so forth to develop an evidence-based argument for benchmark *ideas*? (This could include reading material that develops a case.)

Introducing terms. Does the material introduce technical terms only in conjunction with experience with the idea or process and only as needed to facilitate thinking and promote effective communication?

Representing ideas. Does the material include appropriate representations of scientific ideas?

Connecting ideas. Does the material explicitly draw attention to appropriate connections among benchmark ideas (e.g., to a concrete example or an instance of a principle or generalization, to an analogous idea, or to an idea that shows up in another field)?

Demonstrating/modeling skills and use of knowledge. Does the material demonstrate/model or include suggestions for teachers on how to demonstrate/model skills or the *use* of knowledge?

Encouraging practice. Does the material provide tasks/questions for students to continue practicing skills or *using* knowledge in a variety of situations?

Cluster V. Promoting Student Reflection:

Expressing ideas. Does the material routinely include suggestions (such as group work or journal writing) for having each student express, clarify, justify, and represent his or her ideas? Are suggestions made for when and how students will get feedback from peers and the teacher?

Reflecting on activities. Does the material include tasks and/or question sequences to guide student interpretation and reasoning about phenomena and activities?

Reflecting on when to use knowledge and skills. Does the material help or include suggestions on how to help students know when to use knowledge and skills in new situations?

Self-monitoring. Does the material suggest ways to have students check their own progress and consider how their ideas have changed and why?

Cluster VI. Assessing Progress:

Alignment to goals. Assuming a content match of the curriculum material to this benchmark, are assessment items included that match the content?

Application. Does the material include assessment tasks that require application of ideas and avoid allowing students a trivial way out, like using a formula or repeating a memorized term without understanding?

Embedded. Are some assessments embedded in the curriculum along the way, with advice to teachers as to how they might use the results to choose or modify activities?

Cluster VII. Enhancing the Learning Environment:

Teacher content learning. Would the material help teachers improve their understanding of science, mathematics, and technology, as well as their interconnections?

Classroom environment. Does the material help teachers to create a classroom environment that welcomes student curiosity, rewards creativity, encourages a spirit of healthy questioning, and avoids dogmatism?

Encouragement for all students. Does the material help teachers to create a classroom community that encourages high expectations for all students, that enables all students to experience success, and that provides different kinds of students with a feeling of belonging in the science classroom?

Connections beyond the unit. Does the material explicitly draw attention to appropriate connections to ideas in other units?

Other strengths. What, if any, other features of the material are worth noting?

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California Department of Education Curriculum Frameworks and Instructional Resources

K-8 Mathematics Instructional Resources Evaluation Form

(Approved by the State Board of Education on April 11, 1996)

This evaluation form will be used by the Instructional Resources Evaluation Panel (IREP) as they review K-8 resources. The criteria are based on Appendix A of the *Mathematics Framework for California Public Schools, Kindergarten Through Grade Twelve,* approved by the State Board of Education on November 8, 1991, and are designed to be used with complete programs (at least a full grade level). This form is different from the evaluation form used for the 1994 primary adoption. It has been revised to include the importance of a "...mathematics program that reflects a balance of basic skills, conceptual understanding, and problem solving." The concept of the "balanced program" has been added to the following categories: (1) Mathematical Content; (2) The Work Students Do; (3) Program Organization and Structure; and (4) Assessment.

The criteria are organized into the following categories. The percent that each category contributes to the overall score is listed in parentheses.

- **Mathematical Content:** Which mathematical ideas and subject matter provide the basis for the instructional program. (20%)
- **Program Organization and Structure:** How the program is organized into a year's work of cohesive units, lessons, and tasks. (15%)
- **The Work Students Do:** What the students work on and how they do it. (25%)
- **Student Diversity:** How the program deals with diverse cultural and economic backgrounds, achievement levels, English language proficiencies, and interests of students. (10%)
- **Assessments:** How the program integrates assessment with instruction, and how the program helps teachers assess student performance. (10%)
- **Support for the Teacher:** How the resources support what the teacher does in the classroom. (20%)

Each category offers a different perspective of how the total program is intended to be experienced by the students. In using these categories, reviewers should keep in mind the following general points:

- These categories are not distinct; they overlap. For example, students' experiences in a program cannot be judged simply by looking at the category, "The Work Students Do." Their experiences will also be affected by the role of the teacher, by the kinds of units and tasks that students work on, and by the mathematical content of the program.
- In each category, all of the components of an instructional program (such as student resources, teacher resources, and technology) are to be examined in terms of how they work together to provide a quality program for students in a classroom. These criteria do not presuppose the presence or absence of any particular component. It is possible to design a complete program that does not have a single student text, and it is possible to design a high-quality program that does have a student text at its center. Similarly, videotapes, computer software, and other technology might or might not be included in a program.
- Each category is described by a few paragraphs. These paragraphs and the subpoints within them are not necessarily of equal weight. They should not be judged individually. Rather, they should be used as an aid to identifying the qualities that contribute to a category.
- Instructional resources need to be descriptive enough to help conscientious teachers implement a new kind of program, yet not so tightly structured that teachers have little flexibility in their implementation.
- In applying these criteria, reviewers will take into account appropriateness for particular grade levels.

A rating, ranging from 0 to 5, is made for each category. Paragraph descriptions of "5," "3.5," and "1" ratings are provided in this evaluation form to assist the reviewer. A weighted score of 70 out of a possible 100 (average rating 3.5) will be required for IREP recommendation for adoption.

The following notes supplement the tables that follow:

* The strands as defined in the *Mathematics Framework* (logic and language, geometry, functions, discrete mathematics, measurement, number and operation, algebra, and statistics and probability) and the *Curriculum and Evaluation Standards for School Mathematics* of the National Council of Teachers of Mathematics, are specified by grade spans, not by grade levels. The levels of analysis will be at those of the 13 standards, for which the bullets serve as exemplars of what the standards look like in that span. It is permissible to introduce an idea from a later span at an earlier time and to continue to study an idea from an earlier span at a later time. It is also permissible to include ideas that are not specifically mentioned in the *Standards.*

** Definition of "all three areas":

- **Basic Skills** are those skills that every student needs to be able to use mathematics and solve problems. Basic skills are not only part of the number and operation strand, but are also part of all other strands. For example, students need to know: number facts, how to find correct answers to addition, subtraction, multiplication, and division problems; fractions, decimal, and percent equivalencies; how to measure; correct terms for geometric shapes; how to read graphs of data; and how to solve equations.
- **Conceptual understanding** means that students make sense of the mathematics operations they perform. They not only know *how* to apply skills but also *when* to apply them and *why* they are being applied. Conceptual understanding provides students with the basis for seeing the relationships between skills and problem solving and among mathematical ideas. Students with conceptual understanding see the structure and logic of mathematics, use mathematics more flexibly and appropriately, and are able to recall or adapt rules because they see the larger pattern.
- **Problem solving** requires the use of mathematical reasoning—analyzing the situation, thinking about approaches that are reasonable, considering appropriate methods to find a solution, and determining how to verify that results make sense in the context of the original situation. Solving a problem involves applying mathematical skills, understandings, and experiences to resolve new or perplexing situations.

Evaluation Table: Mathematical Content

Mathematical Content (5)	Mathematical Content (3.5)	Mathematical Content (1)
The program reflects a balance of basic skills, conceptual understanding, and problem solving, within the eight strands* included in the 1992 Mathematics Framework.	Most of the program reflects a balance of basic skills, conceptual understanding, and problem solving, within the eight strands* included in the 1992 *Mathematics Framework.*	The program does not reflect a balance of basic skills, conceptual understanding, and problem solving, within the eight strands* included in the 1992 *Mathematics Framework.*
At each grade level, all three areas** (basic skills, conceptual understanding, and problem solving) are emphasized; none is neglected nor deemphasized more than another, and overall, the program reinforces the relationships among the areas.	At each grade level, all three areas** (basic skills, conceptual understanding, and problem solving) are included, although one area may be emphasized more than the others. Frequently, lessons include all three areas, and overall, the program reinforces the relationships among the areas.	At some grade levels, one of the three areas** (basic skills, conceptual understanding, and problem solving) may be omitted, and/or one area may be emphasized at the exclusion of the others. Frequently, lessons address only one of the three areas.
At each grade level, basic skills, conceptual understanding, and problem solving are developed in most, if not all, of the strands,* and all of the strands are developed in each grade span. Most, if not all, of the strands* are developed in each year's program. Overall, the units of instruction interweave ideas from more than one strand. The unifying ideas are fully explored over the course of a given year. The mathematical subject matter is coherent.	At each grade level, basic skills, conceptual understanding, and problem solving are developed in most of the strands,* and most of the strands are developed in each grade span. Most of the strands* are developed in each year's program. More than half of the units of instruction interweave ideas from more than one strand, while others concentrate on a single strand. The unifying ideas are explored over the course of a given year, though a few may be given limited attention. The mathematical subject matter in a few of the units fails to meet the criteria of coherence.	Some of the strands* are ignored or treated superficially in each year's program. Units of instruction typically treat one strand independent of the others. The unifying ideas are treated superficially, if at all. The mathematical subject matter is fragmented and fails to achieve coherence.
"Number sense" is usually developed in realistic contexts, and students nearly always produce numerical results for a purpose. Students have ample opportunities to devise their own procedures and are consistently expected to decide the most efficient means for calculating a numerical result in a given situation: mentally, with paper and pencil, or with a calculator. The numbers in problems are nearly always realistic, and problems in upper elementary grades and beyond have rarely been contrived to keep solutions confined to integers.	More than half of the time, "number sense" is developed in realistic contexts, and students produce numerical results for a purpose. Students have regular opportunities to devise their own procedures and to decide the most efficient means for calculating a numerical result in a given situation: mentally, with paper and pencil, or with a calculator. The numbers in problems are usually realistic, and problems in upper elementary grades and beyond are usually not contrived to keep solutions confined to integers.	"Number sense" is not developed in realistic contexts; students often produce numerical results without purpose and have few opportunities to devise their own procedures. They are usually required to decide the most efficient means for calculating a numerical result in a given situation: mentally, with paper and pencil, or with a calculator. The numbers in problems are often unrealistic, and problems in upper elementary grades and beyond have often been contrived to keep solutions confined to integers.

