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ABSTRACT

The Third International Mathematics and Science Study (TIMSS) covered five different grade levels, with more than 40 countries collecting data in more than 30 different languages [illegible] million students were tested. The present report contains the TIMSS results for students in the final year of secondary school. Mathematics and science literacy achievement results are reported for 21 countries; advanced mathematics results and physics results, respectively, are reported for 16 countries. These results complete the first round of descriptive reports from the TIMSS study. Together with the results for primary school students (third and fourth grade in most countries) and middle school students (seventh and eighth grades in most countries), the results contained in this report provide valuable information about the relative effectiveness of a country's education system as students progress through school. A ten-page Executive Summary details the extensive conclusions to be drawn from the study. Dozens of tables and figures provide detailed statistics for all participating countries. The Netherlands and Sweden were the top performing countries in mathematics; France was the top performer in advanced mathematics; Norway and Sweden had physics achievement levels significantly higher than other participating countries. The appendixes contain extensive information pertaining to the development of the TIMSS tests, sample sizes and participation rates, compliance with sampling guidelines, and the test-curriculum matching analysis. (DDR)

TIMSS

Mathematics and Science Achievement in the Final Year of Secondary School

IEA's Third International Mathematics and Science Study

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IEA

TIMSS

International Association for the Evaluation of Educational Achievement

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Executive Summary

Mathematics and Science Achievement in the Final Year of Secondary School

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.

The scope and complexity of TIMSS is enormous. The mathematics and science testing covered five different grade levels, with more than 40 countries collecting data in more than 30 different languages. More than half a million students were tested around the world. The present report contains the results for students in the final year of secondary school.

As can be imagined, testing this "grade" was a special challenge for TIMSS. The 24 countries participating in this component of the testing vary greatly with respect to the nature of their upper secondary education systems. First, there was the question of how many students of the age-eligible cohort are even in school by the final year, and how this might differ across countries. Second, it was no small task for many countries to describe the final year of school. In most TIMSS countries, students' final year of school depends on their course of study (e.g., academic, technical, or apprenticeship). Thus, the final year of schooling varies across and within countries, with some students completing secondary school after a two-, three-, four-, or even five-year program. Understandably, it was difficult for some countries to test all of the final-year students, particularly the ones in on-site occupational training. To give some indication of the proportion of the entire school-leaving age cohort that was covered by the testing in each country, TIMSS developed its own index – the TIMSS Coverage Index or TCI. In general, the smaller the TCI, the more elite the group of students tested.

Given the extensive diversity of students' curricula there also were many questions about what mathematics and science understandings students should have to meet the challenges beyond secondary school. Thus, TIMSS developed three different tests. The mathematics and science literacy test was designed for all final-year students, regardless of their school curriculum. By and large, the purpose of this test was to measure how well students can use their knowledge in addressing real-world problems having a mathematics or science component. This test was designed to be reported separately for mathematics and for science. There also was great interest on the part of some TIMSS countries to determine what school-leaving students with special preparation in mathematics and science know and can do, since the capabilities of these students may help determine a country's future potential to compete in a global economy. Thus, a second test was developed for students having taken advanced mathematics. For the sciences, it was not possible to study all branches of science in detail. The participating countries chose physics for detailed study because it is the branch of science most closely associated with mathematics, and came closest to embodying the essential elements of natural science. The third test, then, was a physics test designed to measure learning of physics concepts and knowledge among final-year students having studied physics. Each of the three tests contains multiple-choice questions as well as questions in an open-ended 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. Not all of the 24 countries participated in the three different parts of the testing (see Table 1).

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. Most countries tested the mathematics and science achievement of their students in May and June of 1995.

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 for the students in their final year of secondary school complete the first round of descriptive reports from the TIMSS study. Together with the results for primary school students (third and fourth grades in most countries) and middle school students (seventh and eighth grades in most countries), the results contained herein will provide valuable information about the relative effectiveness of a country's education system as students progress through school.

The following sections summarize the major findings described in this report.

Mathematics and Science Literacy

The report presents mathematics and science literacy achievement results for 21 countries. Even though there was quite a range in the TCIs, about half the countries were able to cover 70% or more of the entire school-leaving age cohort (see Table 1.1). Also, contrary to some previous international studies, for the mathematics and science literacy testing, the higher-performing countries tended to have better coverage than the lower-performing countries. Although differing levels of selectivity among education systems was not a large issue, low student participation rates were a problem in many of the countries. Because final-year students have many demands on their time and their educational situations can make testing difficult (e.g., apprenticeship training), countries had some difficulty in encouraging students to attend the testing sessions. Only eight countries met the TIMSS guidelines for sample participation (see Table 1.1).

- ▷ The Netherlands and Sweden were the top-performing countries. Iceland, Norway, and Switzerland also performed well, similar to each other but significantly below the Netherlands and Sweden. Other countries performing above the international average of the 21 countries were Denmark, Canada, New Zealand, and Austria. [The only two high-performing countries with a low degree of coverage of the school-leaving age cohort (less than 60%) were Denmark and Iceland. However, of the high-performing countries, only Sweden, Switzerland, and New Zealand met the sampling guidelines. The Netherlands and Denmark deviated from the approved sampling procedures and had low participation rates.]

- ▷ Countries performing below the international average were (in descending order of average achievement): Hungary, the Russian Federation, Italy, the United States, Lithuania, Cyprus, and South Africa. In general, Hungary, the Russian Federation, Italy, the United States, and Lithuania performed similarly, followed by Cyprus and South Africa.

- ▷ As noted above, selectivity in education systems and sampling approaches did not seem to be much of a factor in the mathematics and science literacy testing. Still, to place countries on a more equal footing, it is interesting to look at performance for the top 25% of the students in the entire school-leaving age cohort. From this perspective, Sweden, the Netherlands, Norway, and Switzerland were the highest performing countries.

- ▷ When the results were looked at separately for mathematics and science, the top-performers in mathematics literacy were the Netherlands, Sweden, Denmark, and Switzerland. The top-performers in science literacy were Sweden, the Netherlands, Iceland, and Norway.

- Countries that had higher achievement in mathematics literacy than in science literacy were Denmark, France, Hungary, Lithuania, and Switzerland. Those with higher achievement in science literacy were Canada, the Czech Republic, Iceland, Norway, the Russian Federation, Sweden, and the United States.

- In all countries except South Africa, males had significantly higher average achievement than females in mathematics and science literacy. This also was true for science literacy. In mathematics literacy, there were no significant gender differences in performance in Hungary, the United States, and South Africa.

- Countries ranking high in mathematics achievement at the eighth grade did not always rank high in mathematics literacy at the upper secondary level. Only five countries were above the international average both at the eighth grade and for their upper secondary school students: Switzerland, the Netherlands, Austria, France, and Canada.

- In general, the students no longer taking mathematics performed less well in mathematics literacy than those still studying the subject. Similarly, there was a positive association between taking science subjects and performance in science literacy in almost every country.

- In nine countries (Australia, Cyprus, the Czech Republic, France, Hungary, Italy, Lithuania, the Russian Federation, and Slovenia), 85% or more of the students reported that they were currently taking mathematics. In contrast, countries where as many as one-third of the final-year students reported that they were not currently taking mathematics included Canada, Iceland, the Netherlands, Switzerland, and the United States.

- Compared with mathematics, higher percentages of students in most countries reported that they were taking no science subject at the time of testing. Half or more of the students in the Czech Republic, Denmark, Norway, Sweden, and Switzerland, reported that they were not taking science, and nearly half of the final-year students so reported in Canada and the United States.

- Even though a strictly comparable classification of educational programs was not always possible across countries, students enrolled in academic programs had higher average achievement than students in vocational programs. The average achievement of students in technical programs generally was somewhere between that of the academic and vocational students.

- Students generally reported positive perceptions about their performance in mathematics and science. The highest perceptions of success in mathematics were reported in Australia, Denmark, Italy, and the United States, where 70% or more of the students agreed that they usually did well. Perceptions of doing well in science were generally higher; in 12 countries more than 70% of the students agreed that they usually did well. Eighty percent or more so agreed in Italy, Lithuania, and the United States.

- Despite the different educational approaches, structures, and organizations across the TIMSS countries, it is clear that parents' education is positively related to students' mathematics and science literacy. As was the case for eighth graders, in every country final-year students whose parents had more education had higher mathematics and science literacy.

- More than 30% of students in Canada, Iceland, Lithuania, the Russian Federation, and the United States indicated that at least one parent had finished university, while in contrast, more than 30% of the students in Australia, Cyprus, the Czech Republic, France, Italy, and South Africa reported that the highest level attained by either parent was finished primary but not upper secondary school.

- In most countries, more than 80% of the students reported at least weekly use of calculators (at school, at home, or anywhere else). Only in the Czech Republic, Norway, and the Russian Federation did 20% or more of the students report rarely or never using calculators. The frequent use of calculators was positively related to mathematics and science literacy in all countries.

- Final-year students were given the option of using a calculator when completing the TIMSS tests. Most students made moderate use of a calculator on the mathematics and science literacy test. The students who reported the most calculator use on the test performed best.

- The final-year students in a number of countries reported relatively infrequent computer use (at school, at home or anywhere else). Only in Australia, Austria, Canada, Denmark, Iceland, the Netherlands, New Zealand, Switzerland, and the United States did more than 50% of the students report at least weekly use of computers.

- Students in most countries reported spending between two and three hours per day on homework, on average. One-fourth or more of the final-year students in Austria, the Czech Republic, the Netherlands, Norway, Sweden, Switzerland, and the United States reported studying for less than one hour per day.

- ▷ Students were also asked about other ways they could spend their time out of school. Socializing is clearly an important activity for final-year students, with students in many countries devoting up to about two and one-half hours each day to spending time with friends. Watching television or videos also is a frequent activity (about an hour or so a day).

- ▷ Students' reports about the time spent working at a paid job varied across countries. In about half the countries, most final-year students (more than 80%) reported working at a paid job for less than one hour each day. However, in Australia, Canada, Iceland, the Netherlands, New Zealand, Norway, and the United States, at least one-fourth of the students reported working for three hours or more each day.

Advanced Mathematics

The report presents results for 16 countries participating in the testing of students having taken advanced mathematics courses. The test questions covered primarily the content areas of equations and functions, calculus, and geometry, and results are provided overall as well as separately for these three areas. The percentages of students tested in each country reflect the fact that a relatively small subset of the final-year students in each country have taken the advanced mathematics courses necessary to participate in this portion of the testing. The percentages of the school-leaving age cohort covered by the sample of students tested in advanced mathematics in each country ranged dramatically, although most countries tested 20% or less of this cohort. Countries with coverage below 10% were the Russian Federation (2%), Lithuania (3%), and Cyprus (9%). Austria (33%) and particularly Slovenia (75%) were at the high end. Compared to the mathematics and science literacy testing, countries had more success in locating these advanced students and encouraging them to participate in the testing. Thus, 10 of the 16 countries met the TIMSS sampling guidelines (see Table 5.1).

- ▷ Led by France, the countries performing above the international average of the 16 countries also included the Russian Federation, Switzerland, Denmark, Cyprus, and Lithuania. Australia, Greece, Sweden, and Canada also performed similarly to several countries in this top group. [Among these countries, the Russian Federation and Lithuania tested a very small percentage (2-3%) of their school-leaving age cohort. Denmark did not meet the TIMSS guidelines for either sampling procedures or participation rates, and Australia had school participation rates below the required 85%.]

- ▷ The cluster of lower-performing countries included Slovenia, Italy, the Czech Republic, Germany, the United States, and Austria. All except Slovenia and Italy performed below the international average.

- Interestingly, looking at the top 10% of the school-leaving age cohort, Slovenia and France had significantly higher performance than other participating countries. Even though Slovenia had difficulty in implementing the TIMSS sampling guidelines, the advanced mathematics testing covered three-fourths of its entire school-leaving age cohort. Similarly, France followed all of the sampling guidelines and also had relatively high coverage (20%). It appears that having higher percentages of students enrolled in advanced mathematics courses need not have a negative impact on the performance of the top students in that group.

- Significant gender differences favoring males in advanced mathematics achievement were found in all countries except Greece, Cyprus, Australia, Italy, and Slovenia. In some countries many more males than females have taken advanced mathematics courses, but this varied across countries.

- Compared to the other participating countries, most countries showed particular strengths or weaknesses in the content areas tested. For example, Sweden performed above the international average in numbers and equations, below the international average in calculus, and about at the international average in geometry.

- Most countries also did relatively better in some content areas than others compared to their overall performance in advanced mathematics. For example, compared to their overall average achievement, students in the United States performed better in numbers and equations and worse in geometry.

- Although the majority of students in many TIMSS countries reported receiving from three to five hours of mathematics instruction each week, in Austria and Sweden more than 60% of the students had less than three hours each week, and in Australia, Canada, Cyprus, France, Greece, and the Russian Federation, the majority of students had five hours or more.

- The amount of homework assigned also varied considerably. At one extreme, more the 40% of the advanced mathematics students in the Czech Republic and Sweden reported that they were assigned mathematics homework less than once a week, while at the other extreme, more than 80% of the students in Australia, Canada, Cyprus, Greece, Lithuania, the Russian Federation, and the United States reported having homework assigned three or more times a week.

- Advanced mathematics students were asked how often several different types of instructional activities were used in their classrooms. Among these, almost all students in all countries reported being asked to do reasoning tasks in at least some lessons. In almost every country, the students with the highest achievement were those that reported engaging in reasoning tasks most frequently.

- Algebra is an essential component of mathematics in upper secondary school, and students in every country reported that they are often asked to solve equations in mathematics class. Spending time working on equations also was an indicator of high achievement on the TIMSS advanced mathematics test.

- Final-year advanced mathematics students reported that the use of computers to do exercises or solve problems in mathematics class is comparatively rare.

- Calculator use by final-year advanced mathematics students was very common. In Australia, Canada, Cyprus, Denmark, Sweden, and the United States, more than 80% of the students reported using a calculator daily (at home, at school, or anywhere else), and in several other countries more than half of the students reported this level of use. In general, the advanced mathematics students with the highest average achievement were those who reported the highest level of calculator use.

- Most of the advanced mathematics students made moderate use of a calculator on the TIMSS test. In general, the students who reported that they did not use a calculator on the advanced mathematics test did not do as well as those who reported using one, although the extent of calculator use was not consistently related to achievement in every country.

- Among the final-year students taking advanced mathematics, the majority in every country reported that they plan to attend university. When asked about their plans for areas of future study, the most popular choices were business, health sciences or related occupations, and engineering.

- Even though not many students chose mathematics as their preferred area of future study, the majority of the students in many of the countries agreed that they would like a job that involved using mathematics. In general, more males than females agreed that they would like a job involving mathematics.

PHYSICS

Physics achievement results for students having taken physics are reported for 16 countries. The physics test was designed to measure five content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle, quantum and astrophysics, and relativity. The percentage of the entire school-leaving age cohort that participated in the physics study was approximately 15% in several countries, although it varied from as little as 2% to 3% in the Russian Federation, Latvia (LSS), and Denmark to 33% in Austria and 39% in Slovenia. Eleven of the countries met the TIMSS sampling guidelines (see Table 8.1).

- ▷ Norway and Sweden had average physics achievement similar to each other and significantly higher than the other participating countries. The Russian Federation and Denmark also performed above the international average. [The Russian Federation had a very low coverage index (2%) as did Denmark (3%), and Denmark did not comply with the guidelines for sampling procedures or participation rates.]

- ▷ The cluster of lowest-performing countries included France, the Czech Republic, Austria, and the United States, all of which performed below the international average of the 16 countries.

- ▷ The country rankings for the top 10% of the school-leaving age cohort were quite consistent with those obtained from all the tested students. However, the countries most likely to improve their standing were those with the largest coverage index, since they were least likely to have tested just the elite students. Slovenia joined Sweden as a top-performer, despite having difficulties with low sampling participation and unapproved sampling procedures. Austria also moved from the lowest-scoring cluster of countries to the middle group.

- ▷ Males had significantly higher physics achievement than females in all but one of the participating countries (Latvia (LSS)). Although the proportions of males and females taking physics were about equal in Latvia (LSS), Canada, the Russian Federation, Switzerland, and the United States, in several countries males outnumbered females by two or three to one.

- ▷ Norway and Sweden performed above the international average in all five physics content areas, while Austria and the United States fell below the international average in all five. Nearly every other country scored significantly above or below the international average in at least one content area, and about average in the others.

- ▷ Compared to their overall physics performance, most countries did relatively better in some content areas than others. For example, students in Canada performed relatively less well in mechanics and relatively better in heat than they did on the physics test as a whole.

- ▷ Significant gender differences favoring males were found in more countries in the areas of mechanics (15 countries), wave phenomena (11 countries), and modern physics (12 countries) than in electricity and magnetism (8 countries) or heat (7 countries).

- ▷ The amount of physics instruction received by students varied considerably across countries, but in general was less than five hours per week. The assignment of homework also varied considerably from less than once a week in several countries to three or more times a week in others.

- ▷ Although laboratory work might be expected to play a central role in physics classes, students reports varied across countries. In Austria, Germany, and Greece, the majority of the students reported that they never or almost never conduct laboratory experiments, whereas one-fourth or more of the students in Canada, Cyprus, Denmark, France, Switzerland, and the United States reported conducting experiments in most or all lessons. In about half the countries, the majority of students reported conducting experiments in some lessons. There was no consistent relationship between frequency of conducting laboratory experiments in class and physics achievement.

- ▷ Paralleling the findings for advanced mathematics, physics students frequently use calculators. Although the relationship was less pronounced than for students having taken advanced mathematics, in most countries students who reported daily calculator use performed better on the TIMSS physics test than those who reported less frequent use.

- ▷ Students were given the option of using a calculator when completing the physics test, and most physics students in every country used the calculator on some questions. The extent of calculator use was not consistently related to achievement in every country, but physics students who reported that they did not use a calculator on the test did less well than those who reported using one.

- ▷ Like the plans for further education of final-year students having taken advanced mathematics, those of final-year physics students center mainly on university. Students who have studied physics are well positioned to continue their education in the sciences or in areas of scientific application. Although choice of future study area varied considerably across countries, the most popular were engineering, mathematics or computer/information sciences, health sciences or related occupations, and business. While more females than males chose health sciences or related occupations, males often outnumbered females by a substantial margin in engineering, and in mathematics or computer/information sciences.

Introduction

Mathematics and Science Achievement in the Final year of Secondary School

Several major educational issues are addressed by the secondary school assessment conducted as part of the Third International Mathematics and Science Study (TIMSS). One such issue is how effective educational systems around the world have been in educating their whole populations rather than just an elite group of students. Given the importance of an understanding of mathematics and science to social and economic participation in a technology-based society, there is particular interest in what students finishing secondary school know and can do in mathematics and science; that is, after studying mathematics and science during their years as students, how literate are they in these subjects?

There is also special interest in what school-leaving students with special preparation in advanced mathematics and physics, the potential future mathematics and science specialists, know and can do in these subjects. The achievement of these students may indicate the ability of countries to compete in a global economy based on scientific discoveries, state-of-the-art approaches to financing, and innovations in electronics, computing applications, and fast-paced communication technologies.

Both for the overall school population and for students having taken advanced mathematics and physics, the TIMSS data for final-year students can be used to help determine what understanding of mathematics and science concepts students have after completing their upper secondary schooling, and how effectively they might use that understanding as they move on to their future endeavors in school, occupational, and community settings. Beyond providing the participating countries with a solid basis for examining their students' performance from an international perspective, TIMSS gives each of them an impetus for scrutinizing the quality and effectiveness of its education system.

Together with the previously released results in mathematics and science achievement for primary and middle school students, the TIMSS results for students in the final year of secondary school can heighten countries' awareness of a myriad of educational issues. By expanding each country's knowledge of what is possible through learning about the achievements of others and the techniques they use, TIMSS affords the participants unprecedented opportunity to consider the most-needed reforms and to garner public support for improving students' learning in mathematics and science.

TIMSS 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

[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 B.

in order to enhance mathematics and science learning within and across systems of education. With its wealth of information from more than half a million students at five grade levels in 15,000 schools and 41 countries, TIMSS enables the participants 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.

All countries that participated in TIMSS were to test students in the two grades with the largest proportion of 13-year-olds (seventh and eighth grades in most countries) in both mathematics and science. 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 in the fourth and eighth grades also had the opportunity to participate in a "hands-on" performance assessment.

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 the classroom, school, and national contexts within which education takes place.

The results of the assessments of primary and middle school students have been published in:

Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study[2]

Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study[3]

Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study[4]

[2] Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[3] Martin, M.O., Mullis, I.V.S., Beaton, A.E., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1997). *Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[4] 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: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study[5]

Performance Assessment in IEA's Third International Mathematics and Science Study[6]

These reports have been widely disseminated and are available on the internet (http://wwwcsteep.bc.edu/timss). The entire TIMSS international database containing the achievement and background data underlying these reports also has been released and is available at the TIMSS website.

The present report focuses on the mathematics and science literacy of all students in their final year of upper secondary school, and on the advanced mathematics and physics achievement of final-year students who have taken advanced courses in those subjects. The TIMSS International Study Center also plans to make the data collected in the final-year assessment available at its website, together with this report.

What Assessments Were Conducted and Which Students Were Tested?

The **mathematics and science literacy test** was designed to measure the mathematics and science learning of all final-year students who are at the point of leaving school and entering the workforce or postsecondary education, regardless of their school curriculum. These students may have specialized in mathematics and science in secondary school or have concentrated their studies in other areas, depending on the curricula offered in the participating countries. The mathematics and science literacy study is designed to provide information about how prepared the overall population of school leavers in each country is to apply knowledge in mathematics and science to meet the challenges of life beyond school.

The **advanced mathematics test** was designed to measure learning of advanced mathematics concepts among final-year students who have studied advanced mathematics. These students are at the point of leaving secondary school, and many will go on to further education in university or to another form of postsecondary education. Many of the mathematicians, scientists, engineers, medical practitioners, and business leaders of the future will be drawn from this group. In all countries that participated in the advanced mathematics assessment, the subpopulation of students tested had taken courses in advanced mathematics and was in the final year of secondary school at the time of testing. The exact definition of the subpopulation tested, however,

[5] 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.

[6] Harmon, M., Smith,T.A., Martin, M.O., Kelly, D.L., Beaton, A.E., Mullis, I.V.S., Gonzalez, E.J., and Orpwood, G. (1997). *Performance Assessment in IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

varied across countries in terms of which courses and how much advanced mathematics the students had taken (see Appendix A for more details). In addition to reporting achievement in advanced mathematics overall, this report presents achievement in three advanced mathematics content areas: numbers and equations; calculus; and geometry.

The **physics test** was designed to measure learning of physics concepts and knowledge among final-year students who have studied physics. These students too are about to leave secondary school, and many will go on to university or other postsecondary education. The physics study was designed to provide information about how prepared the population of school leavers that has taken physics is to pursue higher education or occupations in science. In all countries the students participating in the physics testing had taken physics and were in the final year of secondary school at the time of testing, but the exact definition of the population varied across countries in terms of which courses and how much physics the students had taken (see Appendix A for more details). In addition to reporting achievement in physics overall, this report presents achievement in five physics content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity.

Which Countries Participated?

Table 1 shows the countries that participated in the assessment of students in their final year of secondary school in mathematics and science literacy, advanced mathematics, and physics. Each participating country 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.[7] For the sake of comparability, all testing was conducted at the end of the school year. Most 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. The three countries on a Southern Hemisphere school schedule (Australia, New Zealand, and South Africa) tested from August to December 1995, which was late in the school year in the Southern Hemisphere. Students in Australia were tested in September to October; students in New Zealand were tested in August; and students in South Africa were tested in August to December 1995. Three countries tested their final-year students (or a subset of them) at the end of the 1995-96 school year. Iceland tested its final-year students in 1996; Germany tested its gymnasium students in 1996; and Lithuania tested the students in vocational schools in 1996. In Germany and Lithuania, all other students included in the TIMSS assessment were tested in 1995.

[7] Appendix F lists the National Research Coordinators as well as the members of the TIMSS advisory committees.

Table 1

Countries Participating in Testing of Students in Their Final Year of Secondary School*

Mathematics and Science Literacy	Advanced Mathematics	Physics
Australia	Australia	Australia
Austria	Austria	Austria
Canada	Canada	Canada
Cyprus	Cyprus	Cyprus
Czech Republic	Czech Republic	Czech Republic
Denmark	Denmark	Denmark
France	France	France
Germany	Germany	Germany
Hungary	Greece	Greece
Iceland	Israel[1]	Israel[1]
Israel[1]	Italy	Italy[2]
Italy	Lithuania	Latvia
Lithuania	Russian Federation	Norway
Netherlands	Slovenia	Russian Federation
New Zealand	Sweden	Slovenia
Norway	Switzerland	Sweden
Russian Federation	United States	Switzerland
Slovenia		United States
South Africa		
Sweden		
Switzerland		
United States		

* See Appendix A for characteristics of students tested.

[1] Because the characteristics of its sample are not completely known, achievement results for Israel are provided in Appendix D.

[2] Because it had a small sample for the physics testing, Italy's physics achievement results are provided in Appendix D.

What Are the Differences in Upper Secondary Education Systems?

The countries participating in TIMSS vary greatly with respect to their upper secondary education systems. Some countries provide comprehensive education to students in their final years of school, while in other countries students might attend academic, vocational, or technical schools. Some countries fall between these extremes, their students being enrolled in academic, vocational, technical, or general programs of study within the same schools. Across countries the definitions of academic, vocational, and technical programs also vary, as do the kinds of education and training students in these programs receive.

There also are variations across and within countries with respect to the grades representing the final year of schooling. In some countries, all students in their final year of schooling are in the same grade (e.g., secondary schooling ends for all students in grade 12). In other countries, determining the final year of schooling is much more complicated because there are one or more academic tracks, one or more vocational tracks, and apprenticeship programs. In these countries, the final year of schooling may vary by track, with some students completing secondary school after a two-, three-, or four-year upper secondary program, depending on the type of school or program of study. Furthermore, determining when schooling in vocational programs is completed is not always straightforward.

The differences across countries in how education systems are organized, how students proceed through the upper secondary system, and when students leave school posed a challenge in defining the target populations to be tested in each country and interpreting the results. In order to make valid comparisons of students' performance across countries, it is critical that there be an understanding of which students were tested in each country, that is, how each country defined the target population. It also is important to know how each upper secondary education system is structured and how the tested students fit into the system as a whole. In order to provide a context for interpreting the achievement results presented in this report, Appendix A summarizes the structure of the upper secondary system for each country, and specifies the grades and tracks (programs of study) in which students were tested for TIMSS.[8]

[8] Additional information about the education systems can be found in Robitaille, D.F. (Ed.). (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

The TIMSS Coverage Index: What Percent of the School-Leaving Age Cohort Was Tested?

Historically, an important difference between education systems was the proportion of an age cohort that successfully completed upper secondary education. In the 1960s, for example, completion rates among OECD countries ranged from more than 80% in the United States to between 17% and 33% in southern European countries.[9] One of the most significant developments in education systems around the world in the years since then has been the large increase in the number of students completing upper secondary education, with many countries catching up with the United States; yet there remains considerable variation among countries in completion rates. In order to avoid unwittingly comparing the elite students in one country with the more general population in another, therefore, it is important to be aware of the extent to which the upper secondary system in each country includes the total student population.

So as to learn how much of the school-leaving age cohort was still in school and represented by the TIMSS sample, a TIMSS Coverage Index (TCI) was computed for each country. The TCI is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample. It reflects any omissions from the sample, such as students who were excluded because of handicap or who had dropped out of school, and, in some countries, tracks or educational programs that were not covered by the TIMSS sample. The TCI was computed by forming a ratio of the size of the student population covered by the TIMSS sample, as estimated from the sample itself, to the size of the school-leaving age cohort, which was derived from official population census figures supplied by each country.[10]

Countries with high TCIs have most of their students still in school, and have covered this population with their TIMSS sample. Countries with low TCIs have fewer students still in school, or have excluded some components of their system from their sample (or both). Table 2 presents the TCI for each country, and also shows the two parts of the portion of the school-leaving age cohort not covered by the TIMSS sample: system components and students excluded by the country, and others – primarily young people who chose not to complete upper secondary education. The percentage of the age cohort covered by the TIMSS sample (the TCI), the percentage excluded from the sample, and the percentage of others not covered combine to form 100% of the school-leaving age cohort. For example, Australia has a TCI of 68.1%, which indicates that the TIMSS sample of final-year students covers just over two-thirds of the school-leaving age cohort. Of the remainder, 4% have been excluded from the sample, and the remaining 27.9% are presumably no longer attending school. The TCI for Cyprus is lower (47.9%), partly because Cyprus excluded students in private schools and in vocational programs (13.5%), and partly because a greater percentage of the age cohort is no longer attending school (38.6%).

[9] OECD (1996). *Education at a Glance - Analysis.* Paris: Organization for Economic Co-operation and Development.

[10] For more information on the TIMSS Coverage Index, see Appendix B.