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Evaluation Table: Program Organization and Structure

Program Organization and Structure (5)	Program Organization and Structure (3.5)	Program Organization and Structure (1)
The instructional resources reflect a balance of basic skills, conceptual understanding, and problem solving.	Most of the instructional resources reflect a balance of basic skills, conceptual understanding, and problem solving.	The instructional resources do not reflect a balance of basic skills, conceptual understanding, and problem solving.
The instructional resources present students with coherent, connected, and accessible mathematical experiences organized into units of work lasting one to six weeks that have instructional and mathematical coherence. While a year's work may include some activities that do not belong to any unit or units that are distributed and interspersed over a period of time, most of the year's work is organized in concentrated units.	Most of the year's work consists of units that contain investigations, problems, and exercises that are related to one another, though a few of the connections may be weak. Assignments of varying length are found in most units; while there are substantial investigations in some units, others may contain only brief or introductory investigations. More often than not, units involve concepts from more than one strand.	The year's work consists of activities that are fragmented or disconnected from one another. Connections within a unit—investigations, problems, and exercises—are often weak or contrived. Assignments are frequently narrow, with a few substantial investigations and many one-day lessons. Units often focus on a single strand or set of procedures, or fail to demonstrate mathematical ideas in many settings.
Units include investigations, problems and exercises that are related to one another. Assignments vary in length. Some are relatively large and complex and may form the backbone of the unit, while others may be more limited in their scope and provide the tools or techniques for successful completion of the investigation. Lessons and tasks within a unit most often involve concepts from more than one strand and explore their interconnections and relationships. Some tasks are quantitative, interdisciplinary "real life" problems; others are more purely mathematical investigations, including games and puzzles.		
The instructional resources outline a default sequence for the units and indicate how teachers can use the program flexibly, rearranging, substituting, or modifying units and tasks to meet the needs and interests of their students. Students are given opportunities to decide which tasks to work on or in which order, such as provided in a "menu" format or alternative investigations.	The instructional resources outline a default sequence for the units, with some general suggestions of ways teachers can modify the program to meet the needs and interests of their students. Students are occasionally given opportunities to decide which tasks to work on or in which order, such as provided in a "menu" format.	The instructional resources outline a fairly rigid sequence for the units, with few suggestions of ways teachers can modify the program to meet the needs and interests of their students. Students are rarely given opportunities to decide which tasks to work on or in which order, such as provided in a "menu" format.
From year to year, the units—and the tasks within them—increase in depth and complexity. Students encounter the same unifying mathematical ideas in different or more complex context. Gradually, tasks increase in duration; tasks include more abstraction and formalism; students grapple with increasingly complex questions and investigations; and students assume more and more responsibility for developing complete and comprehensive reports or products.	From year to year, a few units may be at a level of depth similar to the previous year's, but most of the units—and the tasks within them—increase in depth and complexity and challenge students to assume increasing responsibility for developing complete reports or products.	From year to year, there is little progression in the level of depth, contexts are repetitious, and few units challenge students to assume responsibility for developing complete reports or products.

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Evaluation Table: The Work Students Do

The Work Students Do (5)	The Work Students Do (3.5)	The Work Students Do (1)
Students are consistently expected to think and reason in their mathematical work, to work on a variety of challenging and meaningful mathematical tasks, and to conjecture and pursue possibilities without knowing the answer will follow. Most assignments ask for complete student work; students are asked to think and communicate, to draw on mathematical ideas, and to use mathematical tools and techniques effectively.	More often than not, students are expected to think and reason in their mathematical work, to work on a variety of challenging and meaningful mathematical tasks, and to conjecture and pursue possibilities without knowing the answer will follow. Many assignments ask for complete student work; students are asked to think and communicate, to draw on mathematical ideas, and to use mathematical tools and techniques effectively.	Only occasionally are students expected to think and reason in their mathematical work, to work on a variety of challenging and meaningful mathematical tasks, and to conjecture and pursue possibilities without knowing the answer will follow; more often students are expected to follow prescribed directions to achieve a predetermined answer. Few assignments ask for complete student work in which students are asked to think and communicate, to draw on mathematical ideas, and to use mathematical tools and techniques effectively; many assignments focus on one of the aspects of mathematical power independent of the others.
Students encounter a varied program of exercises, problems, and investigations that requires the use of a balance of basic skills, conceptual understanding, and problem solving and that includes all of the strands and unifying ideas. Most assignments are open ended and allow multiple approaches. Students are often asked to formulate mathematical questions, generally choose the approaches to take, frequently reflect on the work they are doing, and make connections among the mathematical ideas. Many tasks required time and deliberation and, especially after third grade, are continued over several days. On these extended assignments, resources help teachers set a clear standard of performance for student work and suggest ways to help students meet the standard.	All students encounter a varied program, including experience with exercises, problems, and investigations, that frequently requires the use of a balance of basic skills, conceptual understanding, and problem solving and that includes most of the strands and unifying ideas. Some assignments are open ended and allow multiple approaches. In these assignments, students are asked to formulate mathematical questions, to choose the approaches to take, to reflect on the work they are doing, and to make connections among the mathematical ideas. Many tasks require time and deliberation and, especially after third grade, are continued over at least a few days. On these extended assignments, resources help teachers set a clear standard of performance for student work and suggest ways to help students meet the standard.	Students do not encounter a varied program; some strands and unifying ideas are treated superficially, if at all, and the program does not provide experience with exercises, problems, and investigations. Assignments do not require the use of a balance of basic skills, conceptual understanding, and problem solving. Few assignments are open ended or allow multiple approaches; many are overly directed so that students do not have the opportunity to formulate mathematical questions, choose the approaches to take, reflect on the work they are doing, and make connections among the mathematical ideas. Few tasks require time and deliberations, and most are confined to a single day. Resources do not help teachers set a clear standard of performance for student work or suggest ways to help students meet the standard.
Students are asked to work individually and interact with one another. They often work in small heterogeneous groups to communicate their findings, orally or in writing. When working together, they are expected to share approaches, conjectures, difficulties, results, and evidence within their group and with other groups. Students are often asked to explore situations, gather data, and present their conclusions to other audiences, including interacting with members of their families in homework assignments.	More than half the time, students are asked to interact with one another. They often work in small heterogeneous groups to communicate their findings, orally or in writing. When working together, they are expected to share approaches, conjectures, difficulties, results, and evidence within their group and with other groups. At times, they are asked to explore situations, gather data, and present their conclusions to other audiences, including interacting with members of their families in homework assignments.	Students are infrequently asked to interact with one another, and when they are, their communication is limited to their results and does not usually include their approaches, conjectures, difficulties, and evidence. They are rarely expected to communicate their thinking in writing, or to communicate to other groups or other audiences, such as members of their families, in homework assignments.
Students are directed to use manipulative resources and technology to explore ideas and solve problems. It is assumed that a variety of tools is continually available for students to use and that every student has access to a calculator at all times and may choose to use it for any occasion except when the purpose is developing mental dexterity.	Students are often directed to use manipulative resources and technology to explore ideas and solve problems. Students have the choice of tools to use, although some of the choices may be limited or are made for the students.	Students are rarely directed to use manipulative resources and technology to explore ideas and solve problems, and when they do, they have a limited choice of tools to use or ways to use them.

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Evaluation Table: Student Diversity

Student Diversity (5)	Student Diversity (3.5)	Student Diversity (1)
All students participate fully in each unit; assistance provided to students having difficulty is in addition to, not instead of, the regular program, with the goal of supporting successful participation in the regular program. The tasks and problems students work on are accessible to all students. Many problems are rich and open and can be investigated at many different levels. Many tasks or lessons use students' personal, family, or cultural experiences to create the specific context for the lesson and to include parents as partners in the process. There is room in each unit for some students to pursue depth, complexity, or novelty in some aspect of the unit's investigations, according to their interests or their rapid grasp of the ideas.	All students participate in each unit. The entry point for tasks and problems is accessible to all students, but there is a gradient of difficulty that may sort students by their speed or verbal fluency. At that point, temporary assistance is provided to students having difficulty in lieu of keeping them in the regular program. Remaining students are provided with rich and open activities, in contrast to the narrow and mechanical activities that may be provided for the students having difficulty. Some tasks or lessons use students' personal, family, or cultural experiences to create the specific context for the lesson, and most often include parents as partners in the process. There is room in many units for some students to pursue depth, complexity, or novelty in some aspect of the unit's investigation according to their interests or their rapid grasp of the ideas.	All students participate in each unit. The entry point for tasks and problems is not always accessible to all students, and there is a steep gradient of difficulty that quickly sorts students by their speed or verbal fluency. Assistance for students having difficulty keeps them out of the regular program and limits their experience to narrow and mechanical tasks. Few tasks or lessons use students' personal, family, or cultural experiences to create the specific context for the lesson. Parents are not often included as partners in the progress. There is little room in most units for some students to pursue depth, complexity, or novelty in some aspect of the unit's investigations, according to their interests or their rapid grasp of the ideas.
The regular program is specifically made accessible to English language learners (ELL) by providing editions in the five most common languages other than English spoken in California, comparable in quality to those written in English, or by providing glossaries; summaries of key concepts; and directions, instructions, and/or problems and tasks in these five primary languages.	The regular program is made somewhat accessible to English language learners (ELL) by providing editions in Spanish as well as in at least two languages other than English, comparable in quality to those written in English, or by providing glossaries; summaries of key concepts; and directions, instructions, and/or problems and tasks in these four primary languages.	The regular program is not generally accessible to English language learners (ELL). Directions, instructions, problems and tasks, and/or glossaries and summaries are not provided in any language other than English.
The resources provide teachers with general advice on all of the following points and frequent lesson-specific suggestions to support the learning of all students, including: • ways to encourage students to connect lessons and content of lessons to their personal, family, or cultural experience; • ways to encourage students to value the points of view and the experiences of others; • the use of peer support and collaborative learning groups; and • how to work with students whose primary language is not English, including techniques for the use of the primary language and Specially Designed Academic Instruction in English (SDAIE) so that the program for these students is not limited or diluted. The focus in this criterion is to allow ELL (LEP) students accessibility to the program.	The resources provide teachers with general advice on all of the following points and occasional lesson-specific suggestions, as applicable, to support the learning of all students, including: • ways to encourage students to connect lessons and content of lessons to their personal, family, or cultural experience; • ways to encourage students to value the points of view and the experiences of others; the use of peer support and collaborative learning groups; • and how to work with students whose primary language is not English, including techniques for the use of the primary language and Specially Designed Academic Instruction in English (SDAIE) so that the program for these students is not limited or diluted. The focus in this criterion is to allow ELL (LEP) students accessibility to the program.	The resources provide teachers with general advice on all of the following points and a few lesson-specific suggestions to support the learning of all students, including: • ways to encourage students to connect lessons and content of lessons to their personal, family, or cultural experience; • ways to encourage students to value the points of view and the experiences of others; • the use of peer support and collaborative learning groups; and • how to work with students whose primary language is not English, including techniques for the use of the primary language and Specially Designed Academic Instruction in English (SDAIE) so that that the program for these students is not limited or diluted. The focus in this criterion is to allow ELL (LEP) students accessibility to the program.