Table 2

TIMSS Coverage Indices (TCIs)

Country	TIMSS Coverage Index (TCI)*	Sample Exclusions†	Others Not Covered	Notes on Exclusions
Australia	68.1%	4.0%	27.9%	
Austria	75.9%	16.8%	7.3%	Colleges and courses lasting less than 3 years excluded
Canada	70.3%	6.8%	22.9%	
Cyprus	47.9%	13.5%	38.6%	Private and vocational schools excluded
Czech Republic	77.6%	5.0%	17.4%	
Denmark	57.7%	1.3%	41.0%	
France	83.9%	0.9%	15.3%	
Germany	75.3%	9.6%	-	
[1] Greece	10.0%	56.8%	33.2%	Only students having taken advanced mathematics and physics included
Hungary	65.3%	0.1%	34.6%	
Iceland	54.5%	0.0%	45.4%	
[2] Israel	-	-	-	
Italy	51.5%	0.5%	48.0%	
[1] Latvia	3.0%	16.8%	80.3%	Only students having taken physics included
Lithuania	42.5%	0.0%	57.5%	
Netherlands	78.0%	21.5%	0.5%	Apprenticeship programs excluded
New Zealand	70.5%	0.0%	29.5%	
Norway	84.0%	3.3%	12.7%	
Russian Federation	48.1%	36.3%	15.7%	Vocational schools and non-Russian speaking students excluded
Slovenia	87.8%	5.6%	6.6%	
South Africa	48.9%	0.0%	51.1%	
Sweden	70.6%	0.2%	29.2%	
Switzerland	81.9%	2.1%	16.0%	
United States	63.1%	2.5%	34.5%	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* TIMSS Coverage Index (TCI): Estimated percentage of school-leaving age cohort covered by TIMSS sample. See Appendix B for details.

† Percentage different from that reported in Table B.4 because this is based on the entire school-leaving age cohort rather than the population of those students attending school.

[1] Results for Greece are reported only for advanced mathematics and physics; results for Latvia are available only for physics.

[2] The TCI could not be computed for Israel.

Table 3

TIMSS Coverage Indices (TCIs) for Advanced Mathematics and Physics

Country	Percentage of Students in Sample Having Taken Advanced Mathematics	Mathematics TIMSS Coverage Index (MTCI)*	Percentage of Students in Sample Having Taken Physics	Physics TIMSS Coverage Index (PTCI)†
Australia	23.1%	15.7%	18.5%	12.6%
Austria	43.9%	33.3%	43.5%	33.1%
Canada	22.3%	15.6%	19.4%	13.7%
Cyprus	18.5%	8.8%	18.5%	8.8%
Czech Republic	14.1%	11.0%	14.1%	11.0%
Denmark	35.7%	20.6%	5.5%	3.2%
France	23.8%	19.9%	23.8%	19.9%
Germany	34.9%	26.3%	11.2%	8.4%
[1] Greece	-	10.0%	-	10.0%
[2] Israel	-	-	-	-
Italy	27.4%	14.1%	16.7%	8.6%
[3] Latvia	-	-	-	3.0%
Lithuania	6.1%	2.6%	-	-
Norway	-	-	10.0%	8.4%
Russian Federation	4.2%	2.0%	3.2%	1.5%
Slovenia	85.9%	75.4%	43.9%	38.6%
Sweden	23.0%	16.2%	23.1%	16.3%
Switzerland	17.4%	14.3%	17.3%	14.2%
United States	21.8%	13.7%	22.9%	14.5%

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* MTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of advanced mathematics students. See Appendix A for characteristics of students sampled and Appendix B for details about the MTCI.

† PTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of physics students. See Appendix A for characteristics of students sampled and Appendix B for details about the PTCI.

[1] Greece only sampled students having taken advanced mathematics and physics.

[2] The MTCI and the PTCI could not be computed for Israel.

[3] Latvia only sampled students having taken physics.

Note: Hungary, Iceland, the Netherlands, New Zealand, and South Africa did not participate in the advanced mathematics and physics testing. Norway did not participate in the advanced mathematics testing and Lithuania did not participate in the physics testing.

TIMSS also tested two overlapping subpopulations of the final-year student population: students having taken advanced mathematics, and students having taken physics. In most countries, each group consists of a minority of students from the final-year student population. Table 3 presents the percentage of students in the final-year sample having taken advanced mathematics and the percentage having taken physics. Apart from Slovenia, where a large percentage of upper secondary students take advanced mathematics, the percentage having taken advanced mathematics varies from about 4% in the Russian Federation to about 44% in Austria, with a similar range in physics.

In order to quantify the coverage of the advanced mathematics and physics samples and help interpret the achievement results for these students, TIMSS computed a Mathematics TIMSS Coverage Index (MTCI) and a Physics TIMSS Coverage Index (PTCI), as shown in Table 3. The MTCI is the overall TCI multiplied by the percentage of the final-year sample having taken advanced mathematics. For example, in Australia 23.1% of the final-year sample had taken advanced mathematics. Multiplying this by the TCI (68.1%, from Table 2) gives a MTCI of 15.7%, as shown in the second column of Table 3. This implies that about 16% of the school-leaving age cohort in Australia had taken advanced mathematics in upper secondary school. Similarly, the PTCI for Australia is 12.6%, as shown in the fourth column of Table 3.

How Does TIMSS Document Compliance with Sampling Guidelines?

In addition to a clear definition of the populations assessed, valid samples and high participation rates in each country are crucial to the quality and success of any international comparative study. The accuracy of the survey results depends on the quality of sampling information 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 and participation rates were established, as were clearly documented procedures on how to obtain the national samples. Despite efforts to meet the TIMSS specifications, some countries did not do so. These countries are specially footnoted or shown in separate sections of the tables in this report.[11]

Despite the differences in the structure of the upper secondary systems and the proportion of the school-leaving age cohort assessed, and the difficulties some countries had in meeting the TIMSS sampling requirements, the assessment of final-year students provides valuable comparative information about student achievement. This report describes in as much detail as possible which students were tested in each country, so that the achievement results can be understood and compared appropriately.

[11] The TIMSS sampling requirements and the outcomes of the sampling procedures are described in Appendix B.

How Do Country Characteristics Differ?

International studies of student achievement provide useful information about student performance and instructional practices. The benefits of these studies, however, are accompanied by the problems of 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.[12]

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 systemwide factors that might influence students' opportunity to learn. A number of these factors are summarized in Appendix A and more fully described in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.*[13] However, differences among the participating countries go beyond how their educational systems are organized. Selected demographic characteristics of the TIMSS countries are presented in Table 4, and Table 5 contains information about public expenditure on education. These 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 mathematics or the sciences, they do provide a context for considering the difficulty of the educational task from country to country.

Describing students' educational opportunities also requires an understanding of 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 in 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.*[14]

Depending on the education system, students' learning goals are commonly set at one of three 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 needs of students.

[12] Appendix B summarizes the procedures used and cites references to TIMSS methodology.

[13] Robitaille, D.F. (Ed.). (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

[14] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (1997). *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. (1997). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Table 4

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
Canada	29248	9976	2.90	76.7	78	88
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
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
Hungary	10261	93	110.03	64.2	70	81
Iceland	266	103	2.56	91.4	79	103
Israel	5383	21	252.14	90.5	77	87
Italy	57120	301	189.36	66.6	78	81
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
Russian Federation	148350	17075	8.70	73.2	64	88
Slovenia	1989	20	97.14	62.7	74	85
South Africa	40539	1221	32.46	50.5	64	77
Sweden	8781	450	19.38	83.1	78	99
Switzerland	6994	41	168.03	60.6	78	91
United States	260650	9809	27.56	76.0	77	97

SOURCE: The World Bank, Social Indicators of Development, 1996.

[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] Enrollment of students of all ages in the secondary school system as a percentage of the number of persons in the age group that attends secondary school. The age range varies across countries, but is usually 12-17. The percentage may be in excess of 100% if some pupils are younger or older than the country's standard range of secondary school age.

Table 5

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
Canada	19570	21230	4.62	981
[6] Cyprus	10380	-	3.60	-
Czech Republic	3210	7910	3.75	297
Denmark	28110	20800	4.80	998
France	23470	19820	3.61	716
Germany	25580	19890	2.43	483
Greece	7710	11400	2.27	259
Hungary	3840	6310	4.31	272
Iceland	24590	18900	4.77	902
Israel	14410	15690	3.72	584
Italy	19270	18610	2.89	538
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
Russian Federation	2650	5260	-	-
Slovenia	7140	-	4.20	-
South Africa	3010	-	5.12	-
Sweden	23630	17850	4.92	878
Switzerland	37180	24390	3.72	907
United States	25860	25860	4.02	1040

SOURCE: The World Bank Atlas, 1996; and UNESCO Statistical Yearbook, 1995

[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] Estimates for 1994 at current market prices in U.S. dollars, calculated by the conversion method used for the World Bank Atlas. (Source: The World Bank Atlas, 1996).

[3] Converted at purchasing power parity (PPP). PPP is defined as number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as one dollar would buy in the United States. (Source: The World Bank Atlas, 1996).

[4] 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. (Source: UNESCO Statistical Yearbook, 1995).

[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.

(-) A dash indicates the data were unavailable.

Figures 1, 2, and 3 show the degree of centralization in the TIMSS countries regarding decision-making about curriculum syllabi, textbooks, and examinations. Fourteen of the TIMSS participants reported nationally centralized decision-making about curriculum. Fewer countries reported nationally centralized decision-making about textbooks: six participants were in this category. Eight countries reported nationally centralized decision-making about examinations. Regional decision-making about these three aspects of education does not appear to be very common, with only a few countries reporting it 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. Two countries, Lithuania and Norway, reported nationally centralized decision-making for all three areas: curriculum syllabi, textbooks, and examinations. Five countries – Australia, Hungary, Iceland, Latvia, 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	Regionally Centralized	Not Centralized
Austria	Canada	Australia[4]
Cyprus	Germany	Hungary[5]
Czech Republic	Switzerland[3]	Iceland
Denmark		Latvia
France		Netherlands[6]
Greece		Russian Federation
Israel		United States
Italy		
Lithuania		
New Zealand		
Norway[1]		
Slovenia		
South Africa		
Sweden[2]		

[1] 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.

[2] 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.

[3] Switzerland: Decision-making regarding curricula in upper secondary varies across the cantons and the types of education.

[4] Australia: Students tested in TIMSS were educated under a decentralized system. Reforms beginning in 1994 are introducing regionally centralized (state-determined) curriculum guidelines.

[5] Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

[6] 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), 1995. 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 responsibility for determining the approved textbooks, a country is in the "Not Centralized" category.

Nationally Centralized	Regionally Centralized	Not Centralized
Austria	Canada	Australia
Cyprus	Germany	Czech Republic
Greece	South Africa	Denmark
Lithuania	Switzerland[1]	France
Norway		Hungary[2]
Slovenia		Iceland
		Israel
		Italy
		Latvia
		Netherlands
		New Zealand
		Russian Federation
		Sweden
		United States

[1] Switzerland: Decision-making regarding textbooks in upper secondary varies across the cantons and the types of education.

[2] 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), 1995-96. 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	Not Centralized
Denmark[1]	Australia[7]
Italy[2]	Austria
Lithuania	Canada
Netherlands[3]	Cyprus
New Zealand[4]	Czech Republic
Norway[5]	France
Russian Federation[6]	Germany[8]
South Africa	Greece
	Hungary
	Iceland
	Israel[9]
	Latvia[10]
	Slovenia[11]
	Sweden[12]
	Switzerland
	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 school as an external (ministry-appointed) examiner.

2 Italy: At the end of senior secondary courses lasting four or more years, students who have positive evaluations write the final examination, the esame di maturità. Written papers are determined by the Ministry of Education.

3 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.

4 New Zealand: Centralized examinations taken at Years 11, 12, and 13. Centralized national monitoring at Years 4 and 8.

5 Norway: 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.

6 Russian Federation: Centralized examinations are taken in Grades 9 and 11 in mathematics and Russian/literature.

7 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, 7, and 10. In most states, centralized examinations are taken at Grade 12.

8 Germany: Not centralized as a country, but is centralized within 6 (of 16) federal states.

9 Israel: Centralized examinations are taken at the end of secondary school that affect opportunities for further education.

10 Latvia: Centralized examinations can be taken at Grade 9 and Grade 12.

11 Slovenia: Two-subject national examinations are taken after Grade 8 (end of compulsory education); five-subject externally-assessed baccalaureat after Grade 12 for everyone entering university.

12 Sweden: There are no examinations in Sweden.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96. Information provided by TIMSS National Research Coordinators.

Mathematics and Science Literacy in the Final Year of Secondary School

Mathematics and Science Literacy in the Final Year of Secondary School

Chapter 1

International Student Achievement in Mathematics and Science Literacy

This chapter summarizes achievement on the TIMSS mathematics and science literacy test for each of the participating countries. The test was designed to measure the mathematics and science learning of all final-year students, regardless of their school curriculum. These students, who are at the point of leaving school and entering the workforce or postsecondary education, may have specialized in mathematics and science in upper secondary school or have concentrated their studies in other areas. The mathematics and science literacy study is intended to provide information about how prepared all the school leavers in each country are to apply their knowledge in mathematics and science to meet the challenges of life beyond school.

Comparisons are provided for the populations of school leavers tested in each of the countries. The relationship between achievement and the population tested is examined from several perspectives, because not all of the countries were able to provide coverage of the entire school-leaving age cohort. In all of the participating countries, some members of the school-leaving age cohort no longer attended school, having completed their compulsory education or having dropped out for a variety of reasons. In some of the countries, portions of the students still attending school were not tested, usually because they were in on-site vocational education situations and difficult to locate for the testing.

How Does Performance Compare for the Students Participating in the Testing?

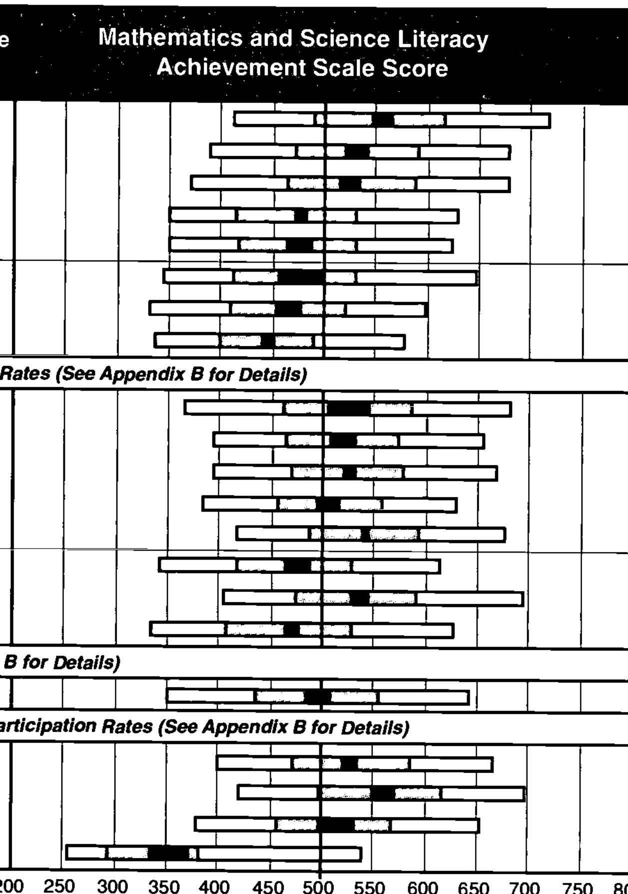
Table 1.1 presents the mean (or average) achievement for the 21 countries that participated in the mathematics and literacy study for students in their final year of secondary school.[1] The mean for each country can be compared with the international average of 500, which represents the average across the means for each of the 21 participants shown in the table. A number of countries had mean achievement well above the international average of 500, and others well below that level. A triangle pointing up next to the mean indicates that the country's performance was significantly higher than the international average, while a triangle pointing down indicates that its performance was significantly lower. Among the countries meeting the TIMSS sampling guidelines, Sweden, Switzerland, and New Zealand performed above the international average.

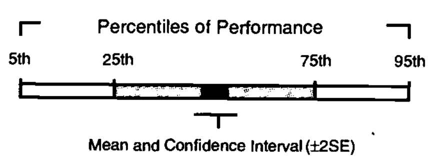
[1] TIMSS used item response theory (IRT) to summarize the achievement for mathematics literacy and for science literacy on two separate scales, each with a mean of 500 and a standard deviation of 100. Scaling averages students' responses to the subsets of items they took in a way that accounts for differences 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 and science literacy tests. The composite results for mathematics and science literacy represent an average of the results on the mathematics and science literacy scales (see Chapter 2 for separate results for mathematics and science literacy). For more detailed information, see the "IRT Scaling and Data Analysis" section of Appendix B.

Table 1.1

Distributions of Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

Country	Mean	TCI ◆	Average Age
Sweden	▲ 555 (4.3)	71%	18.9
Switzerland	▲ 531 (5.4)	82%	19.8
† New Zealand	▲ 525 (4.7)	70%	17.6
Hungary	▼ 477 (3.0)	65%	17.5
2 Russian Federation	▼ 476 (5.8)	48%	16.9
Czech Republic	● 476 (10.5)	78%	17.8
1 Lithuania	▼ 465 (5.8)	43%	18.1
2 Cyprus	▼ 447 (2.5)	48%	17.7
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	● 525 (9.5)	68%	17.7
2 Austria	▲ 519 (5.4)	76%	19.1
Canada	▲ 526 (2.6)	70%	18.6
France	● 505 (4.9)	84%	18.8
Iceland	▲ 541 (1.6)	55%	21.2
1 Italy	▼ 475 (5.3)	52%	18.7
Norway	▲ 536 (4.0)	84%	19.5
United States	▼ 471 (3.1)	63%	18.1
Countries With Unapproved Student Sampling (See Appendix B for Details)			
† Germany	● 496 (5.4)	75%	19.5
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	▲ 528 (3.2)	58%	19.1
2 Netherlands	▲ 559 (4.9)	78%	18.5
Slovenia	● 514 (8.2)	88%	18.8
South Africa	▼ 352 (9.3)	49%	20.1





International Average = 500
(Average of All Country Means)

▲ = Country mean significantly higher than international mean

▼ = Country mean significantly lower than international mean

● = No statistically significant difference between country mean and international mean

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

◆ The TIMSS Coverage Index (TCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample (see Appendix B for more information).

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 1.1

Multiple Comparisons of Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

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	*Netherlands*	**Sweden**	*Iceland*	*Norway*	**Switzerland**	*Denmark*	*Canada*	**New Zealand**	*Australia*	*Austria*	*Slovenia*	*France*	*Germany*	**Hungary**	**Czech Republic**	**Russian Federation**	*Italy*	*United States*	**Lithuania**	**Cyprus**	*South Africa*
Netherlands		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		▲	▲	▲	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼		●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	●	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	●	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●		▲	●	●	●	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	●	●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●		▲
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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

The eight countries shown in 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 the students in their nationally defined target populations. Lithuania is footnoted because its nationally defined population did not include part of the internationally desired population, that is, it included only students in schools providing instruction in Lithuanian (see Table B.4). The Russian Federation and Cyprus are footnoted for not testing final-year students in some vocational tracks (see Table B.4). New Zealand is annotated because it met the sampling guidelines only after including replacement schools (see Table B.10).

Although countries tried very hard to meet the TIMSS sampling requirements, many of them encountered resistance from schools, teachers, and students, and thus did not have the participation rates – 85% or higher for schools and for students both, or a combined rate of 75% – specified in the TIMSS guidelines. Obtaining a high participation rate for secondary school students is particularly challenging when participation is voluntary, because these students have many demands on their time. Also, their educational situations may make testing difficult; for example, in some countries students are engaged in on-site vocational training. The eight countries shown in the second category in Table 1.1 followed procedures but were unable to meet the TIMSS guidelines for sample participation. Beyond the difficulty of encouraging students to attend the testing sessions, the five countries in the remaining two categories encountered various obstacles in implementing the prescribed methods for sampling schools or students within schools, usually because of the organization of the education system. Because Israel did not clearly document its procedures for sampling schools, its achievement results (unweighted) are presented in Appendix D. Appendix B includes a full discussion of the sampling procedures and outcomes for each country.

As mentioned previously, some members of the school-leaving age cohort are no longer attending school. As explained in the Introduction, the degree of coverage of the entire school-leaving age cohort is indicated by the TIMSS Coverage Index (TCI). If the TCI also reflects exclusion of part of the final-year student population, that is noted for the countries concerned: the Russian Federation, Cyprus, Austria, and the Netherlands. (See Table 2 in the Introduction as well as Appendix B for more details about the TCI.)

As shown in the table, there is quite a range in the TCI. About half the countries were able to cover 70% or more of the entire school-leaving age cohort by their in-school sampling procedures, including Slovenia (88%), France (84%), Norway (84%), Switzerland (82%), the Czech Republic (78%), the Netherlands (78%), Austria (76%), Germany (75%), Sweden (71%), New Zealand (70%), and Canada (70%). Countries covering less than half of this cohort included South Africa (49%), the Russian Federation (48%), Cyprus (48%), and Lithuania (43%).

To aid in interpretation, the table also contains the average age of the students. Equivalence of chronological age does not necessarily mean that students have had the same number of years of formal schooling or have studied the same curriculum. Countries with a high percentage of older students may have policies that include retaining students in lower grades. Still, the average age, in combination with the information about secondary school for each country presented in Appendix A, will provide an indication of the amount of schooling received by the students in each country.

Table 1.1 also graphically shows the differences in average mathematics and science literacy achievement between the highest- and lowest-performing countries and 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.[2] Each percentile point indicates the percentages of students performing below and above that point on the scale. For example, 25% of the 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 lower and higher achievement. The dark boxes at the midpoints of the distributions are the 95% confidence intervals around the average achievement in each country.[3]

Comparisons can be made across the means and percentiles. For example, average performance in Sweden was comparable to or even exceeded performance at the 75th percentile in a number of countries, including Hungary, the Russian Federation, the Czech Republic, Lithuania, Cyprus, Italy, the United States, and especially South Africa. Also, the differences between the extremes in performance were very large in most countries.

Figure 1.1 provides a method for making appropriate comparisons of overall mean achievement between countries.[4] The 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, and a triangle pointing down indicates significantly lower performance. Countries shown in italics failed to satisfy one or more guidelines for sample participation rates or student sampling (see Appendix B for details).

The Netherlands and Sweden, with mostly triangles pointing up, had significantly higher mean achievement than the other participating countries, and performed similarly. However, the Netherlands had particular difficulty in meeting the TIMSS sampling guidelines. Students in apprenticeship programs were excluded (21% of final-year students), and overall sample participation rates were very low (49%).

[2] Tables of the percentile values and standard deviations for all countries are presented in Appendix E.

[3] See the "IRT Scaling and Data Analysis" section of Appendix B for more details about calculating standard errors and confidence intervals.

[4] The significance tests in Figure 1.1 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.

Iceland, Norway, and Switzerland performed similarly, but had lower mean achievement than the Netherlands and Sweden. However, of those three countries, only Switzerland met the sampling guidelines. It also can be observed that Switzerland and Norway had among the highest TCIs, 82% and 84%, respectively. Because the measurement in Australia was somewhat less precise than in many other participating countries, it has a rather large confidence interval around its mean achievement, and tends to overlap with more countries than might otherwise be the case. Australia's mean performance is more similar to that of Denmark, Canada, New Zealand, Austria, and Slovenia. Of these countries, only New Zealand met the sampling guidelines. France performed similarly to New Zealand, Australia, Austria, Slovenia, and Germany. Germany's performance resembled that of Slovenia and France as well as the Czech Republic, the Russian Federation, and Italy.

The lower-performing countries included Hungary, the Czech Republic, the Russian Federation, Italy, the United States, Lithuania, Cyprus, and South Africa. Only South Africa had significantly lower mean achievement than the other participating countries. Because of the pattern of relatively small differences from one country to the next, most countries had lower mean achievement than some countries, about the same mean achievement as some countries, and higher mean achievement than other countries.

How Does Performance Compare, Taking Differences in Population Coverage into Account?

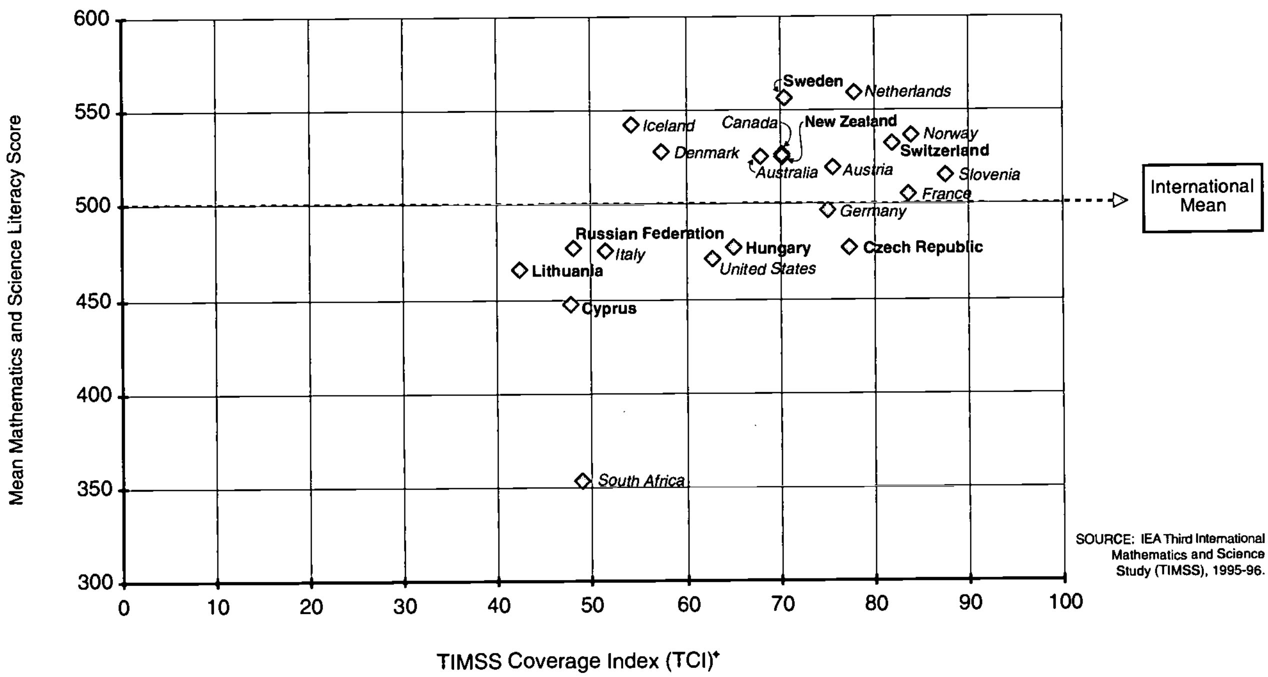
Figure 1.2 shows the relationship between achievement and the TIMSS Coverage Index. It is designed to show whether countries may have achieved higher performance because they tested fewer students – in particular, a more elite group of students. In general, however, the relationship between performance and the degree of sample coverage of the entire school-leaving population shows that the higher-performing countries actually tended to have better coverage than the lower-performing countries.[5] For example, the countries in the upper right corner of the graph had a high percentage of coverage of the entire school-leaving age cohort, as well as high performance. In particular, Switzerland exceeded 80% coverage, met the sampling guidelines, and performed above the international average.

If anything, the countries with greater coverage (more than 70%) tended to have mean performance above the international average, and those with less coverage tended to perform below the international average. The only two high-performing countries with a low degree of coverage (less than 60%) were Denmark and Iceland. The remaining countries with coverage less than 60% all performed below the international average.

[5] The relationship between mathematics and science literacy achievement and the TIMSS Coverage Index has a correlation coefficient of 0.56.

Figure 1.2

Mean Mathematics and Science Literacy Achievement by TIMSS Coverage Index for Students in Their Final Year of Secondary School*



* See Appendix A for characteristics of the students sampled.

✦ The TIMSS Coverage Index (TCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample (see Appendix B for more information).

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Table 1.2 offers another way of examining performance, regardless of whether or not countries may have tested only their elite students. The table shows the 75th percentile of performance for the entire school-leaving age cohort for each country. It also presents the mean achievement of students performing above the 75th percentile – the top 25% of the students in the entire school-leaving age cohort for each country. The 75th percentile is the point on the mathematics and science literacy composite scale that divides the higher-performing 25% of the students from the lower-performing 75%.

The 75th percentile is 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 (that is, students in the school-leaving age cohort not included in the samples tested).

As indicated by the TCI, the samples in some countries represented nearly all of the students in the school-leaving age cohort, while other countries covered only about half of these students. To compute the 75th percentile, TIMSS assumed that students in the school-leaving age cohort not covered by the sample in each country would score below the 75th percentile, primarily because they were no longer in the system by virtue of dropping out, being tracked out of the system, or being in difficult-to-test vocational tracks. The percentages of students assumed to be below the 75th percentile were added to the lower tail of the achievement distribution before calculating the 75th percentile using the modified distribution.

Notwithstanding the additional difficulties in estimating achievement for the entire school-leaving age cohort for each country, rather than for the population of students actually tested, the results for the top 25% of the students in each country appear quite consistent with those obtained for the tested students. Of the countries meeting the sampling guidelines, Sweden, Switzerland, and New Zealand had the highest mean achievement for the top 25% of their school-leaving age cohorts.

Figure 1.3 presents the country comparison chart for the top 25% of all students in the school-leaving age cohort. Among the top-performing countries, Sweden, the Netherlands, and Norway performed similarly, with Switzerland also performing similarly to Norway. In summary, the four top-performing countries had rankings very similar to those obtained for the populations of tested students. In particular, Sweden and Switzerland met the sampling guidelines and had high performance. Norway, too, performed very well even though participation rates were slightly below the guidelines (71%). The Netherlands also performed well, but had low participation rates (49%).