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Evaluation Table: Assessment

Assessment (5)	Assessment (3.5)	Assessment (1)
Assessment is consistently integrated into the instructional program. The instructional resources help teachers use assessment in a variety of ways to get information about what the student or groups of students understand and are able to do in solving mathematical problems. Assessment measures a balance of basic skills, conceptual understanding, and problem solving within the eight strands of mathematics.	Assessment is generally integrated with the instructional program. The instructional resources help teachers use assessment in a variety of ways to get information about what the student or groups of students understand and are able to do in solving mathematical problems. Assessment frequently measures a balance of basic skills, conceptual understanding, and problem solving within the eight strands of mathematics.	Assessment is not integrated with the instructional program. The instructional resources do, however, help teachers use assessment to get information about what the student or groups of students understand and are able to do in solving mathematical problems. Assessment does not measure a balance of basic skills, conceptual understanding, and problem solving within the eight strands of mathematics.
Specific assessment tasks are included in the units, though they may or may not be distinguished from learning tasks because they have similar characteristics. Specifically, students formulate problems, consider and apply a variety of approaches, determine and explain their findings; use tools, such as calculators and manipulatives, and other resources, such as notes or reference materials; and have ample time to work on assessment tasks to revise and resubmit important assignments to bring performance up to high-quality standards.	Specific assessment tasks are included in the units and display most of the following desirable characteristics: students formulate problems, consider and apply a variety of approaches, determine and explain their findings; use tools, such as calculators and manipulatives, and other resources, such as notes or reference materials; and have ample time to work on assessment tasks and frequently have the opportunity to revise and resubmit important assignments to bring performance up to high-quality standards.	Specific assessment tasks are included in the units. They display only a few of the following desirable characteristics: students formulate problems, consider and apply a variety of approaches, determine and explain their findings; use tools, such as calculators and manipulatives, and other resources, such as notes or reference materials; and have ample time to work on assessment tasks and frequently have the opportunity to revise and resubmit important assignments to bring performance up to high-quality standards.
The resources include general suggestions to the teacher concerning the following, with frequent unit-specific suggestions: • how to use learning tasks for assessment purposes; • how to observe, listen to, and question students while they work, as well as how teachers might keep track of insights they may have about the students; • how to organize and use student portfolios; • how teachers can keep parents informed about the progress of their children and about the variety of assessment methods being used: both what they are and why they are important; and • how to involve students in self-assessment.	The resources include general suggestions to the teacher concerning the following, with occasional unit-specific suggestions: • how to use learning tasks for assessment purposes; • how to observe, listen to, and question students while they work, as well as how teachers might keep track of insights they may have about the students; • how to organize and use student portfolios; • how teachers can keep parents informed about the progress of their children and about the variety of assessment methods being used: both what they are and why they are important; and • how to involve students in self- assessment.	The resources include general suggestions to the teacher concerning the following, with few unit-specific suggestions: • how to use learning tasks for assessment purposes; • how to observe, listen to, and question students while they work, as well as how teachers might keep track of insights they may have about the students; • how to organize and use student portfolios; • how teachers can keep parents informed about the progress of their children and about the variety of assessment methods being used: both what they are and why they are important; and • how to involve students in self-assessment.

Evaluation Table: Support for the Teacher

Support for the Teacher (5)	Support for the Teacher (3.5)	Support for the Teacher (1)
The resources provide many lesson- and unit-specific suggestions and illustrative examples of how the teacher can instruct and facilitate the student behaviors identified under "The Work Students Do." The resources include the following: • description of the important mathematical ideas in the units, including how students are to encounter the mathematical ideas and how the experiences are related to what is known about children's learning or developmental level; • description/pictures of what units and lessons will look like when implemented in the classroom; • information about what is important to do and say in a lesson or unit; • suggestions for questions to ask and ways to respond that keep students' thinking open and help them on what they have done, how teachers might think about and reflect on what happens in a lesson or unit, when it makes sense to present information to students and how to do it; • suggestions for working with a diverse classroom of students, helping students work together productively, as well as managing manipulative materials, calculators, computers, and other tools so they are accessible when students want to use them; • suggestions for helping students communicate more effectively about their mathematical thinking; • suggestions for involving parents and keeping them informed about the program; and • suggestions for assessing student performance.	The resources provide information, suggestions, and some illustrative examples of how the teacher can instruct and facilitate the student behaviors identified under "The Work Students Do." The materials include most of the following: • description of the important mathematical ideas in the units, including how students are to encounter the mathematical ideas and how the experiences are related to what is known about children's learning or developmental level; • description/pictures of what units and lessons will look like when implemented in the classroom; • information about what is important to do and say in a lesson or unit; • suggestions for questions to ask and ways to respond that keep students' thinking open and help them reflect on what they have done, how teachers might think about and reflect on what happens in a lesson or unit, when it makes sense to present information to students and how to do it; • suggestions for working with a diverse classroom of students, helping students work together productively, as well as managing manipulative materials, calculators, computers, and other tools so they are accessible when the students want to use them; • suggestions for helping students communicate more effectively about their mathematical thinking; • suggestions for involving parents and keeping them informed about the program; and • suggestions for assessing student performance.	The resources provide limited information, suggestions, and few illustrative examples of how the teacher can instruct and facilitate the student behaviors identified under "The Work Students Do." Many of the suggestions are general rather than lesson or unit specific in nature. The materials include few of the following: • description of the important mathematical ideas in the units, including how students are to encounter the mathematical ideas and how the experiences are related to what is known about children's learning or developmental level; • description/pictures of what units and lessons will look like when implemented in the classroom; • information about what is important to do and say in a lesson or unit; • suggestions for questions to ask and ways to respond that keep students' thinking open and help them reflect on what they have done, how teachers might think about and reflect on what happens in a lesson or unit, when it makes sense to present information to students and how to do it; • suggestions for working with a diverse classroom of students, helping students work together productively, as well as managing manipulative materials, calculators, computers, and other tools so they are accessible when the students want to use them; • suggestions for helping students communicate more effectively about their mathematical thinking; • suggestions for involving parents and keeping them informed about the program; and • suggestions for assessing student performance.

K-8 Mathematics Instructional Resources Evaluation Form

Publisher ______________________________

Title ______________________________

Grade Span ______________________________

Category	Rating	Weight		Total
Mathematical Content	_____	x 4	=	_____
Program Organization and Structure	_____	x 3	=	_____
The Work Students Do	_____	x 5	=	_____
Student Diversity	_____	x 2	=	_____
Assessment	_____	x 2	=	_____
Support for the Teacher	_____	x 4	=	_____
		Overall Weighted Total		_____

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Council of Chief State School Officers (CCSSO) State Curriculum Frameworks and Standards Map: Definitions of Categories and Concepts

1. Subject(s) of Framework

A. Title: *Official and complete title of framework or standards document(s)*

B. Date of document reviewed:

C. Status of framework: *Classify the current status in terms of one of the following three phases:* (Select one)

- ☐ **Developing or working draft:** Document is in a predistribution and development phase; it is not yet disseminated for formal review beyond a limited circle of writers or experts.
- ☐ **Review draft:** Document is a completed draft that is being formally disseminated for comment and final revisions.
- ☐ **Adopted:** Document serves as official guidance, mandate, or policy.

D. Implemented/Disseminated:

E. Planned revision date:

F. Main components of document:
(Components present—example list)

- ☐ **Content standards:** Content knowledge and skills students are expected to know and be able to do in mathematics or science, often by grade level.
- ☐ **Performance standards (or outcomes):** Description of the levels of proficiency to which content standards shall be attained by students.
- ☐ **Pedagogy/Instructional strategies:** Pedagogical approaches, ideas, procedures, and processes of teaching recommended for use with curriculum.

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- **Linking to policies and enabling conditions:** Policies or guidelines for assessments, professional development, curriculum design and organization, materials and texts, school and system support, technology, and facilities.
- **Implementation plan for state:**
- **Assessment plans, examples:**

G. Single vs. multiple subjects: *Framework document includes one subject or multiple subjects.*

H. Related documents:

- Key state-designed and disseminated documents, in addition to the framework, related to the curriculum framework or standards (referenced or identified from other information). Indicate author(s), title, and publication date.

2. State Context

A. State's vision for mathematics and science:

- Specific to one subject vs. broad, general.
- Contains specific information about needs, interests of state vs. general statement of vision.
- Page number for vision statement.

B. Intent or purpose of the framework/standards: *Indicate which of the following concepts best describe the rationale, goals, or purpose, as stated in the framework; add any concepts the state identifies that are not described by these overarching statements.*

- Develop student knowledge and habits of mind.
- Modernize and change instruction.
- Design recommended curricula and instructional resources.
- Ensure equity and access for all students.
- Make or implement assessment/evaluation policy.
- Involve parents, business, and other community members.
- Other.

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C. Major sources: *Major national documents or reports, especially: National Council of Teachers of Mathematics'* Curriculum and Evaluation Standards for School Mathematics, Teaching Standards, Assessment Standards; *National Academy of Sciences/National Research Council National Science Education Standards; American Association for the Advancement of Science* Benchmarks; *other states' frameworks or reports; or other studies or reports referenced in the opening sections of the framework that establish the vision and define the conceptual foundation for science/mathematics education.*

- Reference page numbers for national documents.
- Characterize how they are used or modeled closely after national documents; frequent references; listed as resource.
- List other states that are referenced as sources.

D. Mandates or state initiatives supporting frameworks and standards: *Major funding initiatives (internal or external, regulatory or advisory), supplemental financial resources, legislative or board-sponsored mandates, requirements, and supportive arrangements that advanced or contributed to the development and/or implementation of the framework. Mention here any specific decisions that enhance local resources; technology; use of school time; professional development; facilities; schedules, and so forth.*

- Legislative or state board mandates, rules, or regulations.
- External funding—from federal, non-profit agencies, and so forth. (List the funding sources/agencies).

E. Target audiences: *The key groups that the framework was designed to inform, assist, or advise, particularly those expected to make most immediate and regular use of the framework to carry out their mission and primary responsibilities.*

- **Teachers:** Teachers in all subjects and for all grades or special groups; and certified support personnel such as media specialists, counselors, and so forth.
- **School and district curriculum planners:** Curriculum and instructional supervisors, designers, or writers.

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- ☐ **School administrators:** Administrators at school site and central office levels.
- ☐ **Assessment developers:** Test or item authors, contractors designing test and item specifications, administrators or assessment managers.
- ☐ **Board members:** Members of district school boards and/or school-site boards or management teams.
- ☐ **Parents:** PTA organizations, individual parents, and other parent advisory or participant groups.
- ☐ **Business partners:** Business or industry partners who work in a formal relationship with schools or school boards.
- ☐ **Other community constituents:** Public sector agencies and other parent or public groups working with the school system.
- ☐ **Other:** Indicate other users/audiences not indicated above.

F. <u>Key development activities</u>: *Major steps that best describe phases, events, or processes that were used in completing the current edition of the framework if the development process is described in the document.*

- ☐ Expert panel(s) and/or advisory committee(s).
- ☐ Reviews and analyses of other similar or model documents.
- ☐ Suggestions, ideas, and exemplars from teachers, educators, and subject specialists.
- ☐ Teacher participation in writing and editing for the framework's text (including writing of suggested standards).
- ☐ Successive drafts were written, reviewed, and modified.
- ☐ Focus groups for review/discussion of drafts.
- ☐ Pilot study in districts and/or classrooms.
- ☐ Wide dissemination within schools and throughout communities and the state.
- ☐ Other (indicate other activities that differ from those listed above).

3. Standards

A. <u>Content standards</u>: *Categories or headings that organize subject content and indicate the term(s) used for the categories, for example, strands, standards, themes, disciplines, and so forth. List only the broad outline; include examples of detail in the sample* Standards *in the next section. Describe the state's definition and uses of content or performance standards as specified in the framework document.*

- **Definition:** Quote or paraphrase, page reference.
- **Number of standards:**
- **Grade levels/clusters of standards:** If content categories differ greatly across grade levels, separately list content clusters for each grade level or group.

Supply example of *content standard* for subject area.

B. <u>Benchmarks/Indicators</u>: *Next level of detail below* Standards.

- **Definition:** *Term used for this level.*
- Number of benchmarks per *Standard.*
- Grade levels/clusters of this level.

Supply example of a benchmark that matches the *content standard* included above.

C. <u>Cross-cutting themes</u>: *Concepts for organizing and implementing curriculum content that transcend framework's major content organizers, including processes, themes, attitudes, habits of mind, and so forth. They appear repeatedly across several components or sections of the framework, in various content areas and topics.*

4. Performance Standards

A. <u>State's definition and term for performance standards</u>: *Where they are found and name of document. How they are related to content standards.*

- Short quote on definition, page number.
- Number of performance standards; grade clusters.

Supply example of performance standard that matches *content standard* defined above.

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B. Performance standards are designed and described to be used for developing:

- ☐ External accountability/state assessment.
- ☐ End-of-course assessment.
- ☐ Student accountability/classroom assessment.

Describe use(s) for state from interviews.

5. Assessment

How assessment is related to standards:

- ☐ Classroom or instructional assessment.
- ☐ Accountability.
- ☐ Examples of assessments and page numbers.
- ☐ Types of exercises/tasks described or modeled.

6. Features

Methods of presenting and communicating content used ***regularly and throughout*** *the document to illustrate the recommended curriculum content or pedagogical practices. (Indicate page numbers for good examples.)*

- ☐ **Vignettes:** *Illustrative classroom scenarios or essays that describe teaching, situating instruction in a context that demonstrates the give and take among children and their teachers and shows with considerable descriptive detail how teachers define in practice specific content areas and instructional approaches. Vignettes often include dialogue.*
- ☐ **Models or examples of instructional practice:** *"How to" examples of techniques or thumbnail sketches of practice. Compared with vignettes, models are shorter and more static, and they do not attempt to reflect classroom context, discourse, or exchanges that occur among teachers and students.*
- ☐ **Activities and/or instructional tasks:** *Lists or outlines of activities or tasks, reported with a minimum of detail, surrounding context, give or take, or dialogue.*
- ☐ **Diagrams, graphics, photographs:** *Visuals used to model or illustrate the instructional activities, tools, structures, patterns, or approaches.*
- ☐ **Other unique features:** *(ways of presenting content, etc.)*

7. Linkages to Policies and Enabling Conditions

Linkages of content to policies and recommended enabling conditions: *Extent of alignment of framework's vision, content, standards, and pedagogy with other state education policies, or with policy decisions that are left to district or school levels; policies that enable teachers and schools to improve mathematics/science. Record the linkages within one of the following two dimensions:*

- ☐ Current and existing policy links are reported within the document.
- ☐ Policy linkages are proposed and/or recommended, but they are not yet regulated by statute or rule.

Framework/Standards Linkages (Content links to following)	Existing links reported in document	Links are recommended
Professional development		
Assessment for external accountability		
Selecting, developing, or using materials and textbooks		
Teacher preparation and certification		
Student support services		
School and curriculum organization, decision making, uses of time, district and school support		
Technology integration		
Involving community representatives, parents, and business leaders in planning, review, and policy-making committees		
Facilities		

- ☐ Other documents providing linkages to content standards.

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8. Equity

Indicate the ways the framework document addresses race/ethnicity, gender equity, inclusiveness, and attentiveness to handicapping conditions in the curriculum. Framework clearly describes or illustrates state recommendations for any one equity element that is checked.

- ☐ Where/in which sections is equity treated?
- ☐ How is it treated? Cite examples and page numbers.
- ☐ List examples of where equity is treated.
- ☐ **Rationale and vision statements:** *(e.g., importance of all students learning mathematics/science in K-12, how framework will aid this goal.)*
- ☐ **Vignettes, activities, and sample problems:** *(Examples are multiracial/ethnic and cross-gender; refer to education for culturally diverse, handicapped, and limited-English-speaking students; and describe diverse teaching and learning situations.)*
- ☐ **Instructional strategies, curriculum organization:** *(e.g., including content and instructional techniques that nurture the needs of students from varied backgrounds, experiences, cultures, and communities.)*
- ☐ **Curriculum organization and course structure***: (e.g., detracking curriculum; integrated courses and teacher assignments involving multicultural communities in teaching and learning.)*
- ☐ **Materials selection and distribution:** *(e.g., guidelines for materials selection reflect high standards for all groups.)*
- ☐ **Assessment approaches:** *(e.g., strategies that are sensitive to racial/ ethnic and gender differences, minimize bias, and maximize opportunities for students to demonstrate their knowledge in various ways.)*
- ☐ **Staff development:** *(e.g., proposes strategies to reach educators with few development opportunities.)*
- ☐ **Teacher preparation:** *(e.g., designs that prepare teachers to teach mathematics/science content to diverse student groups.)*
- ☐ **Hiring practices:** *(examples of incentives for increasing numbers of minority teachers and administrators.)*
- ☐ **Community and business involvement:** *(e.g., suggested mechanisms for increasing the involvement of diverse groups.)*
- ☐ **Policies and recommendations:** *(e.g., state policies that promote equity and inclusiveness in teaching, curriculum, assessment, and hiring.)*

9. Pedagogy

The approach to teaching and learning—the instructional strategies, processes, or activities recommended, proposed, or modeled—and the means by which these ideas are presented. Pedagogy categories are based on the NCTM Curriculum and Evaluation Standards for School Mathematics *(1989) and on the AAAS* Science for All Americans *(1989).*

A. Explanation of Columns:

- **Lists**: *Items are listed or outlined with little or no detail about how pedagogical elements are to be used within classrooms or by teachers.*
- **Vignettes and examples**: *Illustrative stories with specific examples, "how to" statements describing a story line, or portraits exploring the discourse and instructional processes among students and their teachers. These may include dialogue, thinking, and reflective practice by both teachers and students.*
- **Context**: *In many places throughout the framework, pedagogy is demonstrated through lists, diagrams, pictures, and/or portraiture that tell the tale of events and processes in action.*

Pedagogical Practices	Lists	Vignettes and Examples	Context
Constructive and active lessons			
Technological applications			
Multiple assessment strategies			
Discourse, dialogue, and argument			
Flexible uses of time and facilities			
Working with a mix of tools, manipulatives, textbooks, and resources			
Experiments and multiple solutions			
Representation, including writing, mapping, diagramming, graphing, and so forth			

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B. Definitions for pedagogical practices: *The framework suggests, models, or describes the following pedagogical practices:*

- **Constructive and active lessons:** *Students actively engage with content, materials, tools, and/or peers to build understanding of mathematical and scientific ideas, solutions, or explanations.*
- **Technological applications:** *Students use various technological tools (calculators, including those that graph, and computers) to derive mathematical and scientific solutions.*
- **Multiple assessment strategies:** *Teacher observations, conferences, self-assessments, student journals; projects, experiments, constructions; writing, tasks, and real-world problems to solve; formal and informal tests; oral presentations; and so forth.*
- **Discourse, dialogue, and argument:** *Verbal representations of the logic underlying mathematical and scientific ideas; strategies call upon students to discuss, prove their point of view, probe one another's as well as the teacher's thoughts; and so forth.*
- **Flexible uses of time and facilities:** *Varying time blocks, classroom spaces, libraries, laboratories, and so forth are suggested as resources for learning mathematics and science.*
- **Working with a mix of tools, manipulatives, textbooks, and resources:** *Activities and tasks suggest ways to involve students in a wide range of mathematical and scientific problem-solving tools and materials.*
- **Experiments and multiple solutions:** *Tasks demonstrate ways that mathematics and science are incorporated into applied contexts through problem solving, experiments, and experiences that lend themselves to alternative solutions with no single "best" answer or solution strategy.*
- **Representation, including writing, mapping, diagramming, graphing, and so forth:** *Students are encouraged to explain mathematics and science in various formats, including pictures, diagrams, spreadsheets, models, maps, and so forth, as well as verbally.*

10. Other Framework Components

Major sections or chapters of state framework not addressed by preceding categories.