Looking at the top 25% of performance for the school-leaving age cohort shows a block of countries with very similar mid-range performance, including New Zealand, Australia, Canada, Slovenia, Austria, Iceland, and Denmark. Germany, France, and the Czech Republic performed similarly but generally below the aforementioned countries. The lower-performing countries included Hungary and the United States, followed by Italy and the Russian Federation. Lithuania, Cyprus, and South Africa had lower performance than the other participating countries. The relative standing

Table 1.2

Mathematics and Science Literacy Achievement for the Top 25 Percent[@] of All Students in the School-Leaving Age Cohort*

Country	75th Percentile	Mean Achievement of the Top 25% of Students (Above 75th Percentile)	TCI
Sweden	584 (6.3)	654 (3.4)	71%
Switzerland	575 (4.1)	633 (2.6)	82%
† New Zealand	559 (7.5)	621 (1.9)	70%
Czech Republic	508 (12.0)	584 (4.6)	78%
Hungary	496 (2.8)	563 (3.1)	65%
² Russian Federation	464 (6.3)	539 (4.8)	48%
¹ Lithuania	447 (6.8)	519 (3.6)	43%
² Cyprus	438 (4.0)	501 (3.4)	48%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	555 (8.9)	620 (4.8)	68%
² Austria	552 (5.6)	610 (4.2)	76%
Canada	555 (5.6)	613 (2.6)	70%
France	546 (8.0)	592 (2.6)	84%
Iceland	546 (3.0)	609 (1.4)	55%
¹ Italy	475 (5.6)	543 (4.3)	52%
Norway	578 (3.9)	641 (2.8)	84%
United States	490 (3.1)	559 (2.5)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)			
† Germany	533 (5.6)	593 (2.9)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	539 (4.3)	603 (2.3)	58%
² Netherlands	600 (6.0)	653 (4.9)	78%
Slovenia	560 (9.6)	612 (4.9)	88%
South Africa	328 (4.4)	412 (11.4)	49%
International Average	520 (1.4)	585 (0.9)	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[@] To compute the 75th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 75th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 1.3

Multiple Comparisons of Average Mathematics and Science Literacy Achievement for the Top 25 Percent of All Students in the School-Leaving Age Cohort*

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	**Sweden**	*Netherlands*	*Norway*	**Switzerland**	**New Zealand**	*Australia*	*Canada*	*Slovenia*	*Austria*	*Iceland*	*Denmark*	*Germany*	*France*	**Czech Republic**	**Hungary**	*United States*	*Italy*	**Russian Federation**	**Lithuania**	**Cyprus**	*South Africa*
Sweden		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	●		▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	▼	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲	▲	▲	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		▲	▲	▲	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	▲	▲	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

of Iceland, Denmark, and the Russian Federation dropped somewhat in this analysis compared to the analysis based only on the samples of students tested. This may be because the assumptions of lower performance (below the 75th percentile) for students not represented in the sample do not completely apply in these two countries. For example, in the Russian Federation students not covered in the sampling included those in technical tracks that take mathematics and science, some of whom may have achieved above the 75th percentile.

How Does Performance Compare by Gender?

Table 1.3 shows the differences in mathematics and science literacy achievement by gender for the final-year students in each country. The table presents mean achievement separately for males and females for each country, as well as the difference between the means. The graphic representation of the gender difference, indicated by a bar, shows the amount of the difference, whether the direction of the difference favors females or males, and whether the difference is statistically significant (indicated by a darkened bar). As can be seen, all of the differences favored males rather than females, and all of the differences were statistically significant except in South Africa.

Since the TIMSS science results for seventh and eighth grades showed significant gender differences favoring males to be pervasive across most countries,[6] and the direction of the differences in mathematics favored males much more often than females,[7] these results might have been anticipated for the secondary school students. Still, it is distressing to see such uniform gender differences favoring males in the general population of school-leaving students. There may be many reasons for such differences, including the fact that society encourages males more than females to have an interest in mathematics and science topics. This tends to lead to more outside activities in mathematics and science areas for males and taking more courses in these subjects, which serves to differentiate performance as students progress through school.

Course-taking patterns are explored in more detail in Chapter 4 and in the second section of this report, which presents results for students having taken advanced mathematics courses (Chapter 5) and physics (Chapter 8) during their final years of secondary school. Briefly, however, while males take more mathematics and science courses than females in some countries, especially in physics, course-taking patterns alone do not seem to explain these pervasive gender differences for the overall population of school-leaving students.

[6] 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.

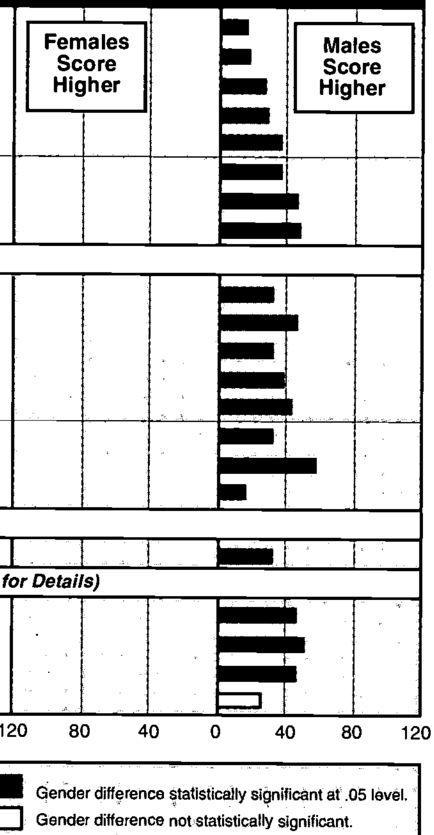
[7] Beaton, A.E., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

Table 1.3

Gender Differences in Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

Country	Males: Percent of Students	Males: Mean Achievement	Females: Percent of Students	Females: Mean Achievement	Difference	TCI
Hungary	52 (2.5)	485 (4.5)	48 (2.5)	468 (4.5)	17 (6.3)	65%
[2] Cyprus	45 (2.1)	456 (4.9)	55 (2.1)	439 (3.0)	18 (5.8)	48%
[1] Lithuania	35 (3.0)	483 (6.7)	65 (3.0)	456 (7.4)	27 (10.0)	43%
† New Zealand	49 (1.7)	540 (5.7)	51 (1.7)	511 (5.5)	28 (7.9)	70%
Switzerland	56 (2.5)	547 (6.0)	44 (2.5)	511 (7.5)	37 (9.6)	82%
[2] Russian Federation	38 (1.0)	499 (5.9)	62 (1.0)	462 (6.5)	37 (8.8)	48%
Sweden	49 (2.5)	579 (5.8)	51 (2.5)	533 (3.6)	46 (6.8)	71%
Czech Republic	51 (5.1)	500 (9.9)	49 (5.1)	452 (13.8)	48 (17.0)	78%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	42 (2.9)	543 (10.7)	58 (2.9)	511 (9.3)	32 (14.2)	68%
[2] Austria	39 (3.2)	549 (7.8)	61 (3.2)	502 (5.5)	47 (9.6)	76%
Canada	47 (1.4)	544 (3.4)	53 (1.4)	511 (3.4)	33 (4.8)	70%
France	47 (3.1)	526 (5.9)	53 (3.1)	487 (4.8)	38 (7.6)	84%
Iceland	48 (0.8)	565 (2.9)	52 (0.8)	522 (1.9)	43 (3.5)	55%
[1] Italy	46 (3.3)	492 (6.9)	54 (3.3)	461 (5.7)	31 (8.9)	52%
Norway	51 (2.0)	564 (5.0)	49 (2.0)	507 (4.5)	57 (6.8)	84%
United States	50 (1.3)	479 (4.2)	50 (1.3)	462 (3.5)	17 (5.5)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)						
† Germany	56 (5.2)	512 (8.2)	44 (5.2)	479 (8.5)	32 (11.8)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	45 (2.0)	554 (4.5)	55 (2.0)	507 (3.7)	47 (5.8)	58%
[2] Netherlands	52 (2.3)	584 (5.5)	48 (2.3)	533 (5.9)	51 (8.0)	78%
Slovenia	51 (3.3)	538 (12.6)	49 (3.3)	492 (7.1)	46 (14.4)	88%
South Africa	49 (1.6)	366 (10.3)	51 (1.6)	341 (11.8)	25 (15.7)	49%

Gender Difference



International Averages		
Males	Females	Difference
519	483	36

(Averages of All Country Means)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of students tested.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

Chapter 2

Achievement in Mathematics Literacy and Science Literacy

This chapter presents data summarizing achievement separately on the mathematics literacy scale and the science literacy scale. The mathematics literacy items address number sense, including fractions, percentages, and proportionality. Algebraic sense, measurement, and estimation are also covered, as are data representation and analysis. Several of the items emphasize reasoning and social utility. A general criterion in selecting the items was that they should involve the types of mathematics questions that could arise in real-life situations and that they be contextualized accordingly. Similarly, the science items selected for the literacy test were organized according to three areas of science – earth science, life science, and physical science – and included a reasoning and social utility component. Again, the emphasis was on trying to measure how well students can use their knowledge in addressing real-world problems having a science component. For both the mathematics literacy and science literacy items, students were permitted to use a calculator if they wished (see Chapter 4 for students' reports on calculator use).

Following the discussion in this chapter of average achievement in mathematics literacy and science literacy, Chapter 3 contains further information about the types of mathematics and science items, including seven example items for each area and the percentage of correct responses on those items for each TIMSS country.

As we have seen in Chapter 1, there are differences in achievement among the participating countries on the TIMSS mathematics and science literacy test. Given that the test was designed to include mathematics and science items, it is interesting to examine whether the participating countries have particular strengths or weaknesses in their achievement in one or the other of the two areas. Thus, this chapter presents the results for the mathematics and science scales that formed the basis for the average composite results presented in Chapter 1.

How Does Performance Compare Between the Mathematics and Science Areas?

Table 2.1 presents the achievement results for the mathematics literacy scale. It shows the mean achievement for each country and the distribution of student performance within each country. Countries with a triangle pointing up performed above the international average of 500, those with a dot performed about the same as the international average, and those with triangles pointing down performed below the international average. The countries conforming to the TIMSS sampling guidelines and performing above the international average in mathematics literacy included Sweden, Switzerland, and New Zealand. Austria, Canada, France, Iceland, Norway, Denmark, and the Netherlands also achieved above the international average, although they encountered various difficulties in their sampling. The countries performing below the international average were Hungary, the Russian Federation, Lithuania, Cyprus, Italy, the United States, and South Africa.

Figure 2.1 provides the information for comparing mean mathematics achievement between countries. This figure shows whether or not the differences in mean achievement between pairs of countries are statistically significant. The top-performing countries in mathematics literacy included the Netherlands, Sweden, Denmark, and Switzerland; both Sweden and Switzerland met the sampling guidelines. Iceland, Norway, France, Australia, New Zealand, Canada, Austria, and Slovenia all tended to perform similarly to Switzerland and to each other. However, of these countries, only New Zealand met the TIMSS sampling guidelines.

Table 2.2 and Figure 2.2 show the corresponding results for the science literacy scale. Table 2.2 reveals that of the countries meeting the TIMSS sampling requirements, Sweden, New Zealand, and Switzerland performed above the international average (triangles pointing up). This parallels the findings in mathematics literacy. Other countries performing above the international average were Austria, Canada, Iceland, Norway, and the Netherlands. The countries performing below the international average in science literacy (triangle pointing down) included the Russian Federation, Hungary, Lithuania, Cyprus, Italy, the United States, and South Africa.

The country comparison chart (Figure 2.2) shows that the countries with the highest mean achievement in science literacy were Sweden, the Netherlands, Iceland, and Norway, with only Sweden meeting the TIMSS sampling guidelines. Canada, New Zealand, and Australia performed similarly to Norway and to each other, with New Zealand meeting the sampling guidelines. Switzerland, which met the sampling guidelines, achieved at about the same level as Canada, New Zealand, and Australia, as did Austria and Slovenia.

Table 2.3 compares performance in mathematics and science literacy. It presents mean literacy achievement separately for mathematics and science, as well as the difference between the means. The last column shows the amount of the difference, whether its direction favors mathematics or science, and whether it is statistically significant (darkened bar). Regardless of direction, the differences between mathematics and science literacy were small or negligible in nearly half of the countries. However, Lithuania, Hungary, Switzerland, France, and Denmark performed significantly higher in mathematics literacy than in science literacy. In contrast, Sweden, the Russian Federation, the Czech Republic, Canada, Iceland, Norway, and the United States had significantly higher achievement in science literacy than in mathematics literacy.

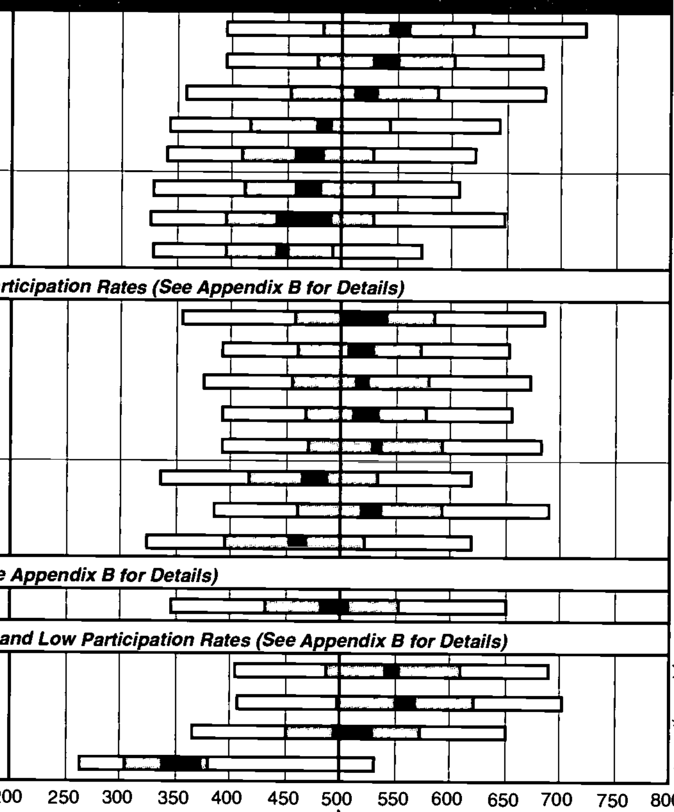
Table 2.4 shows the differences in mathematics literacy performance by gender, and Table 2.5 presents the corresponding gender differences for science literacy. The results differ somewhat from the patterns noted in TIMSS at the eighth grade, where gender differences favoring males were found in both mathematics and science but the differences were more pervasive in science. For students in their final year of school, the gender differences favoring males are significant in mathematics as well as science in most countries. In mathematics literacy, most of the countries showed gender differences favoring males, although these were not statistically significant in Hungary, the United States, and South Africa. All countries except South Africa showed statistically significant gender differences in science literacy favoring males. Thus, it appears that as students leave school the achievement differences favoring males are found nearly equally in mathematics and science literacy.

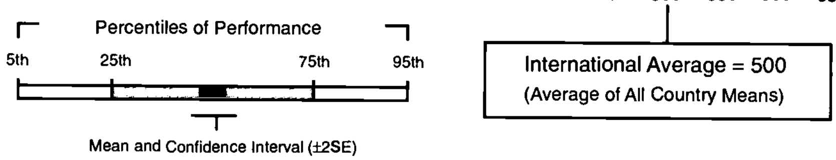
Table 2.1

Distributions of Achievement in Mathematics Literacy for Students in Their Final Year of Secondary School*

Country	Mean	TCI
Sweden	▲ 552 (4.3)	71%
Switzerland	▲ 540 (5.8)	82%
† New Zealand	▲ 522 (4.5)	70%
Hungary	▼ 483 (3.2)	65%
2 Russian Federation	▼ 471 (6.2)	48%
1 Lithuania	▼ 469 (6.1)	43%
Czech Republic	● 466 (12.3)	78%
2 Cyprus	▼ 446 (2.5)	48%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)		
Australia	● 522 (9.3)	68%
2 Austria	▲ 518 (5.3)	76%
Canada	▲ 519 (2.8)	70%
France	▲ 523 (5.1)	84%
Iceland	▲ 534 (2.0)	55%
1 Italy	▼ 476 (5.5)	52%
Norway	▲ 528 (4.1)	84%
United States	▼ 461 (3.2)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)		
† Germany	● 495 (5.9)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)		
Denmark	▲ 547 (3.3)	58%
2 Netherlands	▲ 560 (4.7)	78%
Slovenia	● 512 (8.3)	88%
South Africa	▼ 356 (8.3)	49%

Mathematics Literacy Achievement Scale Score





▲ = Country mean significantly higher than international mean

▼ = Country mean significantly lower than international mean

● = No statistically significant difference between country mean and international mean

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 2.1

Multiple Comparisons of Mathematics Literacy Achievement for Students in Their Final Year of Secondary School*

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	*Netherlands*	**Sweden**	*Denmark*	**Switzerland**	*Iceland*	*Norway*	*France*	*Australia*	**New Zealand**	*Canada*	*Austria*	*Slovenia*	*Germany*	**Hungary**	*Italy*	**Russian Federation**	**Lithuania**	**Czech Republic**	*United States*	**Cyprus**	*South Africa*
Netherlands		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	●	●		●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	●	●	●		●	●	●	●	●	▲	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	●		●	●	●	●	▲	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	●	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	●	●	▲	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	●	▲	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

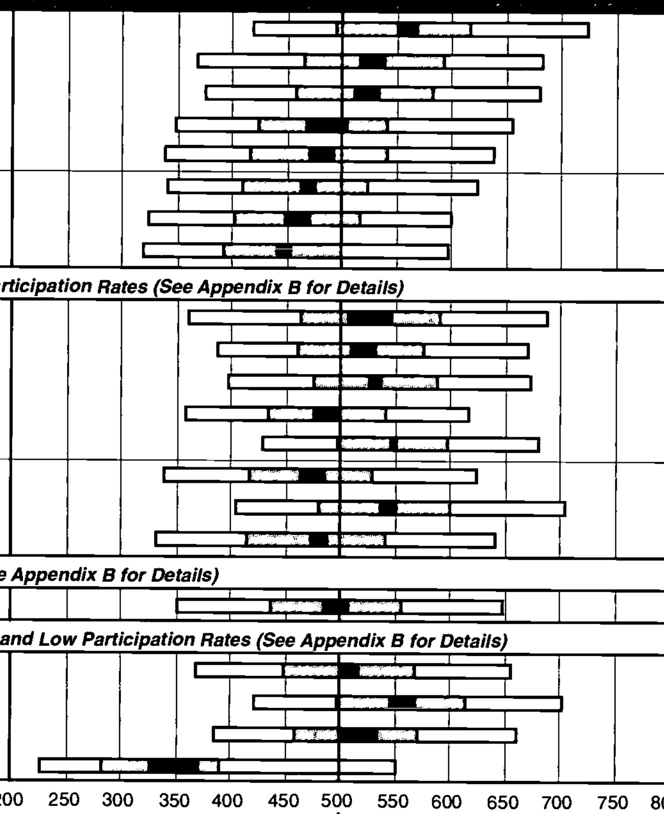
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Table 2.2

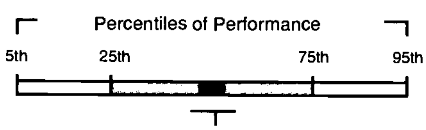
Distributions of Achievement in Science Literacy for Students in Their Final Year of Secondary School*

Country	Mean	TCI
Sweden	▲ 559 (4.4)	71%
† New Zealand	▲ 529 (5.2)	70%
Switzerland	▲ 523 (5.3)	82%
Czech Republic	● 487 (8.8)	78%
[2] Russian Federation	▼ 481 (5.7)	48%
Hungary	▼ 471 (3.0)	65%
[1] Lithuania	▼ 461 (5.7)	43%
[2] Cyprus	▼ 448 (3.0)	48%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)		
Australia	● 527 (9.8)	68%
[2] Austria	▲ 520 (5.6)	76%
Canada	▲ 532 (2.6)	70%
France	● 487 (5.1)	84%
Iceland	▲ 549 (1.5)	55%
[1] Italy	▼ 475 (5.3)	52%
Norway	▲ 544 (4.1)	84%
United States	▼ 480 (3.3)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)		
† Germany	● 497 (5.1)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)		
Denmark	● 509 (3.6)	58%
[2] Netherlands	▲ 558 (5.3)	78%
Slovenia	● 517 (8.2)	88%
South Africa	▼ 349 (10.5)	49%

Science Literacy Achievement Scale Score



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.



International Average = 500
(Average of All Country Means)

▲ = Country mean significantly higher than international mean

▼ = Country mean significantly lower than international mean

● = No statistically significant difference between country mean and international mean

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 2.2

Multiple Comparisons of Science Literacy Achievement for Students in Their Final Year of Secondary School*

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	Sweden	Netherlands	Iceland	Norway	Canada	New Zealand	Australia	Switzerland	Austria	Slovenia	Denmark	Germany	France	Czech Republic	Russian Federation	United States	Italy	Hungary	Lithuania	Cyprus	South Africa
Sweden		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	●		●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	●	●		●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	●	●	●		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	●	●	●	●	●	●		●	●	▲	●	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	●	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	●	●	●	▲	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

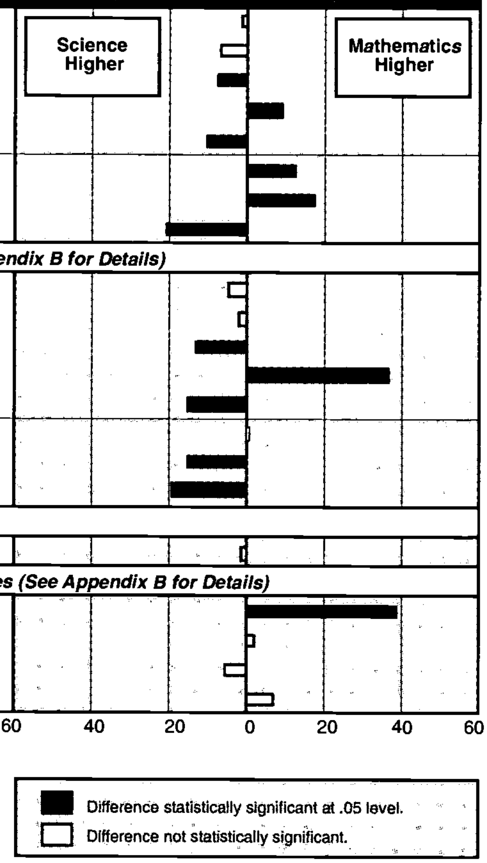
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Table 2.3

Differences in Performance Between Mathematics Literacy and Science Literacy for Students in Their Final Year of Secondary School*

Country	Mathematics Literacy Mean Score	Science Literacy Mean Score	Difference
[2] Cyprus	446 (2.5)	448 (3.0)	2 (2.4)
† New Zealand	522 (4.5)	529 (5.2)	7 (2.8)
Sweden	552 (4.3)	559 (4.4)	7 (1.3)
[1] Lithuania	469 (6.1)	461 (5.7)	9 (2.2)
[2] Russian Federation	471 (6.2)	481 (5.7)	10 (2.5)
Hungary	483 (3.2)	471 (3.0)	13 (1.3)
Switzerland	540 (5.8)	523 (5.3)	18 (2.3)
Czech Republic	466 (12.3)	487 (8.8)	20 (4.1)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	522 (9.3)	527 (9.8)	5 (2.4)
[2] Austria	518 (5.3)	520 (5.6)	2 (2.1)
Canada	519 (2.8)	532 (2.6)	13 (1.7)
France	523 (5.1)	487 (5.1)	36 (2.9)
Iceland	534 (2.0)	549 (1.5)	15 (1.7)
[1] Italy	476 (5.5)	475 (5.3)	1 (2.2)
Norway	528 (4.1)	544 (4.1)	16 (1.8)
United States	461 (3.2)	480 (3.3)	19 (1.5)
Countries With Unapproved Student Sampling (See Appendix B for Details)			
† Germany	495 (5.9)	497 (5.1)	2 (2.4)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	547 (3.3)	509 (3.6)	38 (2.8)
[2] Netherlands	560 (4.7)	558 (5.3)	2 (2.3)
Slovenia	512 (8.3)	517 (8.2)	6 (2.3)
South Africa	356 (8.3)	349 (10.5)	7 (2.9)

Subject Difference



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

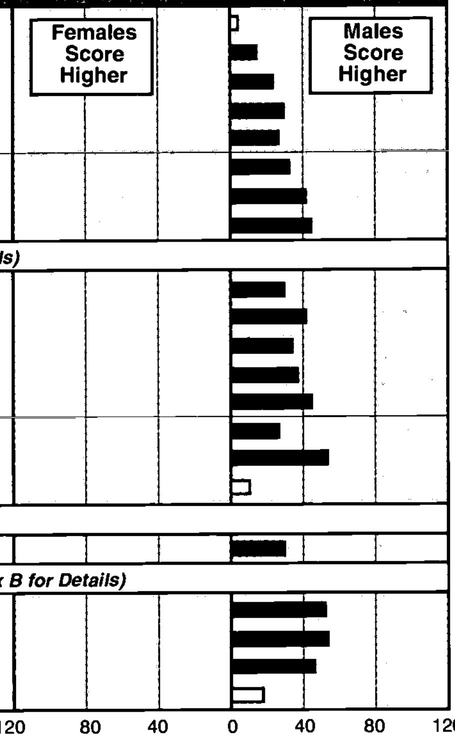
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

Table 2.4

Achievement in Mathematics Literacy by Gender for Students in Their Final Year of Secondary School*

Country	Males: Percent of Students	Males: Mean Achievement	Females: Percent of Students	Females: Mean Achievement	Difference	TCI
Hungary	52 (2.5)	485 (4.9)	48 (2.5)	481 (4.8)	5 (6.9)	65%
[2] Cyprus	45 (2.1)	454 (4.9)	55 (2.1)	439 (3.7)	15 (6.1)	48%
[1] Lithuania	35 (3.0)	485 (7.3)	65 (3.0)	461 (7.7)	23 (10.6)	43%
† New Zealand	49 (1.7)	536 (4.9)	51 (1.7)	507 (6.2)	29 (7.9)	70%
[2] Russian Federation	38 (1.0)	488 (6.5)	62 (1.0)	460 (6.6)	27 (9.2)	48%
Switzerland	56 (2.5)	555 (6.4)	44 (2.5)	522 (7.4)	33 (9.8)	82%
Sweden	49 (2.5)	573 (5.9)	51 (2.5)	531 (3.9)	42 (7.0)	71%
Czech Republic	51 (5.1)	488 (11.3)	49 (5.1)	443 (16.8)	45 (20.2)	78%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	42 (2.9)	540 (10.3)	58 (2.9)	510 (9.3)	30 (13.9)	68%
[2] Austria	39 (3.2)	545 (7.2)	61 (3.2)	503 (5.5)	41 (9.0)	76%
Canada	47 (1.4)	537 (3.8)	53 (1.4)	504 (3.5)	34 (5.2)	70%
France	47 (3.1)	544 (5.6)	53 (3.1)	506 (5.3)	38 (7.7)	84%
Iceland	48 (0.8)	558 (3.4)	52 (0.8)	514 (2.2)	44 (4.1)	55%
[1] Italy	46 (3.3)	490 (7.4)	54 (3.3)	464 (6.0)	26 (9.5)	52%
Norway	51 (2.0)	555 (5.3)	49 (2.0)	501 (4.8)	54 (7.1)	84%
United States	50 (1.3)	466 (4.1)	50 (1.3)	456 (3.6)	11 (5.5)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)						
† Germany	56 (5.2)	509 (8.8)	44 (5.2)	480 (8.8)	29 (12.4)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	45 (2.0)	575 (4.0)	55 (2.0)	523 (4.0)	52 (5.7)	58%
[2] Netherlands	52 (2.3)	585 (5.6)	48 (2.3)	533 (5.9)	53 (8.2)	78%
Slovenia	51 (3.3)	535 (12.7)	49 (3.3)	490 (8.0)	46 (15.0)	88%
South Africa	49 (1.6)	365 (9.3)	51 (1.6)	348 (10.8)	17 (14.3)	49%

Gender Difference



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

International Averages		
Males	Females	Difference
518	485	33
(Averages of All Country Means)		

■ Gender difference statistically significant at .05 level.
□ Gender difference not statistically significant.

* See Appendix A for characteristics of students sampled.
† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).
[1] National Desired Population does not cover all of International Desired Population (see Table B.4).
[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

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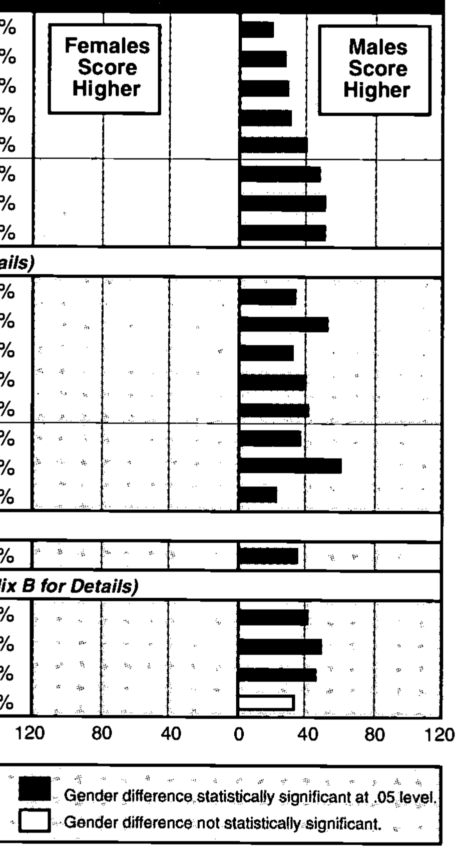
Table 2.5

Achievement in Science Literacy by Gender for Students in Their Final Year of Secondary School*

Country	Males: Percent of Students	Males: Mean Achievement	Females: Percent of Students	Females: Mean Achievement	Difference	TCI
[2] Cyprus	45 (2.1)	459 (5.8)	55 (2.1)	439 (3.0)	20 (6.5)	48%
† New Zealand	49 (1.7)	543 (7.1)	51 (1.7)	515 (5.2)	28 (8.8)	70%
Hungary	52 (2.5)	484 (4.2)	48 (2.5)	455 (4.3)	29 (6.0)	65%
[1] Lithuania	35 (3.0)	481 (6.4)	65 (3.0)	450 (7.3)	31 (9.7)	43%
Switzerland	56 (2.5)	540 (6.1)	44 (2.5)	500 (7.8)	40 (9.9)	82%
[2] Russian Federation	38 (1.0)	510 (5.7)	62 (1.0)	463 (6.7)	47 (8.8)	48%
Sweden	49 (2.5)	585 (5.9)	51 (2.5)	534 (3.5)	50 (6.8)	71%
Czech Republic	51 (5.1)	512 (8.8)	49 (5.1)	460 (11.0)	51 (14.0)	78%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	42 (2.9)	547 (11.5)	58 (2.9)	513 (9.4)	34 (14.8)	68%
[2] Austria	39 (3.2)	554 (8.7)	61 (3.2)	501 (5.8)	53 (10.4)	76%
Canada	47 (1.4)	550 (3.6)	53 (1.4)	518 (3.8)	32 (5.2)	70%
France	47 (3.1)	508 (6.7)	53 (3.1)	468 (4.8)	39 (8.3)	84%
Iceland	48 (0.8)	572 (2.7)	52 (0.8)	530 (2.1)	41 (3.4)	55%
[1] Italy	46 (3.3)	495 (6.7)	54 (3.3)	458 (5.6)	37 (8.8)	52%
Norway	51 (2.0)	574 (5.1)	49 (2.0)	513 (4.5)	61 (6.8)	84%
United States	50 (1.3)	492 (4.5)	50 (1.3)	469 (3.9)	23 (5.9)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)						
† Germany	56 (5.2)	514 (7.9)	44 (5.2)	478 (8.5)	35 (11.6)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	45 (2.0)	532 (5.4)	55 (2.0)	490 (4.1)	41 (6.8)	58%
[2] Netherlands	52 (2.3)	582 (5.7)	48 (2.3)	532 (6.2)	49 (8.4)	78%
Slovenia	51 (3.3)	541 (12.7)	49 (3.3)	494 (6.4)	47 (14.3)	88%
South Africa	49 (1.6)	367 (11.5)	51 (1.6)	333 (13.0)	34 (17.4)	49%

Gender Difference



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

International Averages		
Males	Females	Difference
521	482	39

(Averages of All Country Means)

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

How Does Final-Year Performance in Secondary School Compare with Eighth-Grade Performance?

Achievement for students in the final year of secondary school was estimated separately from achievement at the middle school grades. That is, different tests were used and different content areas emphasized. Therefore, the scale scores are not comparable, and no direct comparison can be made between the performance of the upper secondary school students and that of the eighth-grade students. One way to gauge relative performance at the two levels, however, is to compare a country's performance with the international mean at each of the two points in school. For example, for the countries participating in both the middle school and upper secondary school testing, mean mathematics achievement in comparison with the international average is portrayed in Figure 2.3, with the eighth-grade results for each country derived from *Mathematics in the Middle School Years: IEA's Third International Mathematics and Science Study*[1] and the results for the final year of secondary school taken from Table 2.1 of the present report.

As shown in Figure 2.3, Switzerland, the Netherlands, Austria, France, and Canada were above the international average both at the eighth grade and for their upper secondary school students. However, the countries ranking high in mathematics achievement at the eighth grade did not always rank high in mathematics literacy at the upper secondary level. The Czech Republic, Slovenia, and Australia were above the international average at the eighth grade, but at about the international average for upper secondary school students. Hungary and the Russian Federation performed above the international average at the eighth grade but below it for the final year of secondary school. The United States performed about at the international average at the eighth grade, but below it for upper secondary school students. Conversely, Sweden, New Zealand, and Denmark performed similarly to the international average at the eighth grade, but above it at the upper secondary level, while Norway and Iceland moved from below the international average at the eighth grade to above it for upper secondary school students.

Figure 2.4 shows the results for science achievement relative to the international average at the eighth grade and for science literacy at the upper secondary school level. The eighth-grade results for countries also participating in the science testing of students in the eighth grade were derived from *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study.*[2]

[1] 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: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[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.

Just as with the mathematics results, the high-ranking countries were not the same for the eighth grade and the final year of secondary school. Although the Netherlands, Austria, Sweden, Canada, and Norway were above the international average at both levels, the Czech Republic, Slovenia, Australia, and Germany moved toward the international average at the upper secondary level and the Russian Federation and the United States moved below it. In contrast, New Zealand and Switzerland performed at about the international average at the eighth grade, but above it at the upper secondary level. Iceland moved from below the international average at the eighth grade to above it at the upper secondary level, while France and Denmark moved from below the international average to about the international average.

In reading Figures 2.3 and 2.4, however, it is important to remember that the scales for the eighth grade and the upper secondary level are not directly comparable. For example, looking at the international averages, it cannot be said that the eighth-grade students as a whole outperformed the students in their final year of secondary school. Since seventh and eighth graders were given the same mathematics and science tests, the international average of the TIMSS scales for the two grades combined was set at 500. As would be expected, the eighth graders outperformed the seventh graders, resulting in a mean somewhat higher than 500 (i.e., 511 in mathematics and 515 in science, as shown in Figures 2.3 and 2.4, respectively). Using the same approach, the international average for the secondary school students also was arbitrarily set at 500. Therefore, the differences in the international means between the eighth grade and the final year of secondary school are simply an artifact of the scaling procedures used. Also, note that the international averages shown for the eighth grade in Figures 2.3 and 2.4 will not match those reported previously for all 41 countries participating at the eighth grade, because they are based only on the 20 countries that also participated in the testing of students in their final year of secondary school. (Even though Italy's results are contained in the present report, its eighth-grade results were not available.)

Figure 2.3

Mathematics Performance at Eighth Grade† and Final Year of Secondary School* Compared with the International Averages

Eighth Grade
Mathematics Scale

Country	Difference from International Average
Czech Republic	53 (4.9)
Switzerland	35 (2.8)
Netherlands	30 (6.7)
Slovenia	30 (3.1)
Austria	29 (3.0)
France	27 (2.9)
Hungary	27 (3.2)
Russian Federation	25 (5.3)
Australia	19 (4.0)
Canada	17 (2.4)
Sweden	8 (3.0)
Germany	-1 (4.5)
New Zealand	-3 (4.5)
Denmark	-8 (2.8)
United States	-11 (4.6)
Norway	-7 (2.2)
Iceland	-24 (4.5)
Lithuania	-33 (3.5)
Cyprus	-37 (1.9)
South Africa	-157 (4.4)
International Average (Average of All Country Means)	511 (0.8)

Final Year of Secondary School
Mathematics Literacy Scale

Country	TCI	Difference from International Average
Netherlands	78%	60 (4.7)
Sweden	71%	52 (4.3)
Denmark	58%	47 (3.3)
Switzerland	82%	40 (5.8)
Iceland	55%	34 (2.0)
Norway	84%	28 (4.1)
France	84%	23 (5.1)
New Zealand	70%	22 (4.5)
Canada	70%	19 (2.8)
Austria	76%	18 (5.3)
Australia	68%	22 (9.3)
Slovenia	88%	12 (8.3)
Germany	75%	-5 (5.9)
Czech Republic	78%	-34 (12.3)
Hungary	65%	-17 (3.2)
Russian Federation	48%	-29 (6.2)
Lithuania	43%	-31 (6.1)
United States	63%	-39 (3.2)
Cyprus	48%	-54 (2.5)
South Africa	49%	-144 (8.3)
International Average (Average of All Country Means)		500 (1.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

○ Significantly Higher than International Average

○ Not Significantly Different from International Average

○ Significantly Lower than International Average

† Eighth grade in most countries.

* See Appendix A for characteristics of the students sampled.

( ) 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 or student sampling procedures (see Figure B.4).

Includes countries that participated in TIMSS testing at both eighth grade and final year of secondary school. The eighth-grade results are derived from those reported in *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study.*

Figure 2.4

Science Performance at Eighth Grade† and Final Year of Secondary School* Compared with the International Averages

Eighth Grade — Science Scale

Country	Difference from International Average
Czech Republic	59 (4.3)
Netherlands	45 (5.0)
Slovenia	45 (2.5)
Austria	43 (3.7)
Hungary	39 (2.8)
Australia	30 (3.9)
Russian Federation	23 (4.0)
Sweden	20 (3.0)
United States	20 (4.7)
Germany	16 (4.8)
Canada	16 (2.6)
Norway	12 (1.9)
New Zealand	11 (4.4)
Switzerland	7 (2.5)
France	-17 (2.5)
Iceland	-21 (4.0)
Denmark	-37 (3.1)
Lithuania	-38 (3.4)
Cyprus	-52 (1.9)
South Africa	-189 (6.6)
International Average (Average of All Country Means)	515 (0.8)

Final Year of Secondary School — Science Literacy Scale

Country	TCI	Difference from International Average
Sweden	71%	59 (4.4)
Netherlands	78%	58 (5.3)
Iceland	55%	49 (1.5)
Norway	84%	44 (4.1)
Canada	70%	32 (2.6)
New Zealand	70%	29 (5.2)
Switzerland	82%	23 (5.3)
Austria	76%	20 (5.6)
Australia	68%	27 (9.8)
Slovenia	88%	17 (8.2)
Denmark	58%	9 (3.6)
Germany	75%	-3 (5.1)
France	84%	-13 (5.1)
Czech Republic	78%	-13 (8.8)
Russian Federation	48%	-19 (5.7)
United States	63%	-20 (3.3)
Hungary	65%	-29 (3.0)
Lithuania	43%	-39 (5.7)
Cyprus	48%	-52 (3.0)
South Africa	49%	-151 (10.5)
International Average (Average of All Country Means)		500 (1.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

◯ Significantly Higher than International Average

◯ Not Significantly Different from International Average

◯ Significantly Lower than International Average

† Eighth grade in most countries.

* See Appendix A for characteristics of the students sampled.

( ) 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 or student sampling procedures (see Figure B.4).

Includes countries that participated in TIMSS testing at both eighth grade and final year of secondary school. The eighth-grade results are derived from those reported in *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study.*

Chapter 3

Performance on Mathematics and Science Literacy Example Items

This chapter presents seven example test questions in the mathematics literacy area and seven in the science literacy area, and performance on each of the 14 items for each of the TIMSS countries. The example items in this chapter were chosen to illustrate the different topics covered in each area, the different performance expectations, and the range of item formats used. To provide some sense of what types of items were answered correctly by higher-performing students as compared with lower-performing students, the items in each area span a range of difficulty. 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 two subject areas begins with a brief description of the major topics included in that area, followed by seven tables showing achievement on the example items. Each table presents the example item in its entirety and shows the percentages of correct responses for each of the TIMSS countries. 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 types of student responses that were given full credit. All of the responses shown have been reproduced from students' actual test booklets. The extended-response questions were scored using a method that provided partial credit for responses indicating some conceptual understanding by students, despite a lack of completeness. For these questions, the tables show the percentages of students receiving partial credit in each country as well as the percentages of those receiving full credit.

The seven tables showing the country-by-country results on each item within the subject area are followed by a "difficulty map" relating achievement on each of the example items to performance on the TIMSS international mathematics literacy or science literacy scale.

[1] The IEA retained about 60% of the TIMSS items as secure for possible future use in measuring international trends in mathematics and science literacy achievement. All remaining items are available for general use.

WHAT ARE SOME EXAMPLES OF PERFORMANCE IN MATHEMATICS LITERACY?

The items selected for mathematics literacy were designed to define the content area adequately, while restricting the test items to the few content areas most closely related to the notion of mathematical literacy.[2] The items represent the domains of number sense (including fractions and percentages as well as proportionality); algebraic sense; data representation; and measurement and estimation. Several items were designed to measure the component of reasoning and social utility in mathematics. These items emphasize the types of understanding students will need for full participation in today's technology-dependent, information-rich society.

As shown in Table 3.1, final-year students in most countries selected the correct answer to the proportionality problem requiring calculating the number of calories in a portion of food (Example Item 1). The international average percentage of correct responses across the participating countries was 71%, with 80% or more of the students in the Netherlands and France answering correctly.

Table 3.2 presents Example Item 2, asking students to determine the number of defective light bulbs in a batch on the basis of testing a sample. This proportionality task is set in the context of sampling, which students might encounter in quality-control procedures in the workplace, in opinion polling, or in market research. As with Example Item 1, final-year students in many countries did relatively well on this item (international average 66%). More than three-fourths of the students in New Zealand, Sweden, the Netherlands, and Slovenia selected the correct response.

Example Item 3 was a two-part item, requiring students to interpret the information in a travel graph and respond in an open-ended format. The results are shown in Table 3.3. In part A of the item, which was relatively straightforward, students had to be able to read the line graph and use the labeled information on the vertical axis to provide the answer of 60 km per hour as the car's maximum speed. Students were somewhat less successful with part B, which required interpretation of the information in the graph based on events and the ability to read a marked but unlabeled point on the horizontal axis. Whereas the international average was 74% correct responses on part A, only 59% of the final-year students, on average, provided the correct answer of 9:07 for the time that Kelly slammed on her brakes (part B). About 7% of the students, on average, across countries responded that Kelly slammed on her brakes at 9:06, the closest labeled point on the horizontal axis.

Example Item 4 also asked final-year students to interpret the information in graphs. Students were given a bar graph presenting information about the yearly value of sales in Zedland of music cassettes, records, and CDs, and a pie graph showing the percentage of CD sales by purchasers' age in 1992 (see Table 3.4). Students were asked to use the information in the two graphs to determine the amount of money spent by 12- to 19-year-olds in 1992, and to show their calculations. On average, 44% of the students gave a fully correct response. A number of students responded

[2] For a full discussion of the mathematics literacy items, see Orpwood, G. and Garden, R.A. (1998). *Assessing Mathematics and Science Literacy, TIMSS Monograph No. 4.* Vancouver, B.C.: Pacific Educational Press.

correctly with 86.4 million zeds (720 million zeds x .12) supported by an explanation of how the answer was obtained. However, students did not need to read the bar concerned as representing exactly 720 million zeds; any number in the range of 700 million to 730 million zeds was acceptable. For example, the answer shown for Example Item 4 used 715 million zeds. Thus any answer in the range of 84 million to 87.6 million zeds was given full credit as long as the method of obtaining it was appropriate. Sixty percent or more of the students provided fully correct responses to this question in Sweden, Switzerland, Denmark, and the Netherlands. Another one-fifth to two-fifths of the students in many countries received partial credit for their responses. The latter omitted the factor of 1 million, made a decimal or other computation error, or provided other calculations that indicated understanding of the problem even though the final answer was missing or incorrect.

Example Item 5 is a multi-step measurement item involving volume and percentages. Students were asked about the increase in volume of a cube-shaped carton if each of its sides was increased by 10%. As revealed by the results in Table 3.5, this multiple-choice item was quite difficult for students in most countries. Except in the Netherlands, fewer than half the final-year students selected the correct answer in each of the participating TIMSS countries. Fewer than one-fifth answered correctly in the United States and South Africa.

Example Item 6 is an open-ended question, asking students to explain whether a reporter's statement about a "huge increase" was a reasonable interpretation of a graph showing the number of robberies per year. As shown in Table 3.6, on average approximately one-fifth of the students across countries received full credit for their responses. They did so by noting that only a small part of the graph is shown, that 10 (2%) is not a very large increase over the whole, or that the graph is misleading for some other reason. Another one-fourth of the final-year students, on average, received partial credit for this problem. They disagreed with the reporter, or said that 10 was not a large increase but did not say why, or rejected the interpretation for other reasons not relevant to the task. More than 60% of the students in New Zealand, Sweden, Australia, and Iceland provided either fully or partially correct responses to this question.

In Example Item 7, students were asked to sketch their own line graph. They were presented with a grid and asked to show the relationship between a person's height and age from birth to 30 years. Students were specifically asked to label their graphs and to use a realistic height scale along that axis. To receive full credit, students needed to think out how such a graph might look, and then produce a reasonable sketch. Fully correct responses had correct scales and labels on both axes – Age 0 to 30 years and Height 0 to 200 cm (or 0 to 80 inches, or to 7 feet). Also, the line relating height to age needed to start at approximately 50 cm (20 inches) and reach a reasonable maximum at a realistic age (14 to 20 years), after which it would remain essentially flat. The results are presented in Table 3.7 for students providing fully correct and partially correct responses. Across the participating countries, approximately one-fifth of the final-year students drew fully correct graphs. On average, another 28% drew partially correct graphs. In graphs receiving partial credit, all except one of the features were correct. For example, partially correct graphs may have started the height line incorrectly (e.g., with a height of zero), had an unrealistic age for maximum height, had the line decrease after its peak, or included incorrect scales or labels. More than 60% of the students in Canada and Norway received either full or partial credit for their graphs.

Figure 3.1 shows the relationship between performance on the TIMSS international mathematics literacy scale and achievement on the seven example items in the mathematics literacy area.[3] The international achievement on each example item is indicated by both the average percentage correct across all countries and the international mathematics literacy scale value, or item difficulty level, for each item.

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, final-year students scoring at or above 478 were likely to provide a correct response to the item asking about the number of defective light bulbs, and those scoring at or above 646 were likely to respond correctly to the problem about the increase in volume of the cube-shaped carton. Considering that the international average on the scale was 500, students achieving at about the level of the international average were unlikely to have answered the latter item correctly. These results, however, varied dramatically by country. For example, students in higher-performing countries were much more likely than students in lower-performing countries to answer correctly all but the most difficult of the mathematics literacy questions. In general, the most difficult questions asked students to apply their knowledge of mathematics to particular real-world situations or to use multiple pieces of information in responding.

[3] 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 Mathematics Literacy

Percent Correct for Example Item 1

Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	66 (3.2)	48%
Czech Republic	61 (5.1)	78%
Hungary	59 (1.3)	65%
[1] Lithuania	67 (2.6)	43%
† New Zealand	75 (2.9)	70%
[2] Russian Federation	71 (2.4)	48%
Sweden	74 (1.6)	71%
Switzerland	79 (1.8)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	71 (2.9)	68%
[2] Austria	78 (2.2)	76%
Canada	73 (2.3)	70%
France	80 (2.0)	84%
Iceland	75 (1.5)	55%
[1] Italy	71 (2.3)	52%
Norway	72 (1.4)	84%
United States	68 (1.3)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	74 (2.3)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	75 (1.5)	58%
[2] Netherlands	84 (1.5)	78%
Slovenia	75 (2.4)	88%
South Africa	45 (2.5)	49%
International Average Percent Correct	71 (0.5)	

Example 1

Calories in food portion.

If there are 300 calories in 100 grams of a certain food, how many calories are there in a 30 gram portion of that food?

(A.) 90

B. 100

C. 900

D. 1000

E. 9000

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.2 Mathematics Literacy

Percent Correct for Example Item 2
Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	52 (3.5)	48%
Czech Republic	63 (2.8)	78%
Hungary	52 (1.4)	65%
[1] Lithuania	54 (3.0)	43%
† New Zealand	77 (1.8)	70%
[2] Russian Federation	57 (2.4)	48%
Sweden	77 (1.3)	71%
Switzerland	72 (2.3)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	74 (2.4)	68%
[2] Austria	73 (2.2)	76%
Canada	70 (2.6)	70%
France	73 (1.9)	84%
Iceland	68 (1.5)	55%
[1] Italy	60 (2.6)	52%
Norway	67 (1.5)	84%
United States	62 (1.8)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	66 (3.3)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	73 (1.5)	58%
[2] Netherlands	85 (1.5)	78%
Slovenia	77 (2.4)	88%
South Africa	34 (2.3)	49%
International Average Percent Correct	66 (0.5)	

Example 2

Number of defective light bulbs.

From a batch of 3000 light bulbs, 100 were selected at random and tested. If 5 of the light bulbs in the sample were found to be defective, how many defective light bulbs would be expected in the entire batch?

A. 15

B. 60

C. 150

D. 300

E. 600

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.3 Mathematics Literacy

Percent Correct for Example Item 3, Part A

Final Year of Secondary School*

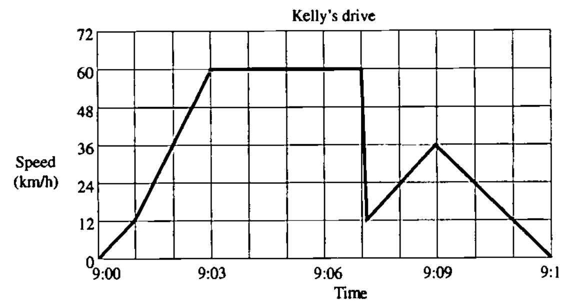
Country	Percent Correct	TCI
² Cyprus	54 (3.4)	48%
Czech Republic	66 (2.1)	78%
Hungary	56 (1.4)	65%
¹ Lithuania	61 (3.0)	43%
† New Zealand	91 (1.7)	70%
² Russian Federation	62 (2.8)	48%
Sweden	85 (1.0)	71%
Switzerland	75 (2.6)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	88 (1.5)	68%
² Austria	84 (1.7)	76%
Canada	80 (2.7)	70%
France	71 (3.0)	84%
Iceland	74 (1.4)	55%
¹ Italy	62 (3.0)	52%
Norway	78 (1.4)	84%
United States	85 (1.0)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	74 (1.5)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	78 (1.2)	58%
² Netherlands	91 (1.6)	78%
Slovenia	80 (2.0)	88%
South Africa	60 (3.1)	49%
International Average Percent Correct	74 (0.5)	

Example 3, Part A

Kelly/Maximum speed of car.

Kelly went for a drive in her car. During the drive, a cat ran in front of the car. Kelly slammed on the brakes and missed the cat.

Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car's speed during the drive.



a) What was the maximum speed of the car during the drive?

60

b) What time was it when Kelly slammed on the brakes to avoid the cat?

9:07

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.3 Mathematics Literacy (Continued)

Percent Correct for Example Item 3, Part B
Final Year of Secondary School*

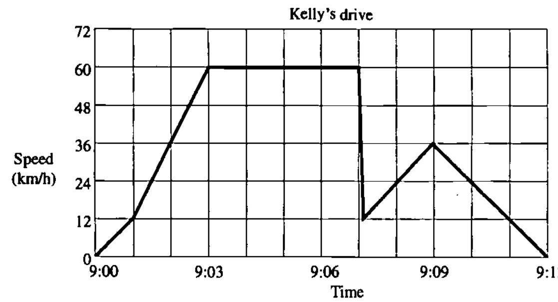
Country	Percent Correct	TCI
² Cyprus	33 (2.9)	48%
Czech Republic	47 (2.3)	78%
Hungary	- -	65%
¹ Lithuania	47 (3.0)	43%
† New Zealand	74 (2.0)	70%
² Russian Federation	46 (2.2)	48%
Sweden	69 (1.7)	71%
Switzerland	62 (2.7)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	68 (3.3)	68%
² Austria	65 (2.4)	76%
Canada	67 (2.6)	70%
France	65 (2.9)	84%
Iceland	63 (1.7)	55%
¹ Italy	47 (2.6)	52%
Norway	65 (1.6)	84%
United States	67 (1.4)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	62 (2.2)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	67 (1.9)	58%
² Netherlands	83 (1.9)	78%
Slovenia	62 (2.7)	88%
South Africa	19 (3.2)	49%
International Average Percent Correct	59 (0.5)	

Example 3, Part B

Kelly/Time slammed on brakes.

Kelly went for a drive in her car. During the drive, a cat ran in front of the car. Kelly slammed on the brakes and missed the cat.

Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car's speed during the drive.



a) What was the maximum speed of the car during the drive?

60

b) What time was it when Kelly slammed on the brakes to avoid the cat?

9:07

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) 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. Internationally comparable data are unavailable for Hungary on Example Item 3B.

Table 3.4 Mathematics Literacy

Percent Correct for Example Item 4
Final Year of Secondary School*

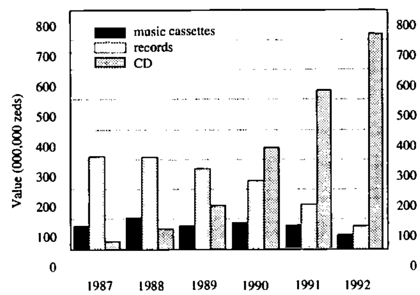
Country	Percent Partially Correct	Percent Fully Correct	TCI
² Cyprus	16 (1.1)	25 (1.5)	48%
Czech Republic	10 (1.1)	39 (4.6)	78%
Hungary	15 (0.7)	46 (1.2)	65%
¹ Lithuania	13 (1.2)	45 (2.4)	43%
† New Zealand	22 (1.6)	38 (1.8)	70%
² Russian Federation	15 (1.4)	37 (2.2)	48%
Sweden	8 (0.7)	64 (1.5)	71%
Switzerland	14 (1.2)	60 (1.9)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	21 (1.4)	45 (2.7)	68%
² Austria	19 (1.4)	50 (2.3)	76%
Canada	17 (1.5)	50 (1.7)	70%
France	12 (1.3)	56 (2.4)	84%
Iceland	17 (1.0)	56 (1.3)	55%
¹ Italy	23 (1.9)	34 (2.4)	52%
Norway	17 (0.7)	53 (1.8)	84%
United States	23 (1.0)	21 (1.2)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):			
† Germany	13 (1.3)	47 (2.3)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	12 (0.8)	62 (1.3)	58%
² Netherlands	17 (1.2)	61 (2.0)	78%
Slovenia	37 (3.2)	23 (2.5)	88%
South Africa	7 (1.2)	8 (1.9)	49%
International Average Percent Correct	17 (0.3)	44 (0.5)	

Example 4

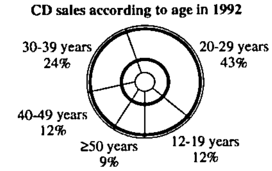
Data from two graphs.

The graphs give information about sales of CDs and other sound recording media in Zedland. Zeds are the monetary units used in Zedland.

Value of various sound recording media sold in Zedland (millions of zeds)



CD sales according to age in 1992



With the aid of both graphs calculate how much money was spent by 12-19 year olds on CDs in 1992. Show your work.

12% of 715= ⇒ 12/100 = n/715
⇒ 12·715÷100 = 85.8 mil zeds

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

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Table 3.5 Mathematics Literacy

Percent Correct for Example Item 5
Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	- -	48%
Czech Republic	21 (3.6)	78%
Hungary	24 (1.3)	65%
[1] Lithuania	29 (3.6)	43%
† New Zealand	36 (2.4)	70%
[2] Russian Federation	30 (2.7)	48%
Sweden	41 (1.6)	71%
Switzerland	42 (2.6)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	30 (3.1)	68%
[2] Austria	33 (2.7)	76%
Canada	29 (1.8)	70%
France	31 (2.4)	84%
Iceland	42 (1.8)	55%
[1] Italy	27 (2.4)	52%
Norway	25 (1.6)	84%
United States	17 (1.4)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	25 (2.4)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	41 (2.1)	58%
[2] Netherlands	50 (2.4)	78%
Slovenia	42 (3.4)	88%
South Africa	6 (1.7)	49%
International Average Percent Correct	31 (0.5)	

Example 5

Increase volume cube-shaped carton.

Brighto soap powder is packed in cube-shaped cartons. A carton measures 10 cm on each side.

The company decides to increase the length of each edge of the carton by 10 per cent.

How much does the volume increase?

A. 10 cm^3

B. 21 cm^3

C. 100 cm^3

(D.) 331 cm^3

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) 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. Internationally comparable data are unavailable for Cyprus on Example Item 5.

Table 3.6 Mathematics Literacy

Percent Correct for Example Item 6

Final Year of Secondary School*

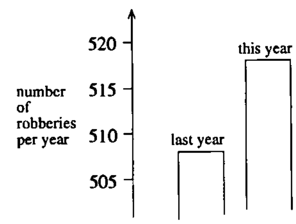
Country	Percent Partially Correct	Percent Fully Correct	TCI
² Cyprus	13 (2.2)	5 (1.7)	48%
Czech Republic	26 (2.1)	6 (1.2)	78%
Hungary	25 (1.0)	4 (0.7)	65%
¹ Lithuania	17 (2.6)	2 (0.4)	43%
† New Zealand	38 (3.2)	33 (3.2)	70%
² Russian Federation	13 (1.8)	7 (1.8)	48%
Sweden	29 (1.8)	37 (2.2)	71%
Switzerland	27 (2.2)	23 (1.5)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	39 (2.3)	26 (2.8)	68%
² Austria	28 (2.4)	19 (2.4)	76%
Canada	35 (2.6)	23 (1.5)	70%
France	25 (2.7)	22 (2.3)	84%
Iceland	25 (1.4)	38 (1.9)	55%
¹ Italy	13 (1.9)	12 (2.1)	52%
Norway	24 (1.3)	34 (1.4)	84%
United States	41 (1.8)	14 (1.3)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):			
† Germany	26 (2.8)	20 (2.4)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	25 (1.7)	26 (1.9)	58%
² Netherlands	27 (2.0)	30 (2.6)	78%
Slovenia	31 (2.1)	6 (1.4)	88%
South Africa	12 (2.1)	3 (1.0)	49%
International Average Percent Correct	26 (0.5)	19 (0.4)	

Example 6

Graph with robberies per year.

A TV reporter showed this graph and said:

"There's been a huge increase in the number of robberies this year."



Do you consider the reporter's statement to be a reasonable interpretation of the graph? Briefly explain.