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Executive Summary of *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

THE SPLINTERED VISION: AN OVERVIEW

There is no one at the helm of mathematics and science education in the United States; in truth, there is no identifiable helm. No single coherent vision of how to educate today's children dominates U.S. educational practice in either subject, nor is there a single, commonly accepted place to turn to for such visions. Our visions—to the extent that they exist at all—are multiple.

These splintered visions produce unfocused curricula and textbooks that fail to define clearly what is intended to be taught. They influence teachers to implement diffuse learning goals in their classrooms. They emphasize familiarity with many topics rather than concentrated attention to a few. And they likely lower the academic performance of students who spend years in such a learning environment. Our curricula, textbooks, and teaching all are "a mile wide and an inch deep."

This preoccupation with breadth rather than depth, with quantity rather than quality, probably affects how well U.S. students perform in relation to their counterparts in other countries. It thus determines who are our international "peers" and raises the question of whether these are the peers that we want to have. In today's technologically oriented global society, where knowledge of mathematics and science is important for workers, citizens, and individuals alike, an important question is: What can be done to bring about a more coherent vision and thereby improve mathematics and science education?

Reforms have already been proposed by political, business, educational and other leaders. Extensive efforts are underway to implement these standards, but the implementation process itself is shaped by the prevailing culture of inclusion. Like the developers of curricula and the publishers of textbooks, teachers add reform ideas to their pedagogical quivers without asking what should be taken away.

The study summarized below represents an effort to describe the nature of the diffuse vision of mathematics and science education in the United States and to raise questions relevant to policy making.

Purpose of *A Splintered Vision*

A Splintered Vision (written by William Schmidt, Curtis McKnight, and Senta Raizen of the U.S. National Research Center for the Third International Mathematics and Science Study and published by Kluwer Academic Publishers) discusses data from the analysis of 491 curriculum guides and 628 textbooks from around the world as part of the recently completed Third International Mathematics and Science Study (TIMSS). It also presents detailed accompanying data on teacher practices in the United States and two other countries: Germany and Japan.

The TIMSS is a large-scale, cross-national comparative study of the national educational systems and their outputs in about 50 countries. Researchers examined mathematics and the sciences curricula, instructional practices, and school and social factors, as well as conducting achievement testing of students. They collected data from representative documents that laid out official curricular intentions and plans, analyzed entire mathematics and science textbooks, and searched entire K-12 textbook series for selected "in-depth" topics (subareas within the subject matter.) In six countries TIMSS conducted classroom observations, teacher interviewing, and videotaping.

The TIMSS curriculum and teacher data are extensive and cannot be explored in a single report. The results of analyses of these data are being reported in a series of volumes, three of which are now available.[1]

The present report intends to document and characterize the state of U.S. mathematics and science curricula, textbooks, and teaching practices and place them in a cross-national context. Unfortunately, this study could provide only a snapshot of the "moving target" that is educational practice in the United States These data were collected in 1992-93, when the mathematics standards had existed for only three years and the science standards were not finalized.[2] The intervening years have been a time of change for state curriculum standards and textbooks. The TIMSS data on teacher practices discussed here were collected in 1995.

This report is meant to be descriptive and, to a lesser extent, interpretive. It is not a plea for specific reforms. We seek to provide data germane to the ongoing public debate about science and mathematics education policies in the United States.

Unfocused Curricula

Curricula in both mathematics and science in U.S. schools are unfocused in comparison with those in other countries studied. The lack of curricular focus is more true in mathematics than in science, though physical science guides closely resemble mathematics in their fragmentation. U.S. curricula are unfocused in several respects:

Topics Covered

Mathematics curricula in the United States consistently cover far more topics than is typical in other countries. The number of mathematics topics in the U.S. composite[3] is higher than the 75th percentile internationally in all grades until ninth, when schools typically teach specific courses such as algebra, geometry, etc.

In science, the tendency toward inclusion is similar, though less pronounced. The number of science topics in the U.S. composite exceeds the 50th percentile internationally in all but one grade until the tenth, when schools tend to abandon general science approaches for specific courses, such as chemistry and physics.

Repetition

In both mathematics and science, topics remained in our composite U.S. curricula for more grades than all but a few other TIMSS countries. The U.S. approach can be characterized as "come early and stay late."

In mathematics, the U.S. practice is to add far more topics than other countries do in grades one and two and then repeat these topics until grade seven. In grades nine and 11 the U.S. composite curriculum drops many more topics than other countries. On average, mathematical topics remain in the U. S. composite curriculum for two years longer than the international median. Only five countries have higher average durations.

In science, U.S. practice is to introduce new science topics at intervals, especially grades one and five, with little change in the intervening grades. In grades 10 to 12, the U.S. composite curriculum drops many more topics than other countries. Average intended duration is close to the international median in earth sciences and life sciences, but the U.S. average duration in the physical sciences is two years longer than the median and higher than all but seven countries.

In mathematics, the tendency to retain topics over many grades may reflect the traditional approach of distributed mastery—the idea that mastering pieces of a subject would lead to mastery of a bigger whole. U.S. curricula lack a strategic concept of focusing on a few key goals, linking content together, and setting higher demands on students.

This propensity for inclusion extends even to reform proposals. Many reform recommendations simply add to the existing topics (or are implemented by adding to existing content), thereby exacerbating the existing lack of curricular focus.

Emphasis

U.S. curricula in mathematics and science seek to do something of everything and less of any one thing. Given roughly comparable amounts of instructional time, this topic diversity limits the average amount of time allocated to any one topic.

In mathematics, this accumulation may be a product of our model of distributed mastery over the grades.

The reasons for the better results in science are less clear but seem related to general science approaches that move from topic to topic.

Variations Among States

While the core of mathematics topics was broad, it varied little among the states.

The number of core science topics was much smaller, and the overlap among state curricula was also small. While students in U.S. states might have studied a number of science topics roughly equal to the international median, the differing curricular intentions of various states are such that students in different states likely studied only a few common topics.

Defining the "Basics"

Student achievement in mathematics and science in any country is largely shaped by what educational policymakers in that nation regard as "basic" in these subjects and how well they communicate and support those basics.

The U.S. mathematics instructional practices defined *de facto* eighth-grade basics of arithmetic, fractions, and a relatively small amount of algebra. In Germany, Japan, and internationally, the basics were defined as algebra and geometry.

For science, the picture is more complex since U.S. curricula include single-area courses, such as physical sciences, life sciences, or earth sciences. These courses defined a more restricted, focused set of basics, but they applied only to the subset of students receiving those particular courses.

Unfocused Textbooks

Textbooks play an important role in making the leap from intentions and plans to classroom activities. They make content available, organize it, and set out learning tasks in a form designed to be appealing to students. Without restricting what teachers *may* choose to do, textbooks drastically affect what U.S. teachers are *likely* to do under the pressure of daily instruction. The question thus arises: Do U.S. mathematics and science textbooks add guidance and focus to help teachers cope with unfocused curricula?

Unfortunately, the answer is "no." The splintered character of mathematics and science curricula in the United States is mirrored in the textbooks used by teachers and students. Textbooks are unfocused in several ways:

Topics Included

The U.S. mathematics and science textbooks include far more topics than was typical internationally at all three grade levels analyzed.

In mathematics, U.S. textbooks are far above the 75th percentile of the TIMSS countries in the number of topics covered. For example, U.S. mathematics textbooks designed for fourth and eighth graders cover an average of 30 to 35 topics, while those in Germany and Japan average 20 and 10 respectively for these populations.

As a result, typical mathematics textbooks in the United States look quite different than those of a nation such as Japan. The typical eighth-grade U.S. textbook (non-algebra) is larger and more comprehensive than the average Japanese text, but it contains fewer sequences of extended attention to a particularly important topic. The U.S. textbooks' sequences are also shorter and have more breaks. The lesson-by-lesson organization of the U.S. book is much less focused than the Japanese book, and there is far more skipping among topics in successive segments.

In science, the differences are even greater. At all three population levels, U.S. science textbooks included far more topics than even the 75th percentile internationally. The average U.S. science textbook at the fourth, eighth, and 12th grade has between 50 and 65 topics; by contrast Japan has five to 15 and Germany has just seven topics in its eighth-grade science textbooks.

Emphasis

The propensity of U.S. curricula to do something of everything but little of any one thing is mirrored in textbooks. The few most emphasized topics account for less content than is the case internationally.

Among the fourth-grade mathematics textbooks investigated, the five topics receiving the most textbook space accounted on average for about 60 percent of space in the U.S. textbooks but over 85 percent of textbook space internationally.

At the eighth-grade level, the five most emphasized topics in non-algebra U.S. textbooks accounted for less than 50 percent of textbook space compared to an international average of about 75 percent. An exception is U.S. eighth-grade algebra books, which were highly focused, with the five most emphasized topics accounting for 100 percent of the books.

Among the U.S. fourth-grade science textbooks investigated, the five topics receiving the most attention accounted for an average of just over 25 percent of total space in U.S. textbooks compared to an average of 70 to 75 percent internationally.

Among the U.S. eighth-grade science textbooks investigated, the five most emphasized topics in more general science texts accounted for about 50 percent of textbook space compared to an international average of about 60 percent. In contrast, U.S. eighth-grade science books oriented to a single area were highly focused, with the five most emphasized topics accounting for more of the textbooks than was true in the international average.

Difficulty

U.S. eighth-grade science textbooks emphasized understanding and using routine procedures, which represent the less complex, more easily taught expectations for student performance. This emphasis was typical of what was done internationally. It is not, however, typical of the diverse and more demanding performances called for in current U.S. science education reform documents.

Most U.S. schools and teachers make selective use of textbook contents and rarely, if ever, cover all of a textbook's content. Publishers can reasonably expect that those who adopt and buy a particular textbook will feel free to use only the contents that suit their purposes. Unfortunately, the result is large textbooks covering many topics but comparatively shallowly. Even in the largest textbooks, space is still limited. It is impossible for textbooks so inclusive to help compensate for unfocused official curricula. Thus, our analysis shows that U.S. textbooks support and extend the lack of focus seen in those official curricula.

How Teachers Deal with the Splintered Vision

Teachers in the United States are sent into their classrooms with a mandate to implement inclusive, fragmented curricula and armed with textbooks that embody the same "breadth rather than depth" approach. How do they handle such a situation? Not surprisingly, the instructional decisions made by U.S. teachers mirror the inclusive approach of the tools they are given. U.S. teachers handle the splintered vision they get in several ways:

Topics Covered

U.S. mathematics and science teachers typically report teaching more topics than their counterparts in other countries, including Germany and Japan. This is true for science teachers even when using a single-area textbook such as physical science, life science, or earth science.

Emphasis

Since instructional time for science or math within a school year is limited, the data show that teaching more topics means that teachers spend little time on most topics.

U.S. eighth-grade mathematics teachers indicated that they taught at least a few class periods on all but one topic area included in the teacher survey's questionnaire. They devoted 20 or more periods of in-depth instruction to only one topic area, fractions and decimals. However, in Germany and Japan many other topic areas received this more extensive coverage.

According to the survey, the five topic areas covered most extensively by U.S. eighth grade mathematics teachers accounted for less than half of their year's instructional periods. In contrast, the five most extensively covered Japanese eighth-grade topic areas accounted for almost 75 percent of the year's instructional periods.

U.S. eighth-grade science teachers also indicated that they would devote at least some class time to every topic area surveyed. None was omitted completely and no topic was marked to receive more than 13 class periods of attention by eighth-grade physical and general science teachers. Additional topic areas received more extensive coverage in Germany and Japan.

On average, U.S. eighth-grade general science teachers' most extensively covered topics accounted for only about 40 percent of their instructional periods, but this percentage was also lower for science in Germany and Japan (about 50 to 60 percent).

Number of Activities

U.S. teachers engage in more teaching activities per lesson than their counterparts in other countries. More than 60 percent of U.S. eighth-grade mathematics and science teachers reported using six or more activities in a typical class. In Germany only 25 percent reported using six or more activities, and even fewer reported doing so in Japan.

Is This The Best Our Teachers Can Do?

U.S. mathematics and science teachers work hard and often face demanding workplaces. Our data show that they are scheduled to work about 30 periods each week, which is more than teachers in Germany (just over 20 periods) and Japan (fewer than 20).

These teachers rarely have the luxury of being idealists. Unfocused curricula and inclusive textbooks set few boundaries for instructional decisions and appear to require a little bit of everything. It is easier for real teachers making real decisions in the real workplaces of U.S. schools to settle for the first alternative that seems good enough rather than search for the best possible instruction. They try to *cover* as much as they can rather than *teach* just a little. In a word, they "satisfice."

The data show that U.S. mathematics and science teachers are aware of and believe in more effective, complex teaching styles than they practice. They often have information that would help them do their work more effectively. Their beliefs suggest that they might choose to organize instruction differently under circumstances less consumed by the need for coverage.

Effective teachers should not be unusual, nor should effectiveness require extraordinary efforts and dedication by teachers. The reality, however, is that U.S. teachers are placed in situations in which they cannot do their best. We have yet to unleash the effectiveness of U.S. teachers. It seems likely that fundamental changes are needed in teacher knowledge, working conditions, curricula quality, student expectations, and textbook content.

What Can We Expect from U.S. Students?

In mathematics, we have a highly fragmented curriculum, textbooks that are a "mile wide and an inch deep," and teachers who cover many topics but none extensively. We make low demands on students and have a more limited conception of "the basics" than the international norm. It seems highly likely that U.S. student achievement in mathematics will be below international averages.

Our science curriculum is less fragmented. Science achievement seems likely to be closer to international averages, but still not what we desire and certainly below some, if not most, of our economic peers.

U.S. students' achievements—the yield of our aggregate national education "system"—in mathematics and the sciences are likely to be disappointing and many of the reasons are not under students' control. We must make substantial changes if we are to compete and to produce a quantitatively and scientifically literate workforce and citizenry.

How Has Our Vision Become So Splintered?

Culture affects education, even in supposedly fixed disciplines such as mathematics and science. Countries differ in the priorities they give to these disciplines, in the way they organize instruction and the value they ascribe to academic success. The qualitative differences found in mathematics and science instruction across France, Japan, Spain, Switzerland, Norway, and the

United States suggest that strong cultural components, even national ideologies, are at work in the teaching of these subjects.

The current state of our nation's composite visions guiding mathematics and science education are clearly shaped by cultural forces particular to the United States, starting with the nation's decentralized approach to education.

A System With Many Actors

Education in the United States always has been guided by agencies and organizations — local, state, and national, official and unofficial—that take their share of responsibility for education. There are many actors, including states, schools, commercial publishers, national associations, test publishers, teachers, and the federal government. While the independence of these groups is essential to education in the United States, the result is a composite of sometimes corresponding, sometimes conflicting separate visions. The conversations that cumulatively shape the national visions of mathematics and science education in the United States appear to be held in the tower of Babel.

Our earlier statement that there was "no one helm" for mathematics and science education should not be taken as implying that there *should* be either a single helm or a single helmsman. At its best, our system of distributed educational responsibility allows local preferences and community needs to help determine what occurs in local schools. It also provides laboratories to test, implement, and replicate new approaches. At its worst, our system requires that we seek consensus on needed changes site by site.

Given the cultural context in which mathematics and science education is carried out in the United States, a decentralized system with many actors is inevitable. We hope the splintering is not.

A Diverse Market for Curricula and Textbooks

U.S. textbook publishers face varied, often conflicting, demands for what should be in mathematics and science textbooks. Official mathematics and science curricula vary widely among states and districts. Over 35 states have textbook adoption policies, but in many states districts are free to choose any textbook.

Textbook publishers are understandably eager to produce products that will appeal to as many markets as possible. The results are large textbooks that embrace virtually all suggestions offered by the various actors. They include something for everyone.

If a clear, coherent vision of what is important existed and was shared by virtually all textbook publishers, it is likely that the resulting materials could soon lead to wide official adoption reflecting that coherent vision.

Standardized Tests

The cacophony of conflicting demands seen in curricula and textbooks is exacerbated by pressures to provide for successful student performance on common standardized tests. These include state assessments and the National Assessment of Educational Progress (NAEP) tests, as well as commercially produced and locally mandated standardized tests.

Despite a seeming sameness about most standardized tests, there are differences in content emphases and student performance demands. These differences are sufficient to constitute yet another set of demands to try to reconcile.

Mass Production and Mass Education

U.S. education has been influenced profoundly by a deeply seated ideology springing from our national experience with the power of industrial and assembly-line production. This ideology revolves around the idea of producing uniform, interchangeable parts that can be assembled into desired wholes. Translated into education, such thinking views school mathematics and science as partitioned into many topics that form the building blocks of curricula. As a result, our students may grasp the pieces but not the whole.

We have applied the term *incremental assembly* to this ideology and believe that it may well keep the United States from finding other, more coherent and powerful ways to think about and organize curricula. This is unfortunate. Henry Ford, presumably, did not try to make all models simultaneously on the same assembly line.

The lack of focus in U.S. mathematics and science education also has roots in behavioral psychology, which has pushed education in the direction of behavioral objectives and programmed instruction. This notion may help explain our curricula of many small topics, frequent low demands, and interchangeable pieces of learning to be assembled later.

The Impact of Reform

In the U.S. today we live in a climate of reform and talk of reform. Professional organizations concerned with mathematics and science education issue platform documents setting out agendas, benchmarks, and "standards." These powerful, demanding, and insightful calls for reform offer coherent visions of what might be done to make major improvements in their targeted educational practices. What has been their impact on mathematics and science education?

Awareness of Reforms

As late as two years ago, state mathematics and science curriculum guides, plans, and statements of intentions still called for coverage of far more topics than most other countries did and, far more than would be indicated by current reform agendas in mathematics and science education. The same can be said of textbooks.

U.S. mathematics and science teachers are generally aware of these reforms. More than 75 percent of U.S. mathematics teachers indicated familiarity with the NCTM *Standards*. Fewer U.S. science teachers indicated similar familiarity with the corresponding science frameworks, but those were released five years after the mathematics report.

These data suggest that more time alone will not be enough. Failure to create widespread change in teaching practice does not appear to be due to lack of information.

An Unfocused Reform

U.S. mathematics and science educators approach reform in the same inclusive style as they deal with traditional content—they add its recommendations but do not take away. This is clearly contrary to the recommendations of the NCTM *Standards*. Textbooks have been affected to some extent by mathematics education reform recommendations, but in a similar inclusive manner. As a result, students cannot focus on or be successful in either the old or new curricula.

This development is troubling because the reform agendas typically are coupled with more demanding, time-consuming, and complex performance expectations that require paying careful attention to a smaller number of strategic topics. Adding more topics will not help.

The impact of science reform recommendations remains untested as yet. Reform documents themselves often emerge from compromise among professionals, and this compromise may prevent them from stating a single vision. Even when a reasonably coherent voice emerges for reform—for example, the NCTM *Standards* in math education and the National Research Council's *National Science Education Standards*—our organizational context causes it to be heard as simply one more voice in a "babel" of competing voices. This "babel" becomes so overwhelming that it is hard for official actors to separate "signal" from "noise" or to prioritize the voices to which they will listen. In such a systemic context, splintered visions are likely to remain splintered.

The Need for Time

The lack of success that reform measures have had to date does not imply that they have been futile. Rather, they imply that reform may take considerable time.