I don't think it is a reasonable interpretation of the graph because if they were to show the whole graph you would see that there is only a slight increase in robberies

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.7 Mathematics Literacy

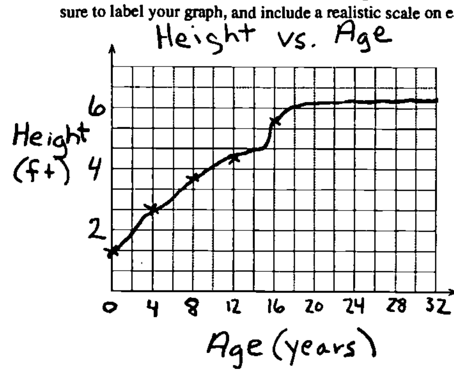
Percent Correct for Example Item 7
Final Year of Secondary School*

Country	Percent Partially Correct	Percent Fully Correct	TCI
[2] Cyprus	18 (2.3)	8 (1.2)	48%
Czech Republic	23 (1.1)	15 (1.6)	78%
Hungary	27 (0.7)	28 (0.9)	65%
[1] Lithuania	21 (1.2)	13 (1.3)	43%
† New Zealand	33 (1.8)	25 (1.5)	70%
[2] Russian Federation	24 (1.7)	11 (1.1)	48%
Sweden	29 (1.4)	19 (1.1)	71%
Switzerland	29 (1.4)	25 (1.5)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	41 (2.3)	14 (2.1)	68%
[2] Austria	21 (1.6)	13 (1.5)	76%
Canada	44 (1.6)	22 (1.3)	70%
France	34 (1.9)	24 (1.5)	84%
Iceland	34 (1.0)	25 (1.1)	55%
[1] Italy	22 (1.6)	13 (1.6)	52%
Norway	27 (1.1)	41 (1.3)	84%
United States	30 (1.6)	11 (0.8)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):			
† Germany	30 (2.4)	20 (1.8)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	31 (1.3)	28 (1.2)	58%
[2] Netherlands	32 (1.6)	23 (1.3)	78%
Slovenia	33 (2.4)	12 (1.8)	88%
South Africa	11 (2.0)	3 (0.8)	49%
International Average Percent Correct	28 (0.4)	19 (0.3)	

Example 7

Draw graph relating height and age.

Using the set of axes below, sketch a graph which shows the relationship between the height of a person and his/her age from birth to 30 years. Be sure to label your graph, and include a realistic scale on each axis.



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

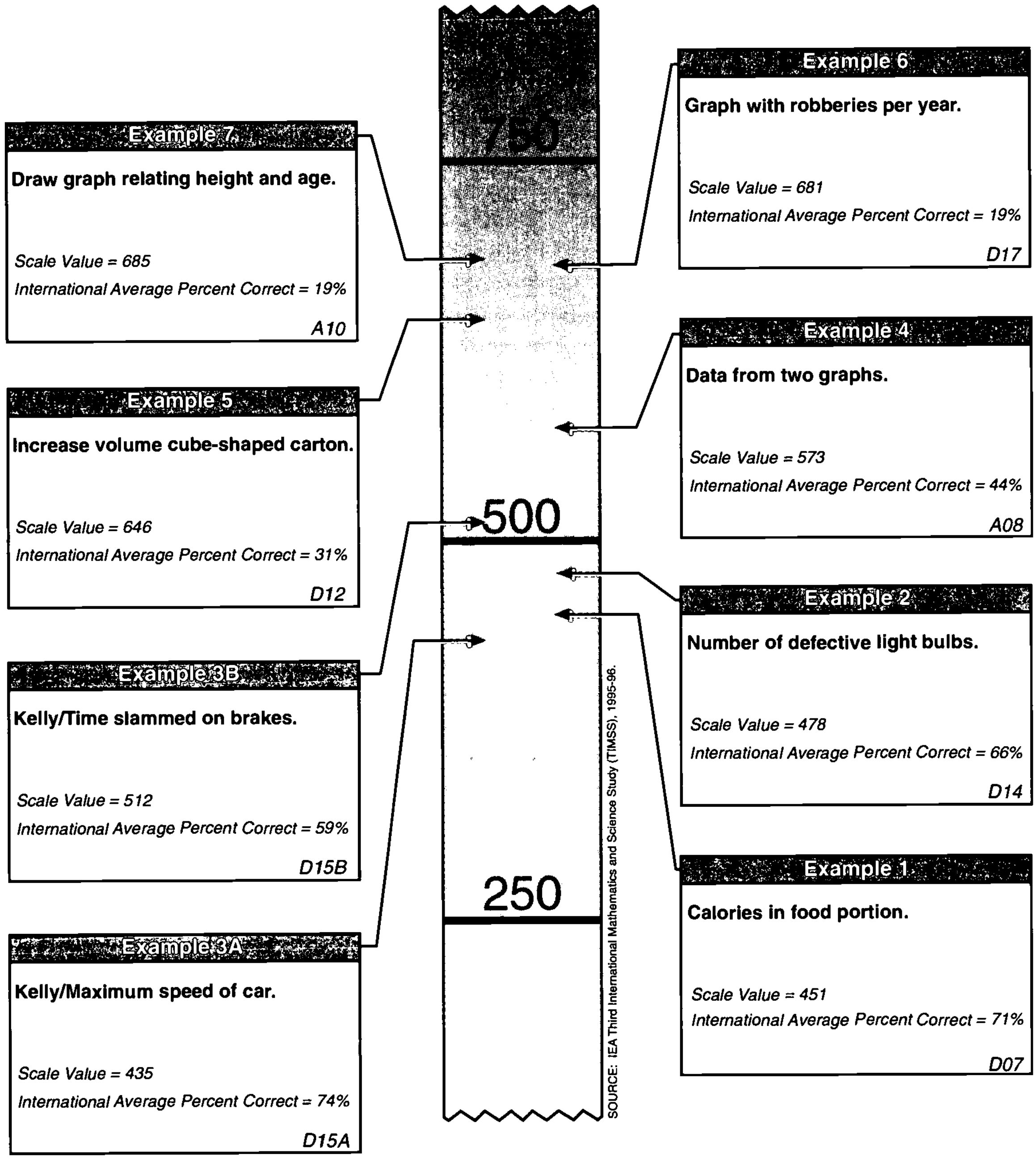
[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 3.1

International Difficulty Map for Mathematics Literacy Example Items
Final Year of Secondary School*



* See Appendix A for characteristics of students sampled.

Note: Items are shown at the point on the TIMSS mathematics literacy scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

85

What Are Some Examples of Performance in Science Literacy?

In the science literacy area, the items covered earth science, life science (human biology and other life science), and physical science (energy and other physical science).[4] In the least difficult of the science literacy example items, Example Item 1, final-year students were asked how to determine whether cooked or uncooked vegetables were more nutritious. As shown in Table 3.8, students in most countries selected the correct answer to this question, which required an understanding that vitamin content and nutrition are related. The international average of correct responses was 87%, and 90% or more of the students selected the correct response in the Czech Republic, Sweden, Switzerland, Austria, Canada, Norway, Denmark, and Slovenia.

Example Item 2 required an understanding of the dangers of chlorofluorocarbons (CFCs) polluting the atmosphere. In particular, it dealt with the risks to the ozone layer caused by the continued use of CFCs. As shown in Table 3.9, this multiple-choice question was answered correctly by a large percentage of students in many countries. More than 90% selected the correct answer in the Czech Republic, Sweden, and Iceland, and more than 80% in Cyprus, Canada, France, Norway, Denmark, and the Netherlands.

On Example Item 3, requiring an understanding of how influenza is transmitted, about two-thirds of the final-year students, on average, responded correctly (see Table 3.10). Correct responses on this open-ended question included specific mention of the transmission of germs; references to transmission by sneezing, coughing, or close contact; or simply the statement that José got influenza from someone who had it. Approximately 11% of the students, on average, across countries responded incorrectly that José got influenza from getting too cold.

Example Item 4 is an open-ended question asking students to explain why a flying stone would crack a window whereas a tennis ball with the same mass and speed would not. Correct responses referred to the longer time the ball would take to reach the window, and (therefore) the smaller force of the ball. These responses could have mentioned the softness or deformability of the ball versus the hardness or solidity of the stone, the larger impact area of the ball versus the smaller area or higher density of the stone, or the compression of the ball compared to the unchanging stone. Table 3.11 reveals considerable variation across countries in performance on this item. For example, two-thirds or more of the final-year students provided correct responses in New Zealand, Sweden, Australia, Canada, Iceland, and Denmark. In contrast, fewer than 40% provided correct responses in Cyprus, Lithuania, the Russian Federation, and South Africa.

Example Item 5 sought to assess the degree to which final-year students could distinguish between the physics concepts of force and pressure when presented with a practical situation. Students were asked why very high heels with a base diameter of about 0.5 cm may cause more damage to floors than ordinary heels with a base

[4] For a full discussion of the science literacy items, see Orpwood, G. and Garden, R.A. (1998). *Assessing Mathematics and Science Literacy, TIMSS Monograph No. 4.* Vancouver, B.C.: Pacific Educational Press.

diameter of about 3 cm. As shown in Table 3.12, about two-fifths of the students, on average, provided fully correct responses. These students referred to greater pressure on the floor because of the small area of the high heels, or to the weight or force acting on a smaller area (without mentioning pressure). Another one-fifth of the students, on average, received partial credit for referring to greater pressure without mentioning the area of the heels, or for communicating correct thinking but misusing the terms force, pressure, mass, or weight.

Example Item 6 concerned the difference between nuclear fusion and fission, and why nuclear fusion is not used by public utilities. As shown in Table 3.13, performance varied across countries. About 40% of the students, on average, correctly answered this multiple-choice question. Half or more of the final-year students selected the correct answer in the Russian Federation, Sweden, Austria, and Denmark.

As shown in Table 3.14, Example Item 7 was a difficult question assessing students' understanding of energy. Correct responses gave reasons why the amount of light energy produced by a lamp is less than the amount of electrical energy used to power it. Specifically, these students mentioned that much of the electrical energy is transformed to heat, or that it is needed to warm up the lamp, or that energy or heat is lost to the surroundings. In general, final-year students in the participating TIMSS countries appear to be unfamiliar with this concept, since only about one-fifth, on average, provided correct responses.

The item difficulty map for the science literacy items is shown in Figure 3.2. The results indicate that students had the most difficulty recognizing the application of physical science principles to practical situations.

Table 3.8 Science Literacy

Percent Correct for Example Item 1
Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	84 (2.5)	48%
Czech Republic	92 (1.1)	78%
Hungary	85 (1.0)	65%
[1] Lithuania	88 (1.6)	43%
† New Zealand	86 (3.4)	70%
[2] Russian Federation	88 (1.2)	48%
Sweden	90 (1.1)	71%
Switzerland	91 (1.2)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	89 (2.2)	68%
[2] Austria	91 (1.3)	76%
Canada	91 (1.1)	70%
France	87 (1.6)	84%
Iceland	87 (1.2)	55%
[1] Italy	82 (2.0)	52%
Norway	93 (0.8)	84%
United States	81 (1.8)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	87 (1.6)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	93 (1.0)	58%
[2] Netherlands	89 (1.4)	78%
Slovenia	90 (1.3)	88%
South Africa	55 (2.8)	49%
International Average Percent Correct	87 (0.4)	

Example 1

Nutrition of vegetables.

It is often claimed that "cooked vegetables are not as nutritious as the same kinds of vegetables uncooked." What could be done to find out if this statement is true?

A. Compare the weight of the vegetables before and after they are cooked.

B. Compare the colour of the cooked and uncooked vegetables.

C. Test the acidity of the water in which the vegetables are cooked.

(D.) Compare the vitamin content of the cooked and uncooked vegetables.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.9 Science Literacy

Percent Correct for Example Item 2

Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	82 (1.8)	48%
Czech Republic	92 (0.9)	78%
Hungary	68 (0.9)	65%
[1] Lithuania	68 (2.4)	43%
† New Zealand	79 (1.6)	70%
[2] Russian Federation	66 (2.4)	48%
Sweden	93 (0.7)	71%
Switzerland	73 (1.6)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	69 (1.5)	68%
[2] Austria	76 (1.8)	76%
Canada	84 (1.1)	70%
France	86 (1.2)	84%
Iceland	93 (0.7)	55%
[1] Italy	78 (1.8)	52%
Norway	82 (1.0)	84%
United States	77 (1.1)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	66 (2.2)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	83 (1.0)	58%
[2] Netherlands	89 (1.0)	78%
Slovenia	71 (2.4)	88%
South Africa	39 (3.3)	49%
International Average Percent Correct	77 (0.4)	

Example 2

Effects of CFCs.

CFCs (chlorofluorocarbons) revolutionized personal and industrial life for 30 years. They were the coolant in refrigerators and the propellants in aerosols, pressure packs and fire extinguishers. There are now very strong international moves to stop the use of these substances because

A. they are chemically inert.

B. they contribute to the greenhouse effect.

C. they are poisonous to humans.

(D.) they destroy the ozone layer.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.10 Science Literacy

Percent Correct for Example Item 3
Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	20 (3.2)	48%
Czech Republic	67 (2.8)	78%
Hungary	68 (1.2)	65%
[1] Lithuania	55 (2.2)	43%
† New Zealand	74 (2.7)	70%
[2] Russian Federation	76 (2.1)	48%
Sweden	88 (1.1)	71%
Switzerland	78 (2.0)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	61 (3.3)	68%
[2] Austria	81 (1.7)	76%
Canada	64 (2.0)	70%
France	68 (2.8)	84%
Iceland	91 (1.2)	55%
[1] Italy	52 (2.6)	52%
Norway	88 (1.1)	84%
United States	59 (2.1)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	66 (2.8)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	86 (1.0)	58%
[2] Netherlands	76 (1.7)	78%
Slovenia	78 (2.9)	88%
South Africa	24 (3.1)	49%
International Average Percent Correct	68 (0.5)	

Example 3

José's influenza.

José caught influenza. Write down one way he could have caught it.

if a friend in school has the flu and if he is sneezing on him and coughing on him.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.11 Science Literacy

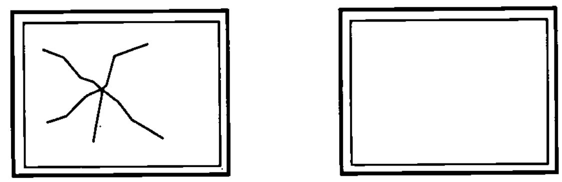
Percent Correct for Example Item 4

Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	26 (3.7)	48%
Czech Republic	62 (2.9)	78%
Hungary	54 (1.3)	65%
[1] Lithuania	37 (2.4)	43%
† New Zealand	76 (1.8)	70%
[2] Russian Federation	35 (2.1)	48%
Sweden	67 (1.6)	71%
Switzerland	61 (2.0)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	72 (2.2)	68%
[2] Austria	64 (2.4)	76%
Canada	67 (1.9)	70%
France	48 (2.8)	84%
Iceland	73 (1.9)	55%
[1] Italy	44 (2.3)	52%
Norway	66 (1.5)	84%
United States	54 (1.5)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	65 (2.7)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	70 (2.1)	58%
[2] Netherlands	66 (2.5)	78%
Slovenia	56 (3.0)	88%
South Africa	38 (3.6)	49%
International Average Percent Correct	57 (0.5)	

Example 4
Impact of stone & tennis ball

The sketch below shows two windows. The left window has been cracked by a flying stone. A tennis ball, with the same mass and speed as the stone, strikes the adjacent, similar window, but does not crack it.



What is one important reason why the impact of the stone cracks the window but the impact of the tennis ball does not?

The tennis ball has air or a hollow inside give it some leeway when it hits the window, But the rock is solid and just hits with full force.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.12 Science Literacy

Percent Correct for Example Item 5 Final Year of Secondary School*

Country	Percent Partially Correct	Percent Fully Correct	TCI
[2] Cyprus	12 (1.3)	45 (2.1)	48%
Czech Republic	22 (2.8)	28 (3.8)	78%
Hungary	20 (0.7)	47 (1.2)	65%
[1] Lithuania	24 (1.7)	21 (1.4)	43%
† New Zealand	23 (1.8)	45 (2.3)	70%
[2] Russian Federation	22 (1.5)	31 (2.1)	48%
Sweden	24 (1.1)	47 (1.7)	71%
Switzerland	22 (1.2)	48 (1.6)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	17 (1.2)	53 (3.6)	68%
[2] Austria	17 (1.3)	51 (2.0)	76%
Canada	18 (1.5)	51 (1.7)	70%
France	12 (1.6)	36 (1.3)	84%
Iceland	22 (0.7)	56 (0.9)	55%
[1] Italy	9 (1.1)	45 (2.3)	52%
Norway	22 (0.9)	50 (1.5)	84%
United States	18 (0.8)	24 (1.3)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):			
† Germany	13 (1.7)	52 (2.4)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	25 (1.5)	39 (1.8)	58%
[2] Netherlands	23 (1.5)	55 (1.8)	78%
Slovenia	51 (2.8)	20 (2.2)	88%
South Africa	9 (1.2)	10 (2.2)	49%
International Average Percent Correct	20 (0.3)	41 (0.5)	

Example 5

Pressure of heels on floor.

Some high heeled shoes are claimed to damage floors. The base diameter of these very high heels is about 0.5 cm and of ordinary heels about 3 cm. Briefly explain why the very high heels may cause damage to floors.

Other shoes have a wider base No matter the size, the same weight ~~the~~ will be distributed all through that area. Therefore, high heels will have all the weight of a person concentrated to that 1 pt. causing more stress.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.13 Science Literacy

Percent Correct for Example Item 6

Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	29 (1.6)	48%
Czech Republic	38 (1.9)	78%
Hungary	41 (1.1)	65%
[1] Lithuania	45 (2.9)	43%
† New Zealand	37 (1.9)	70%
[2] Russian Federation	50 (2.0)	48%
Sweden	54 (1.1)	71%
Switzerland	42 (1.6)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	42 (2.4)	68%
[2] Austria	51 (2.0)	76%
Canada	40 (1.6)	70%
France	31 (1.7)	84%
Iceland	28 (0.8)	55%
[1] Italy	40 (2.2)	52%
Norway	38 (1.3)	84%
United States	41 (1.2)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	44 (2.6)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	51 (1.6)	58%
[2] Netherlands	41 (1.4)	78%
Slovenia	29 (2.1)	88%
South Africa	26 (1.3)	49%
International Average Percent Correct	40 (0.4)	

Example 6

Nuclear energy source.

Nuclear energy can be generated by fission or fusion. Fusion is not currently being used in reactors as an energy source. Why is this?

A. The scientific principles on which fusion is based are not yet known.

(B.) The technological processes for using fusion safely are not developed.

C. The necessary raw materials are not readily available.

D. Waste products from the fusion process are too dangerous.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.
† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).
[1] National Desired Population does not cover all of International Desired Population (see Table B.4).
[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 3.14 Science Literacy

Percent Correct for Example Item 7
Final Year of Secondary School*

Country	Percent Correct	TCI
[2] Cyprus	13 (3.1)	48%
Czech Republic	23 (4.0)	78%
Hungary	16 (1.1)	65%
[1] Lithuania	12 (1.5)	43%
† New Zealand	24 (2.2)	70%
[2] Russian Federation	18 (2.1)	48%
Sweden	31 (2.0)	71%
Switzerland	27 (2.3)	82%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	26 (2.7)	68%
[2] Austria	21 (2.4)	76%
Canada	23 (1.8)	70%
France	19 (2.1)	84%
Iceland	20 (1.6)	55%
[1] Italy	16 (1.8)	52%
Norway	19 (1.5)	84%
United States	11 (1.3)	63%
Countries with Unapproved Student Sampling (See Appendix B for Details):		
† Germany	23 (2.2)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	20 (1.5)	58%
[2] Netherlands	42 (2.3)	78%
Slovenia	35 (3.5)	88%
South Africa	5 (1.4)	49%
International Average Percent Correct	21 (0.5)	

Example 7
Electrical energy and lamp:

Electrical energy is used to power a lamp.

Is the amount of light energy produced more than, less than, or the same as the amount of electrical energy used?

The amount of light energy produced is

____ more than

_✓_ less than (check one)

____ the same as

the amount of electrical energy used.

Give a reason to support your answer.

Be cause the lamp heats up, some of the electrical energy is used for this. The rest of the energy produces light,

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

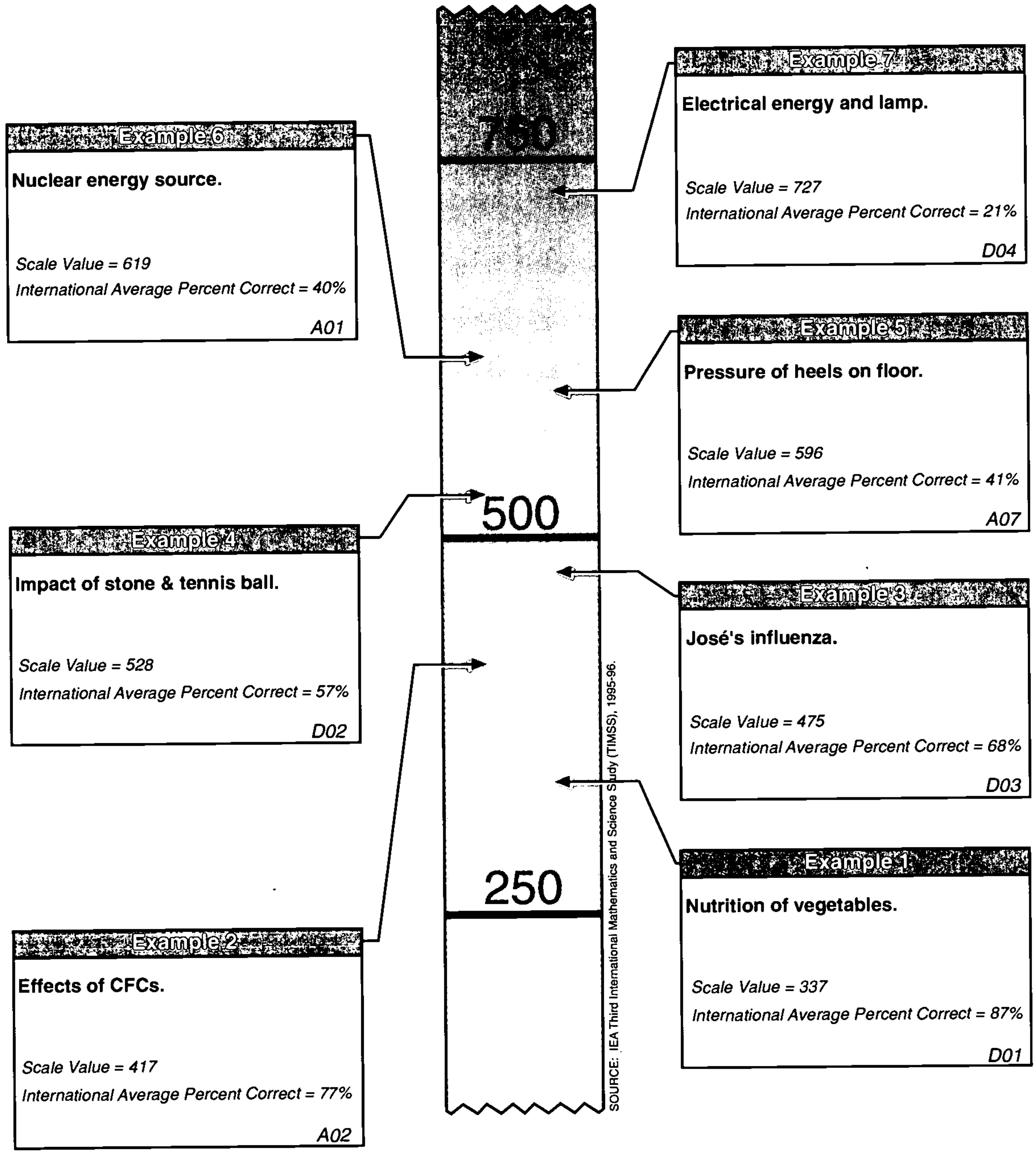
[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 3.2

International Difficulty Map for Science Literacy Example Items

Final Year of Secondary School*



* See Appendix A for characteristics of students sampled.

Note: Items are shown at the point on the TIMSS science literacy scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

Chapter 4

Contexts for Mathematics and Science Literacy Achievement

To provide an educational context for interpreting the results for mathematics and science literacy, 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 the responses of students in the final year of secondary school to a subset of these questions. In many countries, students at this stage of their education have been assigned to educational programs or tracks that reflect their interests and abilities, and these programs in turn determine to a great extent the opportunities for further study or employment that will be available.

Several of the questions presented in this chapter concern students' academic preparation and their plans for future education. Because students' attitudes towards mathematics and science and their perceptions of success in these subjects are closely related to each other and to achievement, results are also described for several questions in these domains. In an effort to explore the degree to which the students' home and social environments foster academic development, some of the questions presented herein concern the availability of educational resources in the home. Since the optimal use of calculators and computers by students learning mathematics and science remains an area of debate, several questions on this issue are included. Another group of questions examines whether or not students typically spend their out-of-school time in ways that support their academic performance. Finally, since a secure and supportive school environment is generally accepted as a prerequisite for effective learning, results for several questions about students' experiences in school are presented.

What Are Secondary School Students' Educational Experiences and Plans?

In many countries, students in the upper secondary grades either choose or are assigned to educational programs or tracks that reflect their abilities and interests. The program to which a student is assigned often largely determines that student's future educational and career prospects. Even in countries with comprehensive systems, students have some latitude in choosing between more and less demanding course options. While it is very informative to compare the achievement of students across different educational programs within a country, it is quite difficult to define international categories that are comparable across countries. Although countries vary widely in the way upper secondary education is organized, four broad categories can be distinguished to which most programs may be assigned – academic, technical, vocational, and general.

While none of the TIMSS countries had programs that fit into all four categories, most included national options that distinguished between academic and vocational programs. The percentage of students in each of the four program types is presented in Table 4.1 for each country, together with mean achievement in mathematics and science literacy. The source of the data varied across countries: in 12 countries, the data are based on students' responses to questions about their educational track or program, while in the other 9 countries, they are based on school tracking information.

In most countries, the majority of students were following programs of study that could be broadly categorized as academic or general. In particular, in Australia, Canada, France, Iceland, Slovenia, and the United States, fewer than one-fifth of final-year secondary students covered by the TIMSS testing were enrolled in vocational programs. In contrast, a well-developed vocational sector is a feature of many of the education systems in continental Europe. Between half and three-fourths of the students in Austria, the Czech Republic, Germany, the Netherlands, and Switzerland were in vocational programs or tracks. In the Czech Republic, France, Hungary, and Italy, more than one-fourth of the students were enrolled in technical programs; Austria and Slovenia also had a substantial proportion of students in this sector.

As might be expected, students enrolled in academic programs had higher mean achievement than students in vocational programs, often by a wide margin. The largest differences were in the Czech Republic and Slovenia, where the mean for the academic students exceeded that for vocational students by approximately 140 scale-score points (almost one and one-half standard deviations on the international mathematics and science literacy scale). The mean achievement of students in technical programs generally was somewhere between that of the academic and vocational students.

Figure 4.1 summarizes the programs or tracks in each country, and indicates the category to which they were assigned for the purpose of this report. Although there is no single definition of these broad program categories that applies across all countries, the following international working definitions based on the program options across countries are used for the purpose of this report.

Academic programs include general academic programs or tracks in academic, general, or comprehensive schools. The focus of coursework is mainly academic and may include many different areas of concentration (e.g., math, natural or physical sciences, languages, humanities, economics, social science, the arts). In many countries, a final leaving examination or university-preparation examination is required on completion of these programs. Students from these programs may attend university or equivalent institutions of higher education. In nearly all countries, the academic programs terminate after grade 12 or 13. In three countries with comprehensive schools (Australia, Canada, and the United States), a distinction was made between pre-university programs and general studies in the question asked of students. In these countries, only the pre-university programs are included in the academic program category, although the distinction between pre-university and general is based on the emphasis on specific types of courses within the comprehensive schools and may not be uniformly interpreted by all students. In contrast, in the Netherlands and the Russian Federation, the academic program category includes both the academic and general programs.

Table 4.1

Mathematics and Science Literacy Achievement by Educational Program†

Final Year of Secondary School*

Country	Academic Program		Technical Program		Vocational Program		General Education Program	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	54 (2.4)	561 (8.8)	- -	- -	10 (1.1)	466 (13.5)	36 (2.1)	497 (11.9)
Austria	23 (1.9)	565 (8.5)	22 (1.3)	569 (8.3)	55 (2.4)	482 (5.9)	- -	- -
Canada	77 (1.6)	538 (3.3)	- -	- -	7 (0.6)	497 (8.3)	16 (1.4)	485 (7.7)
Cyprus	89 (0.7)	452 (2.5)	11 (0.7)	408 (8.8)	- -	- -	- -	- -
Czech Republic	14 (2.0)	582 (7.2)	29 (5.5)	523 (10.8)	57 (6.5)	427 (5.4)	- -	- -
Denmark	56 (2.9)	550 (3.5)	- -	- -	44 (2.9)	499 (6.2)	- -	- -
France	54 (3.5)	534 (6.7)	34 (4.5)	486 (5.0)	12 (3.2)	435 (6.7)	- -	- -
Germany	26 (3.2)	567 (4.1)	11 (4.9)	502 (20.9)	63 (5.0)	466 (7.2)	- -	- -
Hungary	27 (1.3)	530 (5.5)	35 (1.2)	504 (5.4)	39 (1.1)	416 (3.4)	- -	- -
Iceland	82 (0.6)	551 (1.5)	- -	- -	18 (0.6)	516 (4.9)	- -	- -
Italy	38 (2.4)	501 (8.4)	37 (2.0)	481 (6.6)	25 (2.4)	426 (12.2)	- -	- -
Lithuania	74 (3.8)	475 (5.4)	- -	- -	26 (3.8)	437 (16.3)	- -	- -
Netherlands	43 (1.5)	612 (9.9)	- -	- -	57 (1.5)	519 (5.3)	- -	- -
New Zealand	100 (0.0)	525 (4.7)	- -	- -	- -	- -	- -	- -
Norway	57 (2.5)	560 (4.5)	- -	- -	43 (2.5)	503 (6.3)	- -	- -
Russian Federation	100 (0.0)	476 (5.8)	- -	- -	- -	- -	- -	- -
Slovenia	67 (4.1)	547 (7.3)	24 (2.9)	469 (7.1)	9 (3.2)	408 (10.5)	- -	- -
South Africa	100 (0.0)	352 (9.3)	- -	- -	- -	- -	- -	- -
Sweden	66 (2.7)	587 (4.8)	- -	- -	34 (2.7)	500 (4.6)	- -	- -
Switzerland	23 (1.5)	607 (3.9)	- -	- -	69 (1.5)	506 (6.5)	7 (1.9)	530 (13.8)
United States	55 (1.4)	504 (3.7)	- -	- -	12 (0.9)	410 (4.4)	33 (1.4)	444 (3.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Program options were defined by each country to conform to their own educational system and may not be comparable across countries. See Figure 4.1 for national definitions of program options included in each category.