Slow progress is certainly no reflection on the quality or power of mathematics and science reform efforts that have yet to be as effectual as their supporters wish in this climate. Certainly, it would be drastically wrong to conclude, based on these "early returns," that these reforms have failed. Rather, it seems more appropriate to be amazed at their current successes.

Who Are Our Curricular Peers?

If we take seriously that the proportions of curricula, as set forth in state guidelines and textbooks, set bounds on what is broadly achieved by those taught, we should identify those countries that set similar bounds to their students' achievement.

In grade-eight mathematics, the U.S. composite curriculum as represented by textbooks is most like those of Australia, New Zealand, Canada, Italy, Belgium (French language system), Thailand, Norway, Hong Kong, Ireland, and Iceland.

In grade-eight science, our curriculum is most like that of New Zealand, Iceland, Greece, Bulgaria and the Peoples' Republic of China.

Are These the Peers We Want?

While the curriculum of any country is interesting and has some important features, we must ask if these are the countries with whom we are and will be trying to compete.

As a nation we desire to empower and inform our citizenry comparably as well as to effectively compete economically with other developed countries. We want attainments similar to the European Union, to the APAC countries (especially Japan and the "young tigers" of Korea, Singapore, etc.), and, most definitely, with the other G-7 countries.

When we find ourselves most similar to countries other than those with whom we seek to be peers, we have reason for deep concern. In matters of what is basic in teaching children mathematics and science, we are not peers with the composite of other TIMSS countries. We as a nation must be concerned.

What Is Necessary for Reform to Succeed?

The U.S. vision of mathematics and science is splintered. We are not where we want to be. We must change. But the required change is fundamental and deeply structural. There are no single answers or instant solutions.

Most nations do not share similarly splintered visions in mathematics and science education. Theirs are more coherent. While central guiding visions do not alone guarantee student achievement, they contribute to optimal attainments. These shared visions are insufficient to ensure desired achievements, but they seem necessary starting points.

The United States has a decentralized educational system in which the component organizations do not always work towards common goals, nor do they always aim at producing important combined results. Formal mechanisms of coordination—either by regulation or rewards for selected behaviors—have proven politically sensitive and are in limited use. Given such a culture of education, how can a focused vision be achieved? Several principles would seem to be at work:

Effective Reform Will Necessarily Be Systemic

Information- and motivation-based reforms and improvement policies alone will not bring fundamental improvements. Any serious attempt at change in U.S. science and mathematics education must be deeply structural. The fundamental problem is not a conglomeration of individual problems. Any effective reform in this context will necessarily be systemic—affecting several parts at once.

Not every systemic reform automatically will address the core of our problems. Appropriate structural reform must pursue focused and meaningful goals. We may not be able to do everything and do any of it well. Instead, it appears we must make choices regarding which goals are more important and how many goals we can effectively pursue.

Effective Reform Must Respect Cultural Context

Whatever actions are taken must be appropriate to our educational federalism and our context of shared educational responsibility. When discussion suggests the need for more powerful and coherent guiding visions, they must be sought in processes that will achieve wide consensus necessary for change in our context.

A corollary is that we may learn from other countries but we cannot emulate their centrally administered changes. Any reform in the United States must seek visions that can achieve broad consensus.

Conclusion

The United States needs powerful mathematics and science education because they:

- Provide a strong basis for our democracy by helping create a literate and informed citizenry;
- Help each individual to grow, develop, reach his or her individual potential, and become more autonomous and empowered; and
- Provide a sound basis for continuing national prosperity in a competitive, information-driven, technological, and changing international arena.

Perhaps we do not need a central focus for our curricula and teaching. Perhaps the value of diversity outweighs the value of focus. Perhaps our de facto emphasis on breadth will prove more effective overall than other countries' strategies of focusing on strategic topics. That is a matter for further empirical evidence and public discussion.

Both conventional wisdom and a considerable body of research, however, suggest that focus and selection are needed in situations in which too much is included to be covered well. The impact of these unfocused curricula and textbooks in mathematics and science likely includes lower "yields" from mathematics and science education in the United States Focus would seem to be a necessary but not a sufficient condition for high student attainments.

What kinds of mathematics and science education do we, as a nation, want for our children? While this is a central question for public debate, it seems likely that we want educations that:

- Are more focused, especially on powerful, central ideas and capacities;
- Provide more depth in at least some areas, so that the content has a better chance to be meaningful, organized, linked firmly to children's other ideas, and to produce insight and intuition rather than rote performance; and
- Provide rigorous, powerful, and meaningful content that is likely to produce learning that lasts and not just learning that suffices for the demands of schooling.

Questions to Ask

The authors of this report do not represent any official or policymaking group. Our job has been to design relevant research, analyze its results carefully, and report them objectively. Because of who we are, we do not feel it appropriate to make specific recommendations. We can, however, at least ask questions—questions that our results lead us to believe important for those who do set policy.

Most of these questions are not original with us, although their form here has been influenced by the data we investigated. In fact, some efforts are currently underway to address these questions, including the National Science Foundation's State Systemic Initiatives and the recently convened executive committee of the National Governors' Association in conjunction with business leaders. Those efforts may include answers to several pressing questions raised by these findings:

- How can we focus our mathematics and science curricula and textbooks around an intellectually coherent vision?
- How can we raise expectations and demands on our students?
- How can we help our teachers to do the best they can in teaching mathematics and science to our students?
- How can we find a better model for curriculum and instruction?
- How can we develop a new vision of what is basic and important?

Certainly these are not the only questions that must be asked and answered on the way to the revolution or, if one prefers, to a fruitful evolution in mathematics and science education. We have not touched on whole domains of issues—for example, concerns for equity in educational opportunity—because we did not want a report on the "splintered vision" of our children's education to be itself unfocused. Others must join in seeking answers to the questions raised here and the others we did not raise. Our data can help.

Presently, however, our story is simple. The U.S. vision of mathematics and science education is splintered. We are not where we want to be. We must change.

Works Cited

[1] The first, *Characterizing Pedagogical Flow*, discusses curriculum data in mathematics and science along with classroom observations and teacher interviews in six TIMSS countries. The second and third, *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in Science Education*, are reports that present data on the full set of almost 50 TIMSS countries.

[2] At that time the National Council of Teachers of Mathematics (NCTM) *Standards* (for mathematics education) had existed for only about three years. The American Association for the Advancement of Science's (AAAS) *Benchmarks* (for science and mathematics literacy) had been released only in preliminary form. The National Academy of Science's National Research Council's *Science Education Standards* had yet to be fully formulated or released. Therefore this report cannot offer any conclusions about these reforms.

[3] Because the U.S. does not have a national curriculum, we aggregated states to find a representative average.

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Annotated Bibliography for *Guidebook to Examine School Curricula*

Anderson, C.W. "Strategic Teaching in Science." In Marcia K. Pearshall, ed. *In Scope, Sequence, and Coordination of Secondary School Science, Volume II: Relevant Research.* Washington, DC: The National Science Teachers Association, 1992, pp. 221-236.

A discussion of strategic teaching in elementary science classrooms. Using a hypothetical teacher, Ms. Lane, the author notes the various difficulties she might face in teaching a unit on light and vision. The four problem areas identified are (1) definitions of strategic teaching, (2) course curriculum, (3) student learning, and (4) student instruction. The author elaborates on the difficulties faced in each area and examines possible teaching responses. A teaching strategy based on conceptual change learning was found to be the most effective. Recommendations for improving teachers' ability to utilize strategic thinking and conceptual change learning are offered.

Anderson, Ronald H. *Studies of Education Reform: Study of Curriculum Reform.* Washington, DC: U.S. Department of Education, 1996.

A study of curriculum reform in mathematics, science, and higher order thinking. The study examined emerging reform practices focusing on which ones worked; what incentives for change were effective; and which means of overcoming barriers to change were successful. Nine case studies were conducted at various sites where reform was in progress. Preparatory work, reform methods, and results are discussed.

Archbald, Douglas A., and Porter, Andrew C. "Curriculum Control and Teachers' Perceptions of Autonomy and Satisfaction." *Educational Evaluation and Policy Analysis,* 16(1), Spring 1994, pp. 21-39.

A study designed to determine the effects of centralized curriculum control on teachers' opinions. High school mathematics and social studies teachers from six urban school districts were asked to rate their control and autonomy in various contexts. The districts were divided by type into high, medium, and low levels of centralized curriculum control. Mean ratings were presented from teachers in all three levels of centralization. The four scales were (1) Policy and Teacher-Discretion Influences, (2) Teacher Control Over Classroom Content and Pedagogy, (3) Staff Involvement in Decision Making for Course Content, and (4) Teacher Empowerment. Results were discussed in terms of individual scale ratings, overall ratings, and comparisons between mathematics and social studies teachers.

Ball, D.L., and Cohen, D.K. "Reform by the Book: What Is—Or Might Be—The Role of Curriculum Materials in Teacher Learning and Instructional Reform?" *Educational Researcher,* Volume 25, December 1996, pp. 6-8.

A discussion of the impact of curriculum materials on classroom instruction. The article suggests that the design of curriculum materials is one of the oldest ways to influence classroom instruction. Reformers have often used instructional materials as a means to shape what students learn. This strategy is often unsuccessful for it undermines the professional work of teaching and severely limits local discretion over curriculum. Curriculum materials play an "uneven role" in teaching practice because: (1) curriculum developers and others often have failed to take account of the teacher; (2) a gap exists between curriculum developers' intentions for students and teachers' understanding of the material and their beliefs about what is important for students to learn; and (3) many educators do not follow textbooks, but instead make their own curriculum. Hostility to texts has inhibited careful consideration of the constructive role that curriculum might play. The authors suggest that curriculum materials could lead to improved practice if they were created with closer attention to processes of curriculum enactment.

Brophy, J., and Alleman, J. "Activities as Instructional Tools: A Framework for Analysis and Evaluation." *Educational Researcher*, Volume 20, May 1991, pp. 9-23.