* See Appendix A for characteristics of the students sampled.

Source of data varies across countries:

Data are based on students' reports of their educational program in Austrialia, Canada, Cyprus, Czech Republic, France, Iceland, Netherlands, Norway, Slovenia, Sweden, Switzerland, and the United States.

Data are based on students' school tracking information in Austria, Denmark, Germany, Hungary, Italy, Lithuania, New Zealand, Russian Federation, and South Africa.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates the program category is not included for that country.

Figure 4.1

Definitions of National Options Included in the International Categories for Students' Educational Programs† Mathematics and Science Literacy Final Year of Secondary School*

Australia	Austria	Canada	Cyprus	Czech Republic	Denmark	France
Academic: Full academic (preparation for university)	Academic: Academic (AHS)	Academic: University/college preparation program (general or with specialization in math, science, or both)	Academic: Lyceum (math/science, classical, economics, commercial/secretarial, and foreign language tracks)	Academic: Gymnasium (general program or program specializing in mathematics, physical science, natural science, computer science, humanities, or foreign language)	Academic: Gymnasia	Academic: Lycees Serie S (scientific), L (literacy), or ES (economic and social)
Vocational: Program in specific area (e.g. business) or school-industry link	Technical: Higher technical/vocational school (BHS)	Vocational: Trade/technical school preparation program	Technical: Technical/vocational schools	Technical: Secondary technical school	Vocational: Commercial or technical schools (Handelsskoler, Tekniskeskoler) with both academic and non-academic programs	Technical: Lycees technical serie STI or other technical tracks
General: Part academic/part general	Vocational: Intermediate vocational/technical school (BMS) or apprenticeship program (BS)	General: Other general graduation program		Vocational: Vocational training center or secondary school without maturita.		Vocational: Long or short vocational/professional degree program (Baccalaureat professionnels, BAC, or Brevet d'etudes professionnels, BEP)

Germany	Hungary	Iceland	Italy	Lithuania	Netherlands	New Zealand
Academic: Gymnasia or comprehensive schools (GS, IGS)	Academic: General academic	Academic: Academic programs in gymnasia or comprehensive schools (general or with specialization in mathematics, science, arts, or language)	Academic: Classical schools (classics, languages, teaching, and sciences) or art schools	Academic: Gymnasia or general school	Academic: Academic or senior general schools (VWO or HAVO)	Academic: General academic/comprehensive education
Technical: Technical/professional or applied science programs (Fachgymnasia or Fachoberschulen)	Technical: Vocational/professional programs in vocational schools (industrial, agricultural, merchant, and humanities)	Vocational: Vocational programs in comprehensive schools (Fjölbrautarskólar) or special vocational schools	Technical: Technical schools	Vocational: Vocational school	Vocational: Short or long vocational programs (MBO or KMBO in technology, economics, agriculture, home economics)	
Vocational: Apprenticeship (Berufsschulen) or full-time vocational programs (Berufsfachschulen)	Vocational: Vocational trade schools (trade, merchant, or agricultural)		Vocational: Vocational schools			

Norway	Russian Federation	Slovenia	South Africa	Sweden	Switzerland	United States
Academic: Academic programs (general or math/science specialization)	Academic: General and specialized programs (mathematics science, humanities, foreign languages, etc.) in general secondary schools and gymnasiums	Academic: Gymnasia (matura program)	Academic: General academic/comprehensive education	Academic: General academic programs (with specialization in math/physics; social science and economics; and humanities)	Academic: Gymnasia programs (specialization in science, languages, economics) or matura-level preparation for teacher training	Academic: College preparatory program (high percentage of college-preparatory courses)
Vocational: Vocational programs in commerce (HK), industry (HI), health (HS), home economics (HH) or other	Vocational: vocational schools (not included in sample)	Technical: Technical/professional schools		Vocational: Vocationally-oriented programs	Vocational: Apprenticeship (Berufslehre), full-time vocational school, or apprenticeship plus additional general education leading to technical school-leaving certificate (Berufsmaturitat)	Vocational: Vocational/technical program (high percentage of vocational courses)
		Vocational: 3- or 4-year vocational program			General: Intermediate diploma school (Diplommittelschule)	General: General academic program (combining general academic and vocational coursework)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Educational program or track options were defined by each country to conform to their national systems. The options included in each international reporting category are shown to aid in the interpretation of Table 4.1.

* See Appendix A for characteristics of the students sampled.

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Technical programs include technically or professionally oriented programs provided either in separate technical schools or in higher-level technical/vocational tracks within general academic or technical/vocational schools. These programs are usually of a higher level than many vocational/occupational programs and, in several countries, are comparable to the general academic program both in duration and in preparing students for a final exam or for entry into university or an equivalent institution of higher education. The technical tracks, however, focus more on specialized courses required for specific professions than the more general academic tracks. The technical programs category is included only for countries with clearly defined separate national options for technical schools or tracks that are differentiated from both general academic programs and primarily vocational/occupational tracks.

Vocational programs include vocationally or occupationally oriented programs provided either in separate vocational schools or in specific vocational programs within general or comprehensive schools. The focus of these programs is, in general, more practical than that of the general academic programs, typically preparing students for immediate employment after completion of their upper secondary education and terminating with a certificate, vocational license, or diploma. In many countries, there are clearly defined vocational schools or tracks that are differentiated from the general academic tracks. In other countries with more comprehensive schools, the vocational option refers more to a general program with a focus on vocationally oriented courses than on a formal vocational school or track. The type and duration of vocational programs vary both across and within countries, terminating in nearly all countries after grade 10, 11, 12, or 13. The national options included in the vocational programs category cover a broad range of programs including both full- and part-time programs in vocational/technical/trade schools and apprenticeship programs in industry and business. A large number of occupational programs are offered, including many in skilled-trades, business, and applied science/engineering. Depending on the program, students may continue their education after completing a vocational program. In some countries, the vocational programs category includes some vocational programs terminating with a diploma that may lead directly to university, such as the Baccalaureat professionnel in France. In others, however, students continuing their education after completing vocational programs may attend other tertiary institutions for higher-level vocational training or further upper secondary education.

General programs include any other program or track options not included in the academic, technical, or vocational categories. Only four countries have options in this category: general schools in Switzerland, and the general programs (not fully pre-university) in comprehensive schools in Australia, Canada, and the United States.

One of the consequences of the differentiation in programs and courses that is characteristic of upper secondary education is that students often have the option to discontinue the study of mathematics and science. Table 4.2 presents students' reports on whether or not they were taking mathematics in the final year of secondary school, together with mean achievement on the mathematics literacy test. In most of the countries, a high proportion of final-year students was still enrolled in mathematics class. In nine countries (Australia, Cyprus, the Czech Republic, France, Hungary, Italy, Lithuania, the Russian Federation, and Slovenia), 85% or more of students

Table 4.2

Students' Reports on Currently Taking Mathematics – Mathematics Literacy
Final Year of Secondary School*

Country	Yes		No	
	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement
Australia	87 (2.2)	534 (8.3)	13 (2.2)	465 (15.5)
Austria	74 (3.6)	526 (5.7)	26 (3.6)	503 (12.0)
Canada	54 (2.6)	541 (3.6)	46 (2.6)	496 (3.8)
[1] **Cyprus**	100 (0.0)	446 (2.4)	0 (0.0)	~ ~
Czech Republic	95 (2.1)	465 (12.9)	5 (2.1)	493 (22.9)
Denmark	78 (2.4)	568 (4.1)	22 (2.4)	481 (5.0)
France	100 (0.0)	524 (5.2)	0 (0.0)	~ ~
Germany	- -	- -	- -	- -
Hungary	100 (0.0)	484 (3.2)	0 (0.0)	~ ~
Iceland	65 (1.0)	551 (2.6)	35 (1.0)	506 (4.8)
Italy	88 (3.3)	480 (5.3)	12 (3.3)	450 (17.2)
Lithuania	90 (2.1)	473 (5.1)	10 (2.1)	434 (22.0)
Netherlands	60 (2.6)	601 (6.2)	40 (2.6)	498 (7.7)
New Zealand	73 (1.8)	545 (4.4)	27 (1.8)	461 (5.2)
Norway	68 (2.5)	542 (4.8)	32 (2.5)	500 (5.8)
[1] **Russian Federation**	100 (0.1)	471 (6.1)	0 (0.1)	~ ~
Slovenia	95 (2.7)	519 (8.2)	5 (2.7)	407 (17.4)
South Africa	69 (2.9)	372 (11.5)	31 (2.9)	328 (3.1)
Sweden	70 (2.0)	578 (5.2)	30 (2.0)	494 (4.8)
Switzerland	61 (3.2)	561 (4.0)	39 (3.2)	513 (8.9)
United States	66 (1.9)	477 (3.6)	34 (1.9)	436 (3.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Vocational schools excluded (see Table B.4).

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

reported that they were currently taking mathematics. In contrast, countries where as many as one-third of final-year students reported that they were not currently taking mathematics included Canada, Iceland, the Netherlands, Switzerland, and the United States.

In general, the students no longer taking mathematics performed less well in mathematics literacy than those who were still studying the subject. Differences were particularly pronounced in Australia, Denmark, the Netherlands, New Zealand, Slovenia, and Sweden, where the achievement gap between those taking and not taking mathematics exceeded 50 scale-score points, which is half of a standard deviation on the international mathematics literacy scale.

In some countries, more males than females reported that they were currently taking mathematics (see Table 4.3). One of the largest differences was in Denmark, where the percentage of female students not taking mathematics (31%) was more than twice the percentage for males (12%). The other countries where the difference between males and females was at least 10 percentage points included Canada, Iceland, the Netherlands, New Zealand, and Norway.

In upper secondary school, science typically is not taught as a single subject; rather, subjects such as physics, chemistry, biology, and earth science are taught as separate subjects, and students may have the option to take one or more (or perhaps none) of them. In TIMSS, final-year students were asked to indicate which of the science subjects (physics, chemistry, biology, earth science, or other science) they were currently taking. The results are summarized in Table 4.4. Compared with mathematics, higher percentages of students in most countries reported that they were taking no science subject at the time of testing. Half or more of the students in the Czech Republic, Denmark, Norway, Sweden, and Switzerland, reported that they were not taking science, and nearly half of the final-year students so reported in Canada and the United States. Countries where the majority of students reported that they were taking two or more science subjects included Austria, Cyprus, France, Lithuania, the Russian Federation, and South Africa.

There was a positive association between taking science subjects and performance in science literacy in almost every country. This may be the result of a combination of factors, such as students who had not done well in science in earlier years deciding to take fewer science subjects, and those who took more science subjects learning more science.

Compared with mathematics, somewhat fewer countries exhibited substantial differences in the percentages of males and females currently taking science classes (Table 4.5). In only four countries – France, the Netherlands, Sweden, and Switzerland – were the differences in the percentages not taking any science greater than 10%. Of these, France, the Netherlands, and Sweden had higher percentages of females not taking science, while in Switzerland a higher percentage of males reported taking no science.

Table 4.3

Students' Reports on Currently Taking Mathematics by Gender – Mathematics Literacy Final Year of Secondary School*

Country	Females				Males			
	Yes		No		Yes		No	
	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement
Australia	85 (2.9)	523 (8.8)	15 (2.9)	455 (11.4)	89 (2.8)	550 (9.4)	11 (2.8)	483 (40.8)
Austria	75 (4.8)	511 (5.7)	25 (4.8)	482 (14.2)	72 (3.5)	551 (8.7)	28 (3.5)	533 (10.8)
Canada	50 (2.8)	525 (4.7)	50 (2.8)	483 (6.0)	60 (3.0)	557 (4.1)	40 (3.0)	514 (5.5)
Cyprus	100 (0.0)	439 (3.7)	0 (0.0)	~ ~	100 (0.0)	456 (4.9)	0 (0.0)	~ ~
Czech Republic	93 (3.3)	440 (17.3)	7 (3.3)	486 (22.5)	97 (1.6)	488 (11.7)	3 (1.6)	508 (41.0)
Denmark	69 (2.9)	546 (4.6)	31 (2.9)	475 (4.6)	88 (1.8)	589 (5.6)	12 (1.8)	498 (10.5)
France	100 (0.0)	506 (5.4)	0 (0.0)	~ ~	100 (0.0)	544 (5.7)	0 (0.0)	~ ~
Germany	- -	- -	- -	- -	- -	- -	- -	- -
Hungary	100 (0.0)	481 (4.7)	0 (0.0)	~ ~	100 (0.0)	486 (4.9)	0 (0.0)	~ ~
Iceland	60 (1.7)	529 (2.8)	40 (1.7)	492 (4.5)	70 (1.3)	572 (3.9)	30 (1.3)	526 (7.7)
Italy	91 (3.3)	469 (5.5)	9 (3.3)	414 (24.6)	84 (4.4)	494 (8.3)	16 (4.4)	472 (14.4)
Lithuania	90 (2.4)	465 (6.2)	10 (2.4)	430 (30.7)	91 (3.9)	489 (6.9)	9 (3.9)	444 (11.0)
Netherlands	48 (2.6)	593 (8.5)	52 (2.6)	476 (7.8)	71 (3.9)	606 (6.4)	29 (3.9)	534 (11.5)
New Zealand	66 (2.6)	534 (6.2)	34 (2.6)	456 (6.9)	80 (2.1)	554 (6.3)	20 (2.1)	470 (6.8)
Norway	63 (3.0)	512 (6.1)	37 (3.0)	483 (5.9)	73 (2.7)	568 (6.5)	27 (2.7)	522 (7.5)
Russian Federation	100 (0.0)	461 (6.6)	0 (0.0)	~ ~	100 (0.1)	488 (6.6)	0 (0.1)	~ ~
Slovenia	95 (3.1)	495 (7.6)	5 (3.1)	376 (4.2)	94 (3.3)	543 (13.1)	6 (3.3)	429 (10.0)
South Africa	67 (3.5)	363 (15.1)	33 (3.5)	325 (4.1)	71 (3.0)	381 (12.3)	29 (3.0)	331 (4.4)
Sweden	68 (2.2)	555 (4.1)	32 (2.2)	485 (5.6)	72 (2.8)	601 (7.6)	28 (2.8)	504 (6.4)
Switzerland	63 (4.5)	538 (5.8)	37 (4.5)	498 (14.0)	60 (3.4)	579 (5.5)	40 (3.4)	524 (9.7)
United States	63 (2.4)	472 (4.5)	37 (2.4)	433 (4.6)	70 (1.9)	481 (4.7)	30 (1.9)	440 (4.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

Table 4.4

Students' Reports on Currently Taking Science† – Science Literacy Final Year of Secondary School*

Country	No Science		One Science Course		Two Science Courses		Three or More Science Courses	
	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement
Australia	27 (3.6)	469 (10.2)	36 (1.4)	528 (10.3)	30 (2.8)	578 (11.6)	7 (1.3)	602 (15.5)
Austria	12 (1.7)	478 (8.3)	26 (2.3)	498 (10.8)	24 (2.4)	532 (8.4)	38 (3.3)	552 (8.1)
Canada	45 (2.2)	508 (3.9)	34 (2.0)	543 (5.4)	15 (1.3)	575 (8.6)	6 (0.6)	585 (6.0)
Cyprus	0 (0.0)	~ ~	3 (0.6)	390 (23.0)	77 (1.3)	438 (3.6)	20 (1.5)	496 (8.5)
Czech Republic	66 (5.7)	469 (10.0)	18 (3.7)	490 (13.9)	6 (1.6)	530 (21.7)	11 (1.5)	589 (5.4)
Denmark	r 58 (2.3)	487 (4.6)	26 (1.4)	552 (4.4)	13 (1.6)	571 (8.6)	3 (0.6)	564 (12.1)
France	35 (2.4)	452 (5.4)	11 (2.6)	461 (8.2)	12 (1.7)	490 (12.9)	42 (3.0)	523 (4.8)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	22 (1.9)	446 (4.7)	36 (2.4)	459 (5.3)	32 (1.6)	492 (5.4)	9 (0.7)	509 (7.5)
Iceland	37 (1.2)	526 (2.5)	30 (1.5)	541 (4.1)	15 (1.1)	586 (4.7)	18 (0.8)	597 (3.1)
Italy	19 (2.8)	448 (8.8)	32 (2.5)	465 (7.8)	30 (2.7)	492 (6.4)	20 (2.5)	500 (14.2)
Lithuania	12 (2.4)	434 (18.8)	8 (2.8)	435 (11.8)	6 (1.3)	454 (7.1)	75 (3.4)	470 (5.6)
Netherlands	43 (3.3)	509 (5.8)	24 (2.7)	567 (7.7)	20 (2.0)	597 (7.7)	13 (2.6)	642 (16.0)
New Zealand	32 (1.6)	478 (6.9)	34 (1.7)	521 (6.6)	25 (1.1)	581 (5.2)	9 (1.1)	617 (9.3)
Norway	63 (2.7)	519 (3.9)	23 (2.1)	568 (6.1)	13 (1.6)	633 (10.4)	1 (0.2)	~ ~
Russian Federation	0 (0.1)	~ ~	1 (0.4)	~ ~	2 (0.5)	~ ~	98 (0.7)	483 (5.8)
Slovenia	16 (2.8)	480 (10.8)	47 (3.0)	510 (8.1)	23 (2.4)	547 (8.6)	14 (3.0)	571 (22.4)
South Africa	8 (1.1)	353 (13.6)	22 (2.1)	323 (10.8)	27 (2.4)	363 (15.7)	43 (3.0)	367 (14.0)
Sweden	57 (2.0)	529 (3.2)	22 (1.7)	567 (10.3)	6 (0.7)	605 (11.8)	15 (1.8)	658 (6.4)
Switzerland	50 (2.6)	489 (6.3)	23 (1.9)	545 (7.7)	16 (1.3)	574 (9.3)	11 (1.8)	580 (13.3)
United States	47 (1.7)	456 (3.5)	46 (1.6)	505 (4.6)	6 (0.8)	537 (13.5)	1 (0.1)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Students were asked which of the following science courses they were currently taking: Biology, Chemistry, Physics, Earth Science, and Other Science.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 data available for <50% students.

A tilde (~) indicates insufficient data to report achievement.

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Table 4.5

Students' Reports on Currently Taking Science by Gender† – Science Literacy
Final Year of Secondary School*

Country	Females				Males			
	Yes		No		Yes		No	
	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement
Australia	72 (3.7)	540 (8.5)	28 (3.7)	459 (7.4)	74 (4.4)	577 (11.0)	26 (4.4)	484 (17.7)
Austria	88 (2.7)	508 (5.6)	12 (2.7)	468 (10.2)	88 (1.9)	567 (8.6)	12 (1.9)	495 (11.0)
Canada	53 (3.7)	543 (5.8)	47 (3.7)	493 (6.5)	58 (2.8)	571 (5.5)	42 (2.8)	528 (4.4)
Cyprus	100 (0.0)	437 (3.5)	0 (0.0)	~ ~	100 (0.0)	461 (6.2)	0 (0.0)	~ ~
Czech Republic	32 (8.9)	509 (16.5)	68 (8.9)	442 (12.0)	37 (5.5)	543 (14.8)	63 (5.5)	495 (10.6)
Denmark	r 39 (2.8)	539 (5.9)	61 (2.8)	472 (4.4)	r 47 (3.5)	578 (6.5)	53 (3.5)	508 (6.5)
France	56 (2.8)	493 (4.9)	44 (2.8)	438 (5.1)	75 (2.9)	518 (7.4)	25 (2.9)	481 (10.3)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	76 (2.4)	464 (5.3)	24 (2.4)	434 (5.2)	80 (2.7)	492 (5.1)	20 (2.7)	460 (7.2)
Iceland	66 (1.8)	544 (2.5)	34 (1.8)	508 (3.4)	61 (1.5)	595 (3.4)	39 (1.5)	545 (4.5)
Italy	79 (3.7)	468 (6.2)	21 (3.7)	431 (8.3)	83 (2.7)	502 (7.7)	17 (2.7)	473 (9.3)
Lithuania	88 (2.2)	454 (6.2)	12 (2.2)	426 (27.6)	87 (4.8)	487 (7.1)	13 (4.8)	449 (9.6)
Netherlands	50 (4.9)	579 (10.1)	50 (4.9)	485 (5.6)	63 (3.9)	607 (7.7)	37 (3.9)	539 (7.6)
New Zealand	66 (2.3)	538 (5.4)	34 (2.3)	474 (9.0)	70 (2.1)	573 (8.2)	30 (2.1)	482 (10.4)
Norway	34 (3.3)	553 (8.1)	66 (3.3)	496 (4.0)	40 (3.5)	626 (10.8)	60 (3.5)	545 (5.5)
Russian Federation	100 (0.0)	464 (6.7)	0 (0.0)	~ ~	100 (0.1)	511 (5.9)	0 (0.1)	~ ~
Slovenia	85 (3.4)	503 (6.6)	15 (3.4)	460 (8.3)	83 (3.7)	558 (10.7)	17 (3.7)	498 (21.1)
South Africa	92 (1.6)	337 (14.3)	8 (1.6)	354 (15.0)	92 (1.3)	375 (12.6)	8 (1.3)	352 (17.1)
Sweden	35 (2.2)	569 (6.4)	65 (2.2)	518 (3.2)	51 (2.5)	629 (7.8)	49 (2.5)	545 (5.0)
Switzerland	57 (3.4)	537 (10.0)	43 (3.4)	457 (6.8)	44 (3.7)	588 (8.4)	56 (3.7)	509 (7.5)
United States	52 (1.9)	495 (4.7)	48 (1.9)	445 (4.9)	53 (2.3)	520 (5.9)	47 (2.3)	468 (4.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Students were asked which of the following science courses they were currently taking: Biology, Chemistry, Physics, Earth Science, and Other Science. Percent "Yes" based on students reporting taking one or more science courses.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 data available for <50% students.

A tilde (~) indicates insufficient data to report achievement.

The relationship between choice of program in secondary school and later educational goals may be seen in Table 4.6. Because of the difficulty in establishing consistent definitions of university and vocational/technical programs across countries, Figure 4.2 provides additional information on national adaptations of the educational categories for some countries. In particular, the university category was defined by some countries to include both university and other technically or professionally oriented degree programs at equivalent institutions of higher education, while in other countries it included university only.

More students in countries with well-developed vocational or technical programs in secondary school plan to continue in such programs at a tertiary level, while in countries with more general educational systems greater percentages plan to attend university or an equivalent institution of higher education. Nearly one-fourth or more of final-year students in Austria, the Czech Republic, France, the Netherlands, Norway, the Russian Federation, and Switzerland plan to pursue further education through vocational or technical programs. Countries where the majority of students reported planning to attend university included Australia, Canada, Cyprus, Denmark, France, Iceland, Lithuania, New Zealand, Norway, the Russian Federation, Slovenia, South Africa, Sweden, and the United States. As noted in Figure 4.2, the university category included technical training for some countries. For example, the practically-oriented program (technikon) was included in the university category for South Africa. Although very high percentages of final-year students in most countries reported plans for some form of tertiary education, one-fourth or more of these students in Austria, the Czech Republic, Italy, and Switzerland indicated that they did not intend to continue their education beyond secondary school. In these countries, many vocational programs are offered that provide students with the training needed to enter the workplace directly after completing their upper secondary schooling.

Not surprisingly, in almost all countries, the students planning to attend university had higher average mathematics and science literacy scores than the students with other plans after completing upper secondary schooling.

Table 4.6

Students' Reports on Their Plans for Future Education† Mathematics and Science Literacy Final Year of Secondary School*

Country	University[1]		Vocationally Oriented Programs[2]		Other Post Secondary Education[3]		Does Not Intend to Continue Education	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	68 (2.2)	555 (7.3)	15 (2.3)	472 (12.6)	9 (0.9)	476 (9.4)	9 (0.9)	469 (11.3)
Austria	38 (2.2)	562 (6.2)	23 (1.8)	486 (5.2)	12 (1.2)	510 (7.0)	27 (1.5)	498 (7.8)
Canada	63 (1.8)	545 (3.4)	15 (1.0)	504 (5.4)	18 (1.2)	495 (6.8)	4 (0.5)	475 (11.1)
Cyprus	62 (2.0)	473 (3.8)	10 (1.7)	434 (8.6)	11 (1.5)	403 (10.4)	17 (1.5)	398 (6.4)
Czech Republic	31 (5.2)	563 (7.1)	26 (4.3)	443 (8.0)	3 (0.8)	417 (34.7)	40 (2.5)	436 (5.3)
Denmark	r 51 (1.8)	553 (3.5)	21 (2.3)	508 (6.7)	13 (1.4)	496 (6.0)	16 (1.3)	508 (7.4)
France	51 (2.4)	524 (5.5)	28 (2.7)	500 (6.7)	11 (1.1)	498 (7.8)	10 (1.7)	440 (7.5)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	36 (1.4)	525 (4.2)	21 (1.1)	446 (3.2)	27 (1.1)	482 (4.5)	17 (1.1)	425 (4.3)
Iceland	65 (0.9)	559 (2.2)	16 (0.7)	528 (4.9)	12 (0.9)	500 (4.1)	7 (0.5)	514 (4.8)
Italy	44 (2.6)	502 (6.8)	8 (1.1)	474 (11.4)	16 (1.8)	460 (9.6)	32 (2.0)	452 (6.1)
Lithuania	51 (2.4)	490 (5.9)	16 (1.0)	444 (7.3)	20 (1.1)	441 (7.3)	13 (1.9)	438 (16.6)
Netherlands	17 (2.8)	645 (10.7)	47 (3.2)	564 (4.0)	14 (1.4)	520 (7.9)	22 (1.7)	508 (6.9)
New Zealand	74 (1.7)	542 (5.2)	13 (1.4)	508 (9.2)	3 (0.5)	486 (12.0)	9 (1.5)	444 (11.6)
Norway	55 (1.7)	557 (4.3)	23 (1.2)	532 (5.4)	11 (0.8)	507 (7.2)	11 (0.9)	486 (8.2)
Russian Federation	60 (2.0)	498 (5.7)	32 (1.9)	448 (6.4)	6 (0.6)	471 (12.2)	1 (0.3)	~ ~
Slovenia	75 (3.5)	538 (7.0)	11 (1.2)	466 (11.1)	2 (0.4)	~ ~	12 (2.6)	438 (17.0)
South Africa	75 (1.8)	357 (10.7)	11 (1.1)	325 (11.6)	8 (0.6)	339 (9.1)	6 (0.9)	390 (14.9)
Sweden	64 (1.8)	590 (4.5)	9 (0.9)	500 (7.2)	12 (0.8)	506 (5.3)	15 (1.1)	494 (5.3)
Switzerland	35 (1.7)	585 (3.7)	24 (2.1)	503 (10.6)	10 (0.7)	513 (8.3)	30 (1.7)	501 (5.1)
United States	69 (1.4)	494 (3.6)	16 (0.9)	425 (4.4)	11 (0.7)	440 (4.1)	4 (0.4)	405 (5.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Educational options were defined by each country to conform to their national system and may not be comparable across countries. See Figure 4.2 for definitions and any national adaptations of the international options in each category.

* See Appendix A for characteristics of the students sampled.

1 In most countries, defined as at least a 3-year degree program at a university or an equivalent institute of higher education.

2 Defined in most countries as vocational or technical courses at a tertiary institution not equivalent to a university degree program (e.g., trade or business school, junior or community college, and other shorter vocational programs), but may also include higher-level upper secondary vocational programs in some countries.

3 Includes other postsecondary education defined in each country. Includes categories such as academic courses at junior or community college, short university or polytechnic courses, and college-preparatory courses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 data available for <50% students.

A tilde (~) indicates insufficient data to report achievement.