A study designed to stimulate increased scholarly attention to the design, selection, and assessment of learning activities and scaffolding of student involvement in those activities. It is argued that research has focused much more on content selection and representation and on teacher-student discourse than on activities. A conceptual analysis and a set of principles are proposed as tools for designing, selecting, and evaluating learning activities. The principles were drawn from generic curriculum sources and thus, theoretically, are applicable to all school subjects. Five sets of principles are offered: (1) primary principles that must apply to individual activities; (2) secondary principles that may apply to individual activities; (3) principles that apply to sets of activities; (4) additional principles that are associated with particular philosophies; and (5) principles that apply to the teacher's implementation of activities. The suggested principles are intended to help students engage in actively processing curriculum content, developing personal ownership and appreciation of it, and applying it to their lives in and outside of school.

Eggebrecht, John; Dagenais, Raymond; Dosch, Don; Merczak, Norman J.; Park, Margaret N.; Styer, Susan C.; and Workman, David. "Reconnecting the Sciences." *Educational Leadership*, 53(8), May 1996.

A description and discussion of the Integrated Sciences program at the Illinois Mathematics and Science Academy. Designed to bring all science subjects together into one classroom, the program is a three-semester, double-period course offered as an alternative to standard core sequence science instruction. The program is constantly evolving and adopting new techniques of instruction. By integrating the varied subjects, the instructors hope to overcome the deficiencies of standard science education: transfer of basic scientific knowledge and transfer of scientific authority. According to the authors, the program must be assessed in five key areas: (1) the context of national standards; (2)

student performance in relation to those standards; (3) positive student attitudes toward science; (4) adequate preparation for advancement; and (5) overall improved learning habits. Results indicated a positive outcome in the first four areas, while the fifth was still being determined. The program has demonstrated its success and has led to real intellectual growth for both students and instructors.

Goertz, Margaret E.; Floden, Robert E.; and O'Day, Jennifer. *Studies of Education Reform: Systemic Reform.* Washington, DC: U.S. Department of Education, 1996.

A study of systemic reform in 12 schools. The study was designed to expand knowledge of state approaches to systemic reform, examine responses to reform policies, identify challenges at all levels to reforming education, study the capacity of the system to support reform, and provide guidance to policymakers at all levels as they design and implement reform policies. A discussion of relevant literature is included. Analysis was done in three areas: (1) challenges to implementing systemic reform; (2) teachers' practice and opportunities to learn; and (3) capacity building and systemic reform. Policy and research implications are also offered.

Khattri, Nidhi; Reeve, Alison L.; Kane, Michael B.; and Adamson, Rebecca J. *Studies of Education Reform: Assessment of Student Performance.* Washington, DC: Pelavin Research Institute, 1996.

A study of performance assessments from various educational authorities at 16 school sites. The main objectives of the study were to examine the key characteristics of performance assessments, the facilitators and barriers in assessment reform, and the impacts of performance assessments on teaching and learning. Results were discussed as general policy implications, policy implications if assessment reform is to be used to improve and inform instruction and curriculum, and policy implications if assessment reform is to be used for school and/or district accountability. A discussion of implications for future research is also included.

Porter, Andrew. "A Curriculum Out of Balance: The Case of Elementary School Mathematics." *Educational Researcher*, 18(5), June-July 1989, pp. 9-15.

A study to examine the content of elementary mathematics courses. Using teacher logs and interviews, the researchers determined that teachers overemphasized skill development while neglecting to develop adequate conceptual understanding and problem-solving abilities. They also found that the majority of topics were taught briefly with no expectation of in-depth understanding. The differences in content between grades were negligible and did not align with student progress. Individual teachers and schools varied enormously in the overall amount of time spent teaching mathematics. Recommendations for correction are offered.

Porter, Andrew. "The Uses and Misuses of Opportunity-to-Learn Standards." *Educational Researcher*, 24(1), January-February 1995, pp. 21-27.

A discussion of Opportunity-to-Learn (OTL) standards as defined by the Goals 2000: Educate America Act. Noting the complicated legislative and political atmosphere surrounding the law, the author speculates on possible uses and definitions for OTL standards. The author states that OTL standards are not appropriate as measures of school accountability, but rather as measures of school improvement. It is noted that the standards can be used to determine successful practices, process indicators, and reform progress and as a tool to diagnose poor performance. OTL standards should include first and foremost a basic standard of a safe and orderly environment. What is actually taught in schools; the quality of pedagogy used; and the applications and uses of instructional resources such as libraries, laboratories, and computers should also be included. Criteria suggestions are also offered for other standards. While Goals 2000 may not fulfill all expectations, OTL indicators can be extremely helpful in aiding school improvement.

Roth, Kathleen J. "Science Education: It's Not Enough to 'Do' or 'Relate.'" In Marcia K. Pearshall, ed. *In Scope, Sequence, and Coordination of Secondary School Science, Volume II: Relevant Research*. Washington, DC: The National Science Teachers Association, 1992, pp. 151-164.

A discussion and evaluation of elementary science education teaching perspectives. In addition to traditional textbook-based science teaching, the author compares and contrasts the three main reform movements in science education. Inquiry teaching emphasized process skills and actual scientific work. Science-Technology-Society teaching also promoted process skills, but regards the use of scientific knowledge as most important. Conceptual change teaching involved imparting conceptual understanding of science and the overall usefulness of scientific knowledge. The final perspective was found to be the strongest.

Schmidt, William H.; McKnight, Curtis C.; Raizen, Senta A. *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education.* Boston, MA: Kluwer Academic Publishers, 1996.

A Splintered Vision discusses data from the analysis of 491 curriculum guides and 628 textbooks from around the world collected as part of TIMSS. It also presents detailed accompanying data on teacher practices in the United States, Japan, and Germany. The report documents and characterizes the state of U.S. mathematics and science curricula, textbooks, and teaching practices and places them in a cross-national context. The report's authors conclude that the lack of a single coherent vision of how to educate today's children produces unfocused curricula and textbooks that influence teachers to implement diffuse learning goals.

Smith, Edward L.; Blakeslee, Theron D.; and Anderson, Charles, W. "Teaching Strategies Associated with Conceptual Change Learning in Science." *Journal of Research in Science Teaching,* 30(2), 1993, pp. 111-126.

A study examining conceptual change learning strategies for science teaching and its relationship to student performance. Thirteen seventh-grade life science teachers were observed teaching three units: photosynthesis, cellular respiration, and matter cycling in ecosystems. The teachers were divided into three groups; each group received varying levels of conceptual change learning preparation in the form of workshops and/or course materials. Students were given both pretests and posttests. The results demonstrated that the use of these instructional materials increased conceptual change learning and resulted in better student performance on posttests. Workshops alone had little impact on either area. A combination of both strategies was associated with higher student performances on tests. The study demonstrates the effectiveness of conceptual change learning strategies; however, few of the teachers were successful in implementing the strategies without the course materials. A discussion of conceptual change theories is also included.

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context,* NCES 97-198, by Lois Peak. Washington, DC: U.S. Government Printing Office, 1996.

A report on the U.S. eighth-grade TIMSS results. It draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in international context.

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U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science,* NCES 97-255, Washington, DC: U.S. Government Printing Office, 1997.

> A report on the U.S. fourth-grade TIMSS results. It summarizes the most important findings concerning U.S. achievement and schooling in international context.

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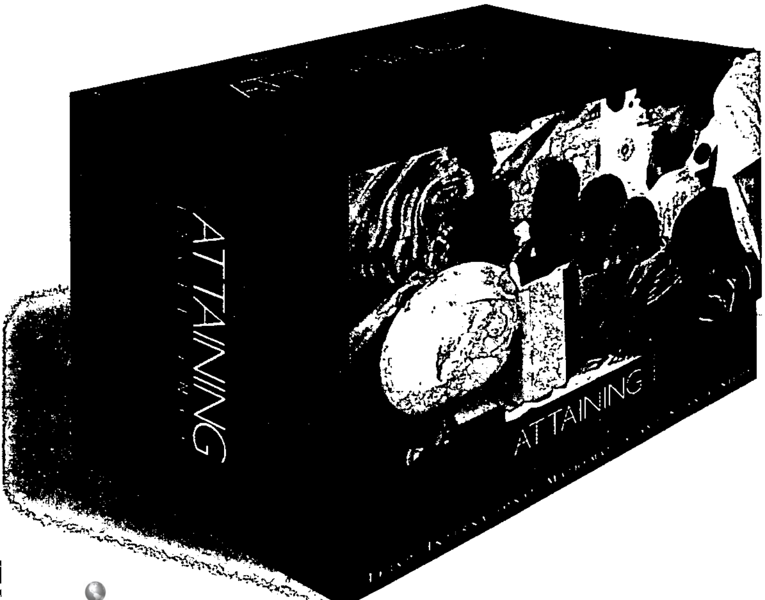

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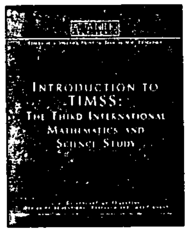

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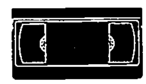

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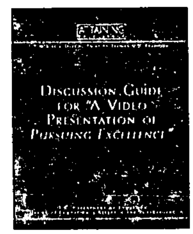

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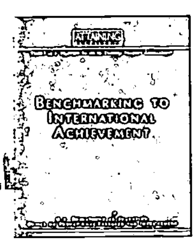

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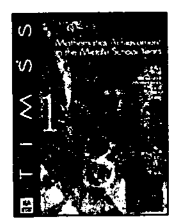

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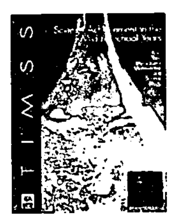

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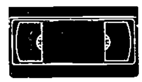

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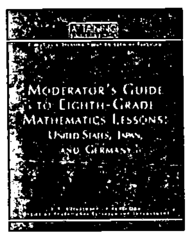

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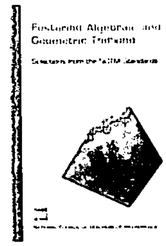

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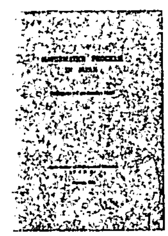

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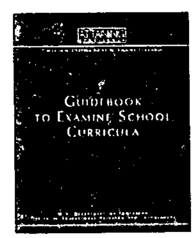

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