Figure 4.2

National Adaptations of the Definitions of Educational Levels for Students' Reports on Their Plans for Future Education†
Final Year of Secondary School*

University

International Version: *Attend a Four-Year College or University*

Australia:	*University education*
Austria:	*University, higher technical institution, or teacher education at a pedagogical academy or university*
Czech Republic:	*Bachelor or equivalent or higher degree in humanities, business/technical subject or other studies*
Denmark:	*University or other higher educational institution or medium-duration specialized educational (e.g. teacher college, nursing)*
France:	*University study (2-3 years study or 4 years study or more)*
Germany:	*University, technical university, teacher college (PH), or specialized higher vocational education (Fachhochschule)*
Greece:	*University education*
Hungary:	*3-5 year course at university, technical college, economical college, or teacher training college*
Iceland:	*University study (3 years of study or longer)*
Italy:	*University degree program*
Lithuania:	*Attend university*
New Zealand:	*University, teacher college, or academic courses at polytechnic*
Norway:	*University study (up to 3-year course or 4 or more years)*
Russian Federation:	*University or other higher educational institute*
Slovenia:	*University study (4 years or more)*
South Africa:	*University or technikon (3-4 year practically-oriented program)*
Sweden:	*University study (up to 3 years or for 3 years or longer)*
Switzerland:	*University, technical university (ETH), teacher college, or specialized higher vocational education (Fachhochschule)*

Vocationally Oriented Programs

International Version: *Vocational or technical courses at a trade or business school or Vocational or technical subjects at a junior or community college*

Australia:	*Apprenticeship or vocational/technical courses at trade/business school*
Austria:	*Apprenticeship (Lehre/Berufsschule) or other occupational training (e.g. health or medical technician, physical therapist)*
Cyprus:	*Vocational/technical training at trade/business school or at higher technical institute*
Czech Republic:	*Extension course*
Denmark:	*Short commercial/technical education*
France:	*Technical institute (BTS, DUT)*
Germany:	*Part-time (Lehre/Berufsschule) or full-time vocational training*
Greece:	*Vocational or teaching courses at a commercial/professional school or at a college (e.g. private or state institute of vocational training)*
Hungary:	*Short vocational training courses*
Iceland:	*Less than 3 years Post secondary vocational study at university, technical school, or technical university, or vocational study in an upper secondary vocational or business school*
Italy:	*Post secondary professional training*
Lithuania:	*Vocational/argicultural high school or vocational/technical courses at trade/business school*
Netherlands:	*Higher Post secondary vocational program (HBO), long senior secondary vocational program (MBO), or short senior secondary vocational program (KMBO).*
New Zealand:	*Vocational/technical study at polytechnic (1-3 year program) or at trade/business school*
Norway:	*Short vocational training or vocational/technical study at vocational school (1-3 year program)*
Russian Federation:	*Vocational/technical courses or short vocational program at college (2 years).*
Slovenia:	*Vocational program at trade/business school or vocational/technical program at a vocational school*
South Africa:	*Vocational/technical courses at trade/business school or technical college*
Sweden:	*Vocationally-oriented courses (up to 1 year)*
Switzerland:	*Postsecondary vocational training or further Upper secondary vocational training (Lehre/Berufsschule)*

Other

International Version: *Academic courses at a junior or community college or Other postsecondary education*

Australia:	*Academic courses at a TAFE (technical and further education) college or other*
Austria:	*Other*
Cyprus:	*Academic courses at college or other*
Czech Republic:	*Other*
Denmark:	*Education for public service or other*
France:	*Other*
Germany:	*Other*
Greece:	*Academic courses at a college or other*
Hungary:	*Other*
Iceland:	*Matriculation exam or other*
Italy:	*Short university course or other*
Lithuania:	*Attend college or other*
Netherlands:	*Other*
New Zealand:	*Other*
Norway:	*Other*
Russian Federation:	*Special courses to prepare for university exam or other*
Slovenia:	*Other*
Sweden:	*Continuing adult education (komvux, folkhögskola) or other*
South Africa:	*Academic courses at private or community college or other*
Switzerland:	*Other*

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Educational options were adapted in each country to conform to their national systems. Countries that used modified response options are indicated to aid in the interpretation of the reporting categories in Tables 4.6, 7.11, and 10.10. Countries not included in figure used translated options considered to be comparable to the internationally-defined options.

* See Appendix A for characteristics of the students sampled.

What Are Students' Attitudes and Perceptions About Mathematics and Science?

Students generally reported positive perceptions about their performance in mathematics and science. Table 4.7 indicates that in all countries, the majority of students agreed that they usually did well in each subject. The highest perceptions of success in mathematics were reported in Australia, Denmark, Italy, and the United States, where 70% or more of the students agreed that they usually did well. Perceptions of doing well in science were generally higher; in 12 countries – Australia, Austria, Canada, the Czech Republic, Denmark, Iceland, Italy, Lithuania, Norway, the Russian Federation, South Africa, and the United States – more than 70% of students agreed that they usually did well.

Students' relative performance in mathematics literacy and science literacy within countries supported their perceptions, with the mean performance of those who agreed that they usually did well exceeding the mean performance of those who did not in almost every country. Students' perceptions of their achievement were less consistent with performance across countries.

Table 4.7

Students' Reports on Their Self-Perceptions About Usually Doing Well in Mathematics and Science – Mathematics Literacy and Science Literacy

Final Year of Secondary School*

Country	Doing Well in Mathematics				Doing Well in Science			
	Agree or Strongly Agree		Disagree or Strongly Disagree		Agree or Strongly Agree		Disagree or Strongly Disagree	
	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement
Australia	72 (1.8)	544 (7.8)	28 (1.8)	477 (10.6)	73 (2.5)	554 (7.4)	27 (2.5)	470 (8.7)
Austria	59 (1.9)	533 (5.6)	41 (1.9)	501 (6.5)	77 (1.5)	532 (5.4)	23 (1.5)	494 (8.1)
Canada	67 (2.3)	542 (3.1)	33 (2.3)	476 (4.9)	75 (1.5)	548 (3.0)	25 (1.5)	489 (3.4)
Cyprus	68 (2.2)	456 (2.4)	32 (2.2)	425 (6.1)	61 (2.5)	461 (4.0)	39 (2.5)	427 (6.0)
Czech Republic	55 (3.1)	487 (14.9)	45 (3.1)	441 (7.8)	71 (1.7)	500 (9.0)	29 (1.7)	463 (9.1)
Denmark	76 (1.0)	566 (3.4)	24 (1.0)	498 (6.2)	r 72 (1.1)	535 (4.2)	28 (1.1)	469 (5.0)
France	63 (2.3)	543 (5.6)	37 (2.3)	492 (4.5)	50 (1.9)	515 (5.6)	50 (1.9)	461 (5.7)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	55 (1.3)	504 (3.8)	45 (1.3)	458 (3.4)	60 (1.2)	488 (3.9)	40 (1.2)	451 (3.0)
Iceland	68 (1.1)	552 (2.3)	32 (1.1)	497 (2.8)	79 (1.2)	564 (1.8)	21 (1.2)	509 (3.4)
Italy	70 (1.9)	485 (5.4)	30 (1.9)	457 (8.4)	86 (1.4)	484 (5.1)	14 (1.4)	433 (9.3)
Lithuania	54 (1.2)	488 (5.8)	46 (1.2)	449 (6.8)	84 (0.9)	464 (5.8)	16 (0.9)	446 (7.0)
Netherlands	63 (1.7)	581 (5.0)	37 (1.7)	527 (5.1)	63 (2.3)	570 (6.3)	37 (2.3)	540 (6.0)
New Zealand	66 (1.8)	557 (4.9)	34 (1.8)	456 (4.5)	68 (1.7)	557 (5.6)	32 (1.7)	471 (6.2)
Norway	57 (1.7)	562 (4.4)	43 (1.7)	485 (4.3)	73 (1.4)	560 (4.2)	27 (1.4)	501 (4.5)
Russian Federation	58 (1.8)	494 (6.8)	42 (1.8)	441 (6.3)	78 (1.4)	489 (6.2)	22 (1.4)	457 (5.8)
Slovenia	62 (2.2)	534 (7.9)	38 (2.2)	482 (9.3)	67 (1.6)	530 (8.5)	33 (1.6)	499 (8.9)
South Africa	58 (2.7)	367 (10.0)	42 (2.7)	353 (8.8)	73 (2.1)	349 (9.9)	27 (2.1)	366 (15.8)
Sweden	62 (1.2)	583 (4.1)	38 (1.2)	507 (4.7)	66 (1.5)	586 (4.7)	34 (1.5)	515 (4.1)
Switzerland	69 (2.1)	560 (4.6)	31 (2.1)	506 (8.7)	66 (1.7)	546 (5.8)	34 (1.7)	489 (6.3)
United States	76 (1.2)	476 (3.7)	24 (1.2)	423 (3.5)	83 (0.9)	491 (3.5)	17 (0.9)	440 (4.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

An "x" indicates data available for <50% students.

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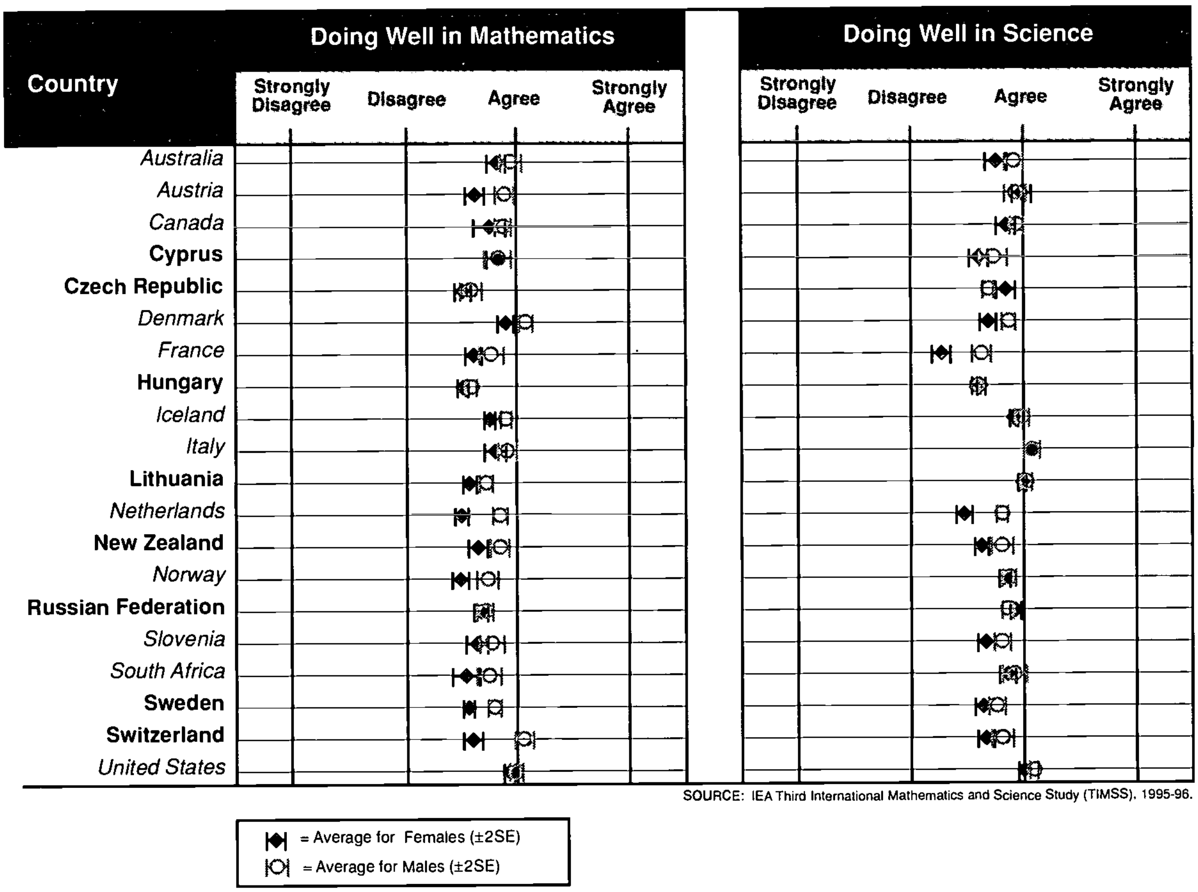
Figure 4.3 depicts gender differences in students' self-perceptions about their performance in mathematics and science. The perceptions of male and female students were quite similar in most countries, although when there were differences, it was generally a greater percentage of males than females who agreed that they were doing well. In Austria, Denmark, Iceland, Lithuania, the Netherlands, New Zealand, Norway, Sweden, and Switzerland, a greater percentage of males than females agreed that they were doing well in mathematics. In Denmark, France, the Netherlands, New Zealand, and Sweden there was a significant gender difference favoring males in self-perceptions about doing well in science. In the Czech Republic, however, females had significantly higher self-perceptions about doing well in science than did males.

To collect information on their attitudes towards mathematics and science, TIMSS asked final-year students how much they liked mathematics and the sciences. Students' liking of these subjects may be considered as both an input and an outcome variable, because it can be related to educational achievement in ways that reinforce higher or lower performance. That is, students who do well in mathematics and science generally have more positive attitudes towards these subjects and thus tend to perform better.

Figure 4.3

Gender Differences in Students' Self-Perceptions About Usually Doing Well in Mathematics and Science
Final Year of Secondary School*



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Data are not available for Germany.

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Table 4.8 summarizes students' responses to the question about how much they like or dislike mathematics. In almost all countries, the majority of students reported that they liked mathematics to some degree. Only in Austria, the Czech Republic, Hungary, and Lithuania did more than half the students report that they disliked mathematics. In every country, a positive relationship was observed between liking mathematics and mathematics literacy. In every country, the average literacy scores of those who reported liking mathematics a lot were substantially higher than the scores of those who reported disliking it a lot.

The data in Figure 4.4 reveal that, on average, in most of the countries there was no significant difference between males and females in degree of liking for mathematics. However, more male students reported liking mathematics in France, Iceland, Sweden, and Switzerland. In no country did a greater percentage of females report liking mathematics.

Students' reports on how much they liked the sciences are summarized in Table 4.9. There were quite marked differences in the degree of liking for the different disciplines. Students in almost all countries expressed greater liking of biological science and earth science than of chemistry and physics. In almost all countries, 60% or more of the students reported liking biology to some degree. Sixty percent or more of the students reported liking earth science in more than half the countries. Only in South Africa did so many students report liking chemistry and physics.

There were striking differences across the science subjects between males' and females' liking of the sciences (Figure 4.5). Significant differences were rare between males and females in their liking for earth science and in their liking for chemistry. However, in many countries female students reported liking biological science more than did male students. The opposite was found in all countries for physics, where the male students reported liking physics significantly more than did female students. In fact, on average, the female students reported disliking physics to some degree in nearly all countries, while the male students were more neutral in their attitude.

Table 4.8

Students' Reports on How Much They Like Mathematics – Mathematics Literacy
Final Year of Secondary School*

Country	Dislike a Lot		Dislike		Like		Like a Lot	
	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement
Australia	14 (1.3)	455 (10.4)	25 (1.6)	513 (6.5)	47 (2.2)	538 (10.6)	14 (1.3)	578 (9.5)
Austria	20 (1.4)	490 (7.7)	33 (1.3)	513 (7.1)	33 (1.4)	539 (5.2)	14 (1.3)	550 (7.9)
Canada	17 (1.5)	476 (7.3)	22 (1.2)	501 (5.4)	46 (1.5)	529 (4.4)	15 (1.0)	573 (6.3)
Cyprus	14 (1.7)	405 (7.9)	18 (1.8)	423 (6.2)	47 (2.1)	451 (4.5)	21 (1.4)	480 (6.3)
Czech Republic	19 (1.8)	435 (9.6)	48 (2.1)	447 (12.8)	28 (2.8)	501 (11.7)	5 (0.8)	575 (12.7)
Denmark	7 (0.9)	460 (8.7)	14 (0.9)	506 (6.0)	44 (1.3)	551 (3.4)	34 (1.2)	586 (5.4)
France	10 (1.2)	466 (7.9)	24 (1.7)	500 (5.8)	56 (1.8)	536 (5.0)	10 (1.1)	566 (9.8)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	26 (1.1)	444 (3.7)	35 (0.9)	478 (3.4)	33 (0.9)	505 (3.9)	6 (0.5)	568 (6.1)
Iceland	7 (0.7)	472 (8.1)	25 (0.7)	504 (4.2)	47 (1.3)	538 (3.7)	21 (1.3)	587 (3.9)
Italy	17 (1.4)	447 (10.3)	29 (1.6)	472 (7.3)	37 (1.5)	477 (5.5)	17 (1.5)	513 (9.4)
Lithuania	14 (0.9)	439 (9.0)	37 (1.1)	460 (7.1)	41 (1.3)	483 (5.7)	8 (0.5)	510 (7.6)
Netherlands	- -	- -	- -	- -	- -	- -	- -	- -
New Zealand	18 (1.6)	468 (9.6)	29 (1.7)	491 (7.3)	42 (1.5)	547 (5.6)	11 (0.8)	592 (9.7)
Norway	19 (1.1)	463 (4.9)	25 (1.0)	507 (4.8)	41 (1.2)	551 (4.7)	14 (1.0)	595 (7.4)
Russian Federation	6 (0.6)	442 (11.4)	32 (1.6)	449 (6.5)	52 (1.5)	480 (7.3)	10 (0.6)	511 (6.1)
Slovenia	14 (1.6)	453 (15.5)	26 (1.4)	495 (8.4)	48 (1.7)	526 (7.2)	12 (1.8)	576 (12.2)
South Africa	r 8 (1.1)	334 (9.1)	14 (1.4)	363 (11.8)	40 (1.9)	367 (11.4)	38 (2.1)	372 (10.1)
Sweden	13 (0.8)	468 (5.6)	29 (1.1)	521 (4.9)	42 (1.0)	574 (3.9)	16 (0.9)	625 (6.0)
Switzerland	17 (1.6)	486 (9.5)	23 (1.2)	520 (7.0)	42 (1.2)	556 (4.8)	17 (1.3)	587 (8.1)
United States	13 (0.9)	414 (3.7)	21 (0.8)	446 (4.2)	45 (1.1)	465 (3.8)	21 (0.8)	509 (6.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

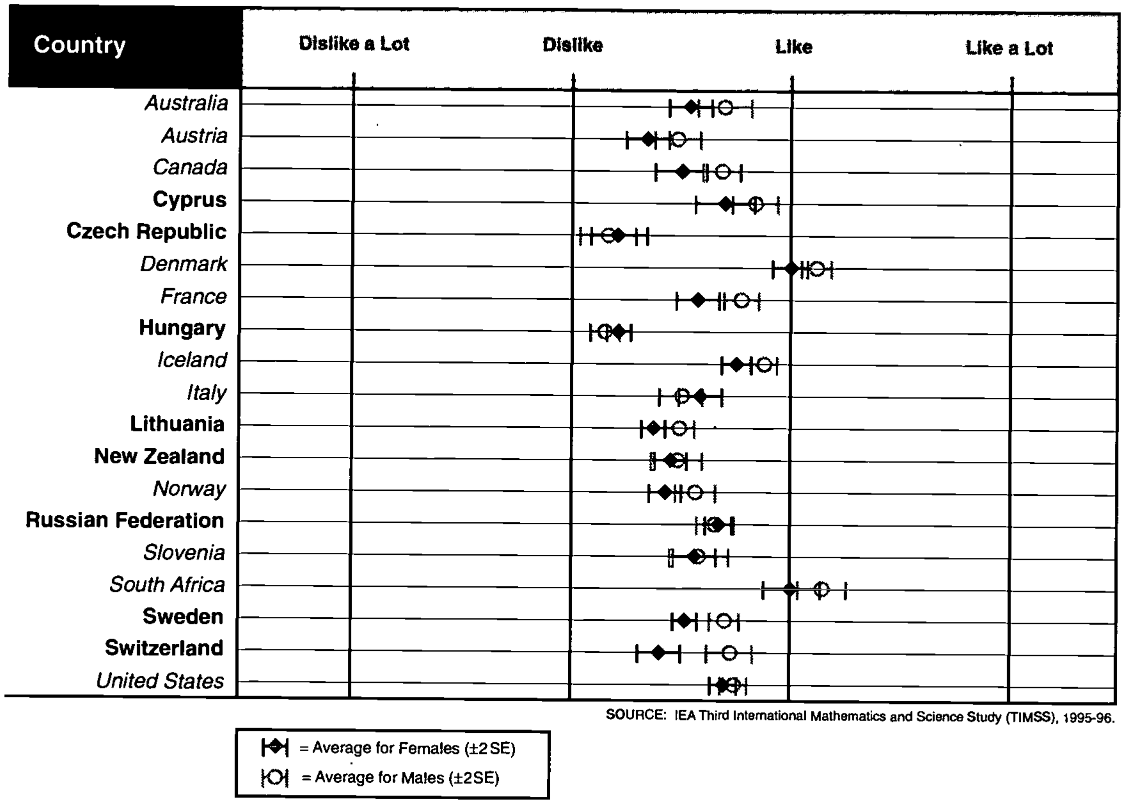
An "r" indicates a 70-84% student response rate.

An "x" indicates data available for <50% students.

A dash (-) indicates data are not available.

Figure 4.4

Gender Differences in Liking Mathematics
Final Year of Secondary School*



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Data are not available for Germany.

Table 4.9

Students' Reports on How Much They Like the Sciences
Final Year of Secondary School*

Country	Percent of Students Reporting That They "Like" or "Like a Lot"†			
	Biological Science	Chemistry	Earth Science	Physics
Australia	** 60 (2.6)	** 37 (2.8)	** 53 (2.2)	** 34 (3.3)
Austria	72 (2.4)	** 38 (2.4)	61 (2.3)	** 36 (2.1)
Canada	70 (1.7)	50 (1.4)	** 71 (2.1)	** 44 (2.3)
Cyprus	62 (2.6)	42 (2.1)	** 27 (2.5)	48 (1.9)
Czech Republic	60 (2.0)	29 (2.1)	66 (1.9)	26 (2.6)
Denmark	61 (1.9)	41 (1.5)	59 (1.7)	43 (1.6)
France	62 (2.9)	45 (1.6)	57 (2.5)	43 (2.3)
Germany	x x	x x	x x	x x
Hungary	63 (1.3)	24 (1.1)	61 (1.1)	28 (1.3)
Iceland	86 (1.2)	59 (1.3)	** 65 (1.6)	** 51 (1.3)
Italy	63 (2.1)	42 (2.2)	70 (1.7)	45 (2.0)
Lithuania	66 (1.6)	28 (1.3)	76 (1.2)	33 (1.5)
Netherlands	x x	x x	x x	x x
New Zealand	** 63 (1.9)	** 38 (1.7)	** 55 (2.4)	** 35 (1.7)
Norway	** 61 (1.6)	** 43 (1.5)	58 (1.5)	** 41 (1.7)
Russian Federation	72 (1.3)	45 (2.0)	72 (1.2)	54 (1.7)
Slovenia	54 (2.2)	29 (2.0)	69 (2.4)	35 (2.9)
South Africa	88 (1.3)	** 67 (3.0)	** 68 (2.4)	** 71 (2.7)
Sweden	69 (1.5)	46 (1.3)	72 (1.0)	47 (2.0)
Switzerland	65 (2.3)	46 (1.8)	71 (1.6)	44 (1.5)
United States	67 (0.9)	49 (1.6)	68 (1.1)	** 47 (1.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† Percentages exclude students reporting that they have not studied the science subjects.

** More than 20% of students report that they have not studied the science subject.

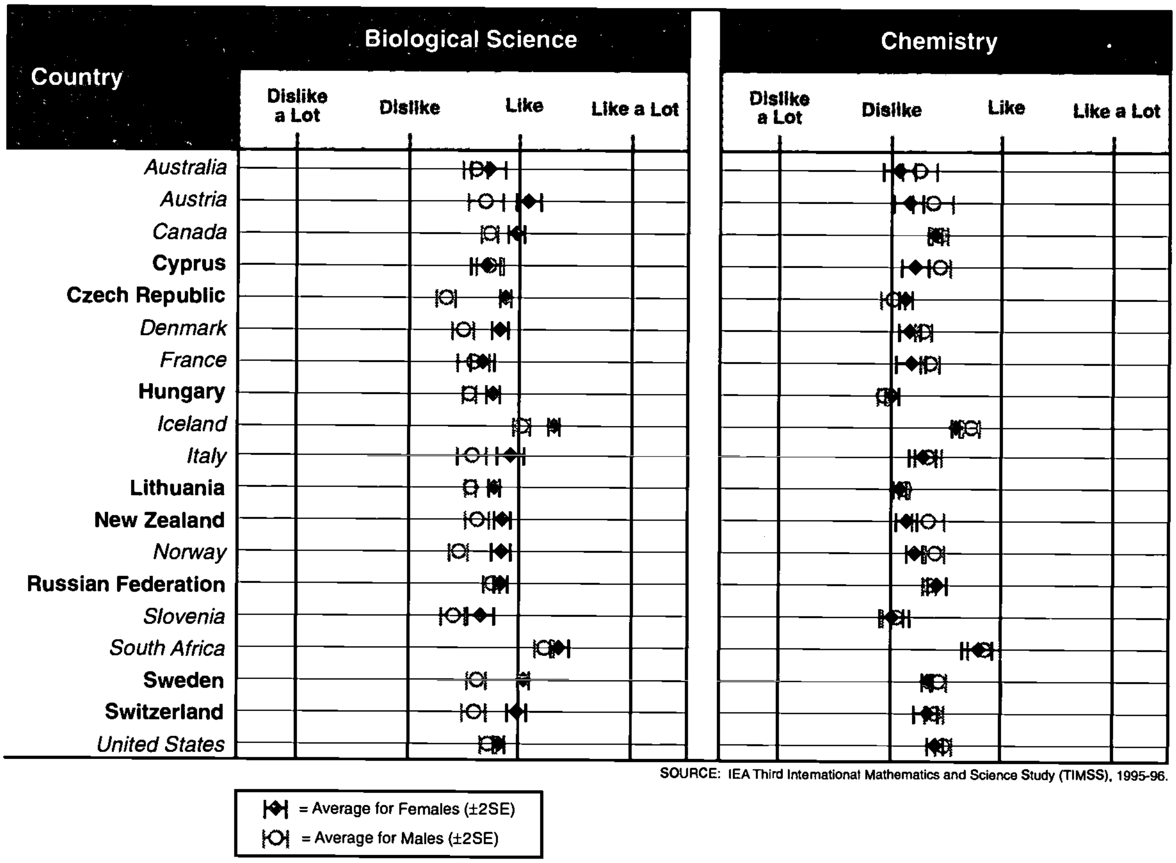
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

An "x" indicates data available for <50% students.

Figure 4.5

Gender Differences in Liking the Sciences† Final Year of Secondary School*



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Averages exclude students reporting that they have not studied the science subjects.

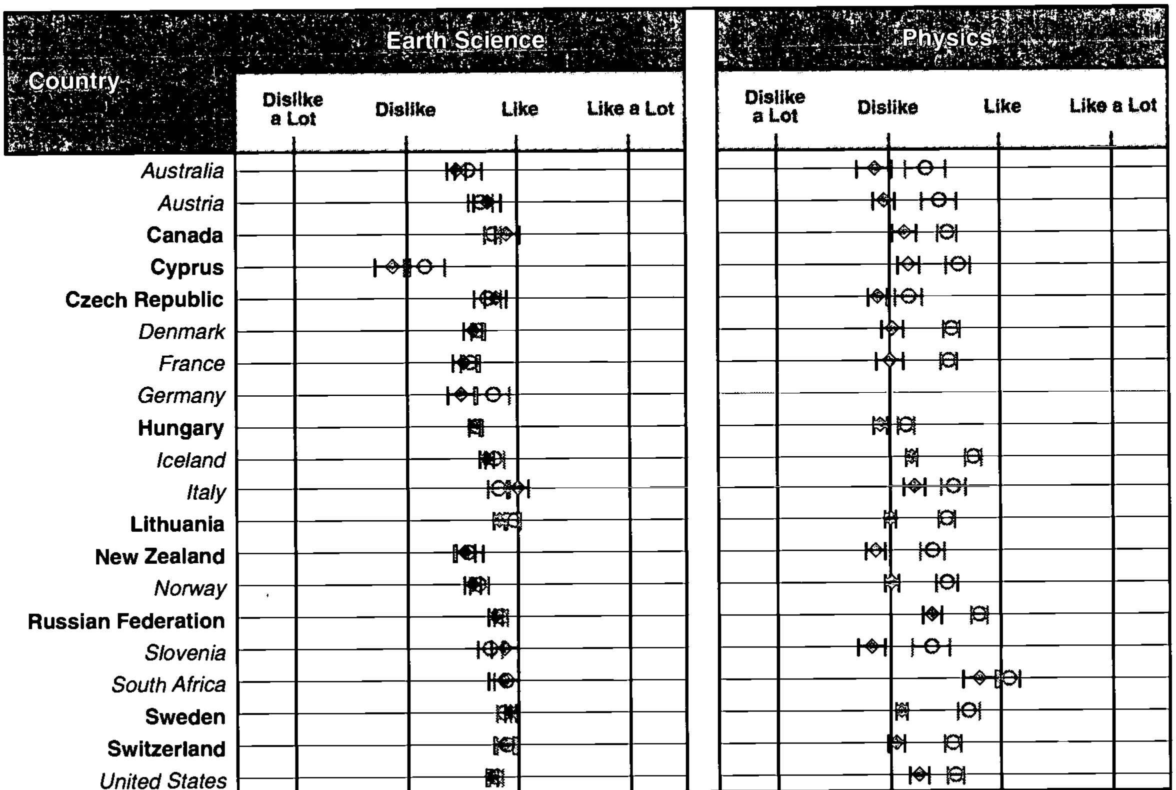
* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Data are not available for Germany and the Netherlands.

Figure 4.5 (Continued)

Gender Differences in Liking the Sciences†
Final Year of Secondary School*



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

= Average for Females (±2SE)
= Average for Males (±2SE)

† Averages exclude students reporting that they have not studied the science subjects.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

Data are not available for Germany and the Netherlands.

What Educational Resources Do Students Have in Their Homes?

Parental education is a useful indicator of the support for academic endeavor that is often associated with student achievement. 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 4.10 presents the relationship between final-year students' mathematics and science literacy and the highest level of education of either parent. Results are presented at three levels: finished university, finished upper secondary school but not university, and finished primary but not upper secondary school. These levels are based on internationally defined categories, which may not be strictly comparable across countries due to differences in national education systems. Although most countries translated and defined the educational categories used in their questionnaires so as to be comparable to the internationally defined levels, some countries used modified response options to conform to their national systems.

Despite the different educational approaches, structures, and organizations across the TIMSS countries, it is clear from Table 4.10 that parents' education is positively related to students' mathematics and science literacy. As was the case for eighth-graders,[1] in every country final-year students whose parents had more education had higher mathematics and science literacy. The percentages of final-year students falling into each of the internationally defined categories agree well with the percentages reported by eighth grade students, although relatively fewer final-year students than eighth-grade students reported that they did not know their parents' educational levels, particularly in Denmark, France, New Zealand, and Sweden. The percentage of students reporting parents' educational levels corresponding to each category varied considerably across countries. More than 30% of students in Canada, Iceland, Lithuania, the Russian Federation, and the United States indicated that at least one parent had finished university, while in contrast, more than 30% of students in Australia, Cyprus, the Czech Republic, France, Italy, and South Africa reported that the highest level attained by either parent was to finish primary but not upper secondary school.

[1] 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: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College; 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.

Table 4.10

Students' Reports on the Highest Level of Education of Either Parent†
Mathematics and Science Literacy
Final Year of Secondary School*

Country	Finished University[1]		Finished Upper Secondary but Not University[2]		Finished Primary but Not Upper Secondary[3]		Do Not Know	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	26 (2.1)	580 (7.9)	39 (2.0)	526 (6.8)	32 (2.3)	497 (9.7)	3 (0.7)	467 (18.5)
Austria	11 (0.9)	559 (8.5)	73 (1.5)	521 (5.2)	12 (0.9)	506 (13.4)	5 (1.0)	465 (12.3)
Canada	44 (1.9)	547 (3.4)	40 (1.4)	519 (4.4)	12 (0.9)	498 (7.0)	4 (0.4)	485 (11.4)
Cyprus	18 (1.5)	492 (8.6)	35 (2.0)	447 (5.2)	41 (2.2)	430 (3.1)	6 (1.2)	426 (9.3)
Czech Republic	18 (1.3)	544 (12.8)	42 (1.6)	494 (9.9)	38 (1.9)	440 (10.2)	3 (0.8)	441 (12.9)
Denmark	21 (1.1)	555 (4.7)	61 (1.4)	529 (4.0)	10 (0.6)	514 (5.6)	8 (0.9)	479 (8.1)
France	16 (2.3)	545 (9.2)	38 (1.4)	517 (4.6)	38 (1.7)	485 (6.7)	8 (0.8)	468 (9.3)
Germany	28 (2.0)	528 (6.3)	67 (2.0)	496 (5.2)	6 (1.2)	409 (15.9)	- -	- -
Hungary	26 (0.9)	521 (5.2)	67 (0.9)	465 (2.9)	7 (0.5)	434 (5.9)	- -	- -
Iceland	31 (1.1)	565 (2.7)	51 (1.5)	536 (2.6)	17 (1.1)	522 (4.1)	1 (0.2)	~ ~
Italy	12 (1.9)	512 (13.5)	43 (1.8)	489 (5.7)	45 (2.2)	456 (6.1)	1 (0.2)	~ ~
Lithuania	41 (2.0)	477 (5.8)	50 (1.7)	460 (6.7)	6 (0.7)	450 (11.7)	3 (0.4)	434 (13.9)
Netherlands	11 (1.5)	598 (12.8)	66 (1.5)	568 (5.0)	10 (0.8)	512 (8.2)	13 (1.1)	528 (7.3)
New Zealand	28 (1.3)	562 (5.0)	39 (1.6)	523 (5.4)	27 (1.6)	510 (6.4)	6 (1.1)	463 (13.6)
Norway	23 (1.5)	569 (5.9)	52 (1.3)	533 (4.8)	14 (0.9)	516 (6.3)	11 (0.8)	506 (7.2)
Russian Federation	41 (2.1)	505 (6.2)	53 (2.1)	460 (5.8)	3 (0.6)	411 (9.2)	2 (0.3)	~ ~
Slovenia	29 (2.7)	548 (9.1)	59 (2.0)	509 (8.2)	12 (1.4)	476 (9.2)	1 (0.2)	~ ~
South Africa	11 (1.9)	418 (26.0)	30 (2.6)	386 (14.8)	44 (3.2)	332 (4.9)	15 (1.2)	314 (3.8)
Sweden	28 (1.3)	590 (4.8)	42 (1.1)	560 (5.3)	17 (0.9)	534 (5.2)	13 (0.8)	520 (8.1)
Switzerland	14 (0.8)	576 (5.5)	69 (1.9)	537 (5.9)	14 (1.5)	479 (11.4)	4 (0.5)	479 (10.7)
United States	35 (1.9)	521 (4.2)	52 (1.4)	462 (3.5)	8 (1.0)	415 (5.7)	4 (0.7)	413 (11.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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 4.6 for definitions and national adaptations of the international options in each educational category.

* See Appendix A for characteristics of the students sampled.

1 In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

2 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.

3 Finished primary or some secondary school not equivalent to completion of upper secondary.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

Figure 4.6 shows the international definitions of the educational categories used for reporting parents' education level and the modifications made to them by some countries to conform to their national education systems. In several countries, the first category – finished primary school but not upper secondary school – 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 middle secondary education was considered part of this category, while in Austria, which has an education system similar to Germany's, middle-level vocational education was included with the second category, upper secondary education.

The second reporting category – finished upper secondary school but not university – was complicated because in many countries, particularly in Europe, several upper secondary tracks lead to university or other tertiary institutions as well as to vocational/apprenticeship programs. In most countries, finishing upper secondary school means completion of 11 to 13 years of education. In some systems, however, 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 education system or considered as postsecondary. All of the upper secondary tracks and any upper secondary or postsecondary 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 last category – 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, and the United States, the finished university category includes the completion of the equivalent of a bachelor's degree at a university, college, or polytechnic institute, while in Austria and France, this category corresponds to the equivalent of a master's degree received at a university.

Figure 4.6

National Adaptations of the Definitions of Educational Levels for Parents' Highest Level of Education†

Final Year of Secondary School*

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)*
Czech Republic:	*Primary or secondary or vocational training without maturita*
Denmark:	*Basic school (Folkeskolen, Realeksamen; 9 or 10 grades)*
France:	*No school, primary, or lower secondary (College, CAP)*
Germany:	*No lower secondary (8 grades); 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*
Sweden:	*Compulsory (9 grades) or started upper secondary*
Switzerland:	*Compulsory (9 grades)*

Finished Upper Secondary School[1] 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 technical/vocational or* *Postsecondary: finished college.*
Denmark:	*Upper secondary tracks: academic or general/vocational (gymnasium, hf, htx, hhx) or vocational training (erhvervsfaglig uddannelse)* *Postsecondary: medium-cycle higher education (mellemlang uddannselse)*
France:	*Upper secondary tracks: BEP (11 grades) or baccalauréat (général, technologique or professionnel; 12 or 13 grades)* *Postsecondary: 2 or 3 years university study after baccalauréat (BTS, DUT, Licence)*
Germany:	*Upper secondary tracks: general/academic or apprenticeship/vocational training (Lehrabschluß, Berufsfachschule, Berufsaufbauschule)* *Postsecondary: vocational schools (Fachschulabschluss)*
Greece:	*Upper secondary: general or technical/vocational Lyceum* *Postsecondary: 4-years at technical institute or some university*
Hungary:	*Upper secondary tracks: apprenticeship (3-year trade school) or final exam in secondary (4-year academic/vocational)*
Italy:	*Upper secondary tracks: completion of secondary with maturita (classical/technical) or vocational training*
Norway:	*Upper secondary tracks: general or vocational programs* *Postsecondary: vocational training or 1-3 years study at university or technical college*
Sweden:	*Upper secondary tracks: academic or vocational (gymnasieutbildning or yrkesinriktad utbildning)* *Postsecondary: less than 3 years of university studies*
Switzerland:	*Upper secondary tracks: vocational (Lehre/Berufsschule), academic (gymnasium, kantonsschule, maturität) or teacher training (Lehrer seminar)* *Postsecondary: Higher vocational/professional school (Fach- and Berufsschule)*

Finished University

Internationally-Defined Levels: *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 university study after baccalauréat*
Germany:	*University, technical university, teacher college or specialized higher vocational degree (Fachhochschulabschluss)*
Hungary:	*University or college diploma*
New Zealand:	*University or teachers' college*
Norway:	*More than 3 years study at university or technical college*
Sweden:	*3 years university studies or more*
Switzerland:	*University or technical university (ETH)*
United States:	*Bachelor's degree at college or university*

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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 Tables 4.10, 7.10, and 10.9. Countries not included in figure used translated options considered to be comparable to the internationally-defined options.

* See Appendix A for characteristics of the students sampled.

[1] Upper secondary corresponds to ISCED level 3 tracks terminating after 11 to 13 years in most countries. (*Education at a Glance*, OECD, Paris, 1996).

The number of books in the home can be an indicator of a home environment that values literacy and the acquisition of knowledge and offers general academic support. Table 4.11 presents final-year students' reports about the number of books in their homes in relation to their achievement on the TIMSS mathematics and science literacy test. In TIMSS reports on fourth and eighth grades,[2] it was noted that in most countries there was a consistent association between students' reports of books in the home and achievement: the more books in the home, the higher students' mathematics and science achievement. This link between books in the home and student achievement is apparent also in the final year of secondary school, with the difference in mean achievement between those reporting most and least books as much as a full standard deviation (100 scale-score points) in several countries.

Although the main purpose of this question was to gain some information about the importance of academic pursuits in students' homes rather than to determine the actual number of books there, students' responses revealed some interesting variations from country to country. Only in South Africa did a large percentage of students report relatively few books in the home, while in Australia, Denmark, Hungary, Iceland, Norway, and Sweden, 40% or more of the students reported more than 200. The number of books in the home reported by final-year students in most countries agreed well with the number reported by their compatriots in fourth and eighth grades.

[2] Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College; Martin, M.O., Mullis, I.V.S., Beaton, A.E., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1997). *Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College; 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: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College; 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.

Table 4.11

Students' Reports on the Number of Books in the Home – Mathematics and Science Literacy
Final Year of Secondary School*

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	2 (0.4)	~ ~	7 (1.3)	466 (15.3)	23 (1.6)	499 (9.6)	26 (1.5)	528 (8.1)	43 (2.6)	555 (7.8)
Austria	4 (0.7)	455 (10.5)	11 (1.0)	480 (9.5)	33 (1.5)	507 (6.9)	19 (1.1)	529 (6.7)	33 (2.1)	550 (6.8)
Canada	3 (0.4)	494 (20.7)	10 (0.8)	502 (8.0)	28 (1.2)	513 (6.0)	26 (1.2)	524 (5.1)	33 (1.6)	549 (3.4)
Cyprus	5 (1.1)	417 (14.8)	14 (1.1)	418 (8.3)	38 (2.4)	439 (5.2)	28 (2.2)	459 (5.9)	15 (1.6)	481 (9.1)
Czech Republic	1 (0.4)	~ ~	4 (0.9)	417 (10.4)	28 (1.6)	442 (7.6)	30 (1.2)	479 (14.0)	37 (1.5)	510 (13.3)
Denmark	3 (0.4)	459 (12.3)	5 (0.6)	487 (8.9)	24 (1.0)	509 (6.1)	26 (1.3)	524 (4.5)	41 (1.7)	553 (3.9)
France	3 (0.6)	419 (13.4)	11 (1.2)	465 (7.4)	37 (1.5)	497 (5.0)	24 (1.1)	521 (5.7)	26 (1.5)	529 (7.0)
Germany	6 (0.9)	428 (10.5)	13 (1.2)	440 (10.6)	26 (1.4)	482 (6.0)	20 (1.4)	515 (8.4)	35 (2.4)	532 (7.5)
Hungary	1 (0.2)	~ ~	4 (0.4)	405 (5.9)	18 (0.8)	437 (3.6)	22 (0.6)	469 (3.3)	54 (1.2)	501 (3.7)
Iceland	1 (0.3)	~ ~	5 (0.5)	504 (10.2)	21 (0.8)	520 (5.0)	24 (1.2)	541 (3.6)	49 (1.2)	557 (2.2)
Italy	4 (0.7)	417 (12.4)	19 (1.5)	444 (7.4)	37 (1.8)	476 (6.5)	22 (1.4)	489 (5.6)	18 (1.5)	505 (9.6)
Lithuania	1 (0.2)	~ ~	9 (0.8)	430 (13.0)	30 (1.2)	447 (6.7)	28 (0.9)	469 (6.0)	33 (1.7)	489 (6.2)
Netherlands	6 (0.8)	514 (10.6)	14 (1.1)	536 (10.0)	34 (1.3)	548 (5.5)	21 (1.5)	566 (7.4)	26 (1.9)	589 (11.6)
New Zealand	3 (0.8)	430 (21.6)	6 (0.9)	469 (17.6)	26 (1.6)	508 (5.7)	25 (1.4)	520 (7.7)	39 (1.9)	558 (4.6)
Norway	2 (0.4)	~ ~	7 (0.6)	489 (6.8)	22 (1.0)	509 (4.3)	20 (0.9)	535 (5.6)	49 (1.4)	557 (4.7)
Russian Federation	3 (0.4)	447 (13.1)	9 (1.0)	434 (11.3)	30 (2.0)	457 (6.9)	30 (1.8)	484 (4.6)	29 (1.3)	504 (6.8)
Slovenia	1 (0.4)	~ ~	6 (1.0)	468 (15.5)	35 (2.4)	502 (10.5)	25 (1.8)	522 (9.2)	32 (2.4)	538 (8.4)
South Africa	31 (2.2)	313 (3.0)	26 (1.6)	338 (5.1)	21 (1.8)	372 (12.0)	10 (1.2)	410 (21.2)	12 (1.7)	413 (22.7)
Sweden	2 (0.3)	~ ~	7 (0.6)	506 (8.7)	24 (1.1)	535 (5.0)	23 (1.0)	555 (5.0)	43 (1.2)	580 (5.0)
Switzerland	6 (0.9)	458 (9.3)	11 (1.1)	489 (10.5)	28 (1.7)	522 (6.7)	23 (1.4)	540 (6.4)	32 (1.1)	561 (6.4)
United States	6 (0.7)	402 (7.0)	12 (0.8)	429 (4.7)	29 (1.2)	456 (3.5)	20 (1.0)	484 (4.4)	33 (1.6)	510 (3.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

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How Often Do Students Use Calculators and Computers?

Although the issue of how calculators should be deployed by students and teachers so as to maximize students' learning remains a matter of debate, it is clear from Table 4.12 that calculator use is now widespread among final-year students in many countries. In most countries, more than 80% of students reported at least weekly use of calculators, including all activities whether at home, at school, or anywhere else. Only in the Czech Republic, Norway, and the Russian Federation did 20% or more of the students report rarely or never using calculators. The frequent use of calculators was positively related to mathematics and science literacy in all countries, with students who reported using calculators daily performing, on average, well above those who rarely or never used them.

Since calculator use by students in upper secondary school is very common in many countries, final-year students were given the option of using a calculator when completing the TIMSS tests. Table 4.13 summarizes students' reports on how frequently they used a calculator during the testing session. Most students made moderate use (i.e., for up to 10 questions) of a calculator on the mathematics and science test, although in Italy, Lithuania, the Russian Federation, Slovenia, and South Africa, more than 30% reported not using a calculator at all. In general, the students who reported most calculator use were also those who performed best on the test. It is not clear, however, whether calculator use assisted performance on the test, or whether the more able students were also those who chose to use a calculator most.

While calculator use by final-year students was widespread, these students reported using computers much less frequently. As may be seen from Table 4.14, in seven countries, Cyprus, the Czech Republic, Hungary, Italy, Lithuania, Norway, and South Africa, the majority of students reported that they rarely or never use a computer. In contrast, more than one-fourth of the students in Australia, Canada, Denmark, Iceland, the Netherlands, New Zealand, Switzerland, and the United States reported using a computer daily. In about half of the countries, the students who reported using a computer most frequently were also those with the highest performance on mathematics and science literacy, but in the rest the relationship was less regular.

Table 4.12

Students' Reports on How Often They Use a Calculator at School, Home, or Anywhere Else – Mathematics and Science Literacy

Final Year of Secondary School*

Country	Rarely or Never		Monthly		Weekly		Daily	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	6 (0.9)	458 (14.3)	4 (0.6)	461 (13.0)	17 (1.2)	497 (10.1)	73 (1.9)	544 (8.4)
Austria	6 (2.3)	465 (30.7)	5 (0.9)	505 (13.7)	37 (2.3)	516 (5.2)	52 (3.2)	532 (6.7)
Canada	8 (0.8)	482 (6.9)	7 (1.0)	478 (12.3)	23 (1.4)	513 (5.4)	61 (2.2)	543 (2.9)
Cyprus	8 (1.5)	405 (11.2)	7 (1.0)	422 (13.1)	18 (1.7)	437 (6.2)	66 (1.8)	457 (3.6)
Czech Republic	21 (1.9)	428 (8.9)	13 (2.0)	459 (6.1)	43 (2.4)	476 (10.1)	23 (3.3)	533 (11.8)
Denmark	8 (1.1)	482 (3.4)	5 (0.6)	492 (4.7)	19 (1.5)	508 (5.8)	67 (2.2)	543 (4.5)
France	4 (0.8)	471 (14.2)	7 (1.3)	468 (11.3)	25 (1.6)	489 (5.2)	63 (2.4)	519 (5.7)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	14 (0.9)	423 (4.0)	2 (0.2)	~ ~	16 (0.8)	453 (4.0)	68 (1.4)	496 (3.4)
Iceland	10 (1.2)	506 (6.0)	6 (0.8)	516 (7.9)	24 (0.8)	530 (3.3)	59 (0.9)	557 (2.5)
Italy	12 (1.4)	436 (11.1)	7 (1.0)	460 (10.4)	36 (2.0)	474 (5.9)	45 (2.3)	491 (7.0)
Lithuania	12 (1.6)	437 (12.4)	6 (0.5)	452 (13.3)	31 (1.3)	455 (5.9)	50 (2.0)	480 (5.7)
Netherlands	10 (1.5)	461 (6.4)	4 (0.7)	467 (9.0)	16 (1.3)	537 (7.4)	69 (2.4)	585 (5.7)
New Zealand	11 (1.1)	465 (8.9)	7 (1.0)	472 (9.5)	20 (1.7)	492 (8.3)	62 (2.1)	554 (4.0)
Norway	31 (2.1)	502 (5.1)	9 (0.8)	519 (7.8)	17 (1.0)	526 (5.1)	44 (2.1)	567 (5.3)
Russian Federation	22 (1.2)	453 (6.0)	8 (0.8)	466 (8.4)	31 (1.6)	480 (6.3)	39 (2.1)	496 (6.2)
Slovenia	5 (1.4)	424 (14.0)	4 (0.9)	472 (21.6)	29 (1.7)	512 (9.3)	62 (2.9)	528 (7.9)
South Africa	14 (1.9)	317 (3.1)	8 (0.7)	314 (5.2)	14 (0.9)	338 (8.7)	63 (2.3)	375 (12.6)
Sweden	13 (1.0)	487 (6.1)	9 (0.7)	508 (5.1)	43 (1.5)	536 (3.7)	35 (1.7)	619 (4.5)
Switzerland	5 (1.6)	471 (11.5)	2 (0.6)	~ ~	42 (2.1)	508 (6.8)	51 (2.1)	559 (4.2)
United States	16 (1.1)	419 (4.5)	8 (0.7)	443 (6.0)	24 (1.1)	464 (4.0)	52 (1.9)	497 (3.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

An "x" indicates data available for <50% of students.

A tilde (~) indicates insufficient data to report achievement.

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Table 4.13

Students' Reports on the Frequency of Calculator Use During the TIMSS Test Mathematics and Science Literacy Final Year of Secondary School*

Country	Did Not Use a Calculator		Used a Calculator Very Little (<5 Questions)		Used a Calculator Somewhat (5-10 Questions)		Used a Calculator Quite a Lot (>10 Questions)	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	13 (2.3)	455 (14.3)	36 (1.7)	531 (9.4)	39 (2.1)	551 (6.4)	12 (1.2)	548 (7.4)
Austria	17 (3.3)	480 (12.4)	35 (1.7)	532 (6.9)	40 (2.3)	531 (5.4)	9 (1.1)	536 (13.1)
Canada	12 (1.1)	464 (7.4)	35 (1.4)	529 (3.9)	39 (1.1)	537 (3.0)	14 (1.1)	553 (7.0)
Cyprus	22 (1.5)	431 (6.7)	48 (2.1)	450 (5.1)	26 (1.9)	456 (6.1)	4 (0.8)	484 (14.4)
Czech Republic	13 (4.8)	448 (24.6)	39 (3.5)	461 (14.9)	41 (2.5)	494 (12.0)	7 (1.0)	512 (15.0)
Denmark	9 (1.3)	488 (6.7)	32 (1.2)	540 (3.8)	44 (1.6)	533 (4.5)	15 (1.0)	550 (5.4)
France	r 13 (1.8)	475 (8.3)	33 (2.0)	514 (5.7)	44 (2.0)	519 (5.0)	10 (1.2)	538 (8.5)
Germany	r 18 (2.9)	448 (14.0)	41 (2.6)	503 (7.0)	31 (2.7)	524 (5.7)	10 (1.4)	538 (14.4)
Hungary	s 20 (1.7)	453 (4.8)	28 (1.2)	485 (5.2)	42 (1.5)	516 (4.2)	10 (0.6)	540 (5.5)
Iceland	24 (1.3)	512 (3.9)	29 (1.1)	537 (3.1)	37 (1.3)	561 (2.7)	10 (0.8)	579 (5.2)
Italy	31 (2.2)	451 (8.7)	31 (1.9)	484 (8.4)	31 (2.0)	490 (6.5)	7 (0.9)	479 (9.9)
Lithuania	r 38 (2.2)	442 (10.7)	25 (1.5)	483 (6.1)	30 (1.5)	497 (6.3)	7 (0.7)	513 (9.4)
Netherlands	11 (1.8)	479 (9.4)	29 (1.7)	560 (5.4)	46 (1.8)	572 (5.9)	14 (1.0)	591 (10.9)
New Zealand	12 (1.7)	436 (8.3)	26 (1.3)	519 (8.5)	48 (1.7)	542 (5.3)	15 (1.5)	562 (5.7)
Norway	21 (2.1)	500 (7.2)	26 (1.3)	529 (5.8)	40 (1.5)	552 (4.2)	13 (0.9)	580 (6.7)
Russian Federation	r 41 (2.7)	467 (7.0)	28 (1.5)	483 (7.1)	24 (1.6)	496 (8.1)	7 (0.9)	509 (12.1)
Slovenia	r 32 (4.4)	495 (15.8)	36 (2.5)	536 (9.8)	27 (2.8)	547 (7.7)	4 (0.7)	528 (19.8)
South Africa	r 55 (4.3)	346 (10.6)	25 (2.5)	362 (10.5)	13 (1.8)	409 (25.7)	8 (1.2)	382 (30.5)
Sweden	8 (1.1)	486 (11.1)	30 (1.1)	554 (6.6)	48 (1.2)	565 (4.6)	15 (0.8)	575 (5.0)
Switzerland	6 (1.0)	491 (11.0)	32 (1.6)	536 (6.6)	47 (1.8)	535 (4.5)	16 (1.4)	546 (10.1)
United States	29 (1.9)	432 (4.7)	35 (1.2)	479 (4.2)	31 (1.3)	498 (4.1)	5 (0.6)	516 (10.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 report rate.

Table 4.14

Students' Reports on How Often They Use a Computer at School, Home, or Anywhere Else† - Mathematics and Science Literacy Final Year of Secondary School*

Country	Rarely or Never		Monthly		Weekly		Daily	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	25 (3.5)	498 (9.7)	13 (1.0)	529 (10.2)	28 (1.4)	534 (9.5)	34 (2.9)	544 (9.4)
Austria	34 (3.4)	496 (8.9)	7 (0.7)	525 (8.3)	39 (2.7)	529 (5.7)	20 (2.6)	546 (12.2)
Canada	21 (1.7)	500 (8.2)	16 (0.9)	513 (6.5)	34 (1.3)	535 (3.9)	28 (1.4)	544 (5.1)
Cyprus	65 (2.0)	436 (3.3)	9 (1.3)	461 (9.8)	17 (2.2)	476 (10.6)	9 (1.5)	454 (10.3)
Czech Republic	62 (3.9)	450 (8.5)	9 (1.1)	483 (31.3)	20 (3.5)	524 (9.2)	9 (1.1)	552 (11.4)
Denmark	18 (1.2)	501 (5.3)	14 (1.3)	528 (7.2)	41 (1.6)	529 (4.1)	27 (1.5)	549 (4.5)
France	48 (2.2)	502 (6.0)	17 (1.7)	523 (8.4)	25 (1.4)	503 (5.3)	10 (1.3)	507 (9.5)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	r 65 (1.9)	471 (3.1)	4 (0.3)	478 (7.7)	19 (1.3)	500 (5.4)	12 (1.1)	525 (9.3)
Iceland	19 (0.9)	505 (3.7)	15 (0.7)	533 (6.5)	40 (1.0)	551 (3.4)	26 (1.0)	563 (3.4)
Italy	56 (2.2)	465 (5.4)	10 (0.8)	486 (7.9)	23 (1.8)	486 (11.1)	12 (1.3)	509 (12.5)
Lithuania	69 (2.1)	460 (6.7)	8 (0.7)	471 (8.8)	19 (1.9)	481 (8.0)	4 (0.4)	482 (9.7)
Netherlands	26 (1.4)	543 (7.7)	13 (1.0)	563 (10.3)	34 (1.3)	562 (5.5)	26 (1.6)	570 (7.1)
New Zealand	27 (1.8)	511 (8.3)	17 (1.6)	536 (8.2)	27 (1.5)	537 (5.4)	29 (1.7)	522 (7.2)
Norway	54 (1.9)	522 (3.8)	13 (1.1)	527 (7.4)	19 (1.1)	556 (6.4)	14 (1.1)	571 (8.3)
Russian Federation	47 (2.0)	468 (7.9)	9 (0.9)	487 (9.9)	32 (1.4)	483 (5.0)	12 (1.0)	504 (8.0)
Slovenia	38 (2.2)	492 (7.5)	15 (1.1)	511 (9.1)	26 (1.7)	531 (10.2)	21 (1.7)	546 (9.3)
South Africa	81 (2.5)	345 (6.2)	6 (1.1)	415 (27.0)	7 (1.3)	436 (22.5)	6 (0.9)	420 (20.3)
Sweden	32 (1.4)	518 (4.6)	18 (1.1)	549 (4.4)	31 (1.2)	566 (4.4)	19 (2.2)	614 (6.8)
Switzerland	38 (2.2)	501 (7.7)	9 (0.6)	556 (8.4)	24 (1.6)	549 (6.2)	28 (1.9)	550 (6.0)
United States	27 (1.1)	435 (3.9)	16 (1.1)	474 (5.9)	27 (1.2)	485 (4.2)	31 (1.1)	494 (4.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Includes both desktop units and mainframe terminals.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 data available for <50% students.

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 students in their final year of secondary school, 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 4.15 presents final-year students' reports about the amount of time they spend in this way on a normal school day. On average, students in most countries reported spending between two to four hours per day on homework. Less than two hours of homework per day was reported by students in the Czech Republic, the Netherlands, Norway, Sweden, and the United States, whereas four hours or more per day, on average, was reported by students in Italy and South Africa. One-fourth or more of the final-year students in Austria, the Czech Republic, the Netherlands, Norway, Sweden, Switzerland, and the United States reported studying for less than one hour per day.

The relationship between time spent doing homework in all subjects and students' average mathematics and science literacy was not consistent across countries. In a few countries, including Australia, Cyprus, Hungary, the Russian Federation, and the United States, the relationship was approximately linear, with students reporting the most time on homework also having the highest scores in mathematics and science literacy. More often, the relationship was curvilinear, the highest achievement being associated with a moderate amount of homework per day (between one and three hours). This pattern suggests that, compared with their higher-achieving counterparts, the lower-performing students may do less homework, whether because they simply 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. Other, more complicated relationships may also be seen in Table 4.15. However, in almost all of the countries, students who reported spending two or more hours studying each day had higher scores in mathematics and science literacy than those spending less than one hour per day.

The amount of time students reported spending on studying or doing homework in mathematics is shown in Table 4.16. Among students taking mathematics in their last year of upper secondary schooling, an average of one-half to one hour of homework was reported in nearly all countries. In only two countries, the Czech Republic and Sweden, did students report an average of less than one-half hour per day, while only in South Africa did they report an average of substantially more than one hour per day. In all countries except South Africa, the majority of students reported spending less than one hour per day on mathematics homework. Fewer than 10% of the students reported spending three hours or more in every country except the Russian Federation and South Africa. In most countries, students spending at least one to two hours per day on mathematics homework had somewhat higher achievement than those spending less, with the largest differences in Australia and Cyprus.

Table 4.15

Students' Reports on the Hours Per Day Spent Studying or Doing Homework†
Mathematics and Science Literacy
Final Year of Secondary School*

Country	Less Than One Hour		At Least 1 Hour But Less Than 2 Hours		2-3 Hours		More Than 3 Hours		Average Hours[1]
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
Australia	13 (1.6)	489 (15.8)	20 (1.5)	527 (12.6)	22 (1.5)	525 (6.5)	44 (2.7)	545 (9.5)	3.3 (0.13)
Austria	31 (2.0)	508 (7.7)	28 (1.4)	533 (6.8)	20 (1.8)	524 (7.9)	20 (1.4)	529 (8.7)	2.0 (0.07)
Canada	18 (1.2)	505 (3.3)	31 (1.7)	527 (5.9)	21 (1.4)	540 (4.7)	30 (2.0)	537 (5.8)	2.7 (0.11)
Cyprus	12 (1.6)	414 (6.4)	20 (1.6)	441 (6.8)	28 (2.1)	444 (5.4)	40 (2.1)	465 (4.0)	3.2 (0.11)
Czech Republic	39 (2.5)	468 (7.7)	31 (1.3)	482 (13.2)	20 (3.0)	498 (9.8)	10 (1.3)	481 (34.2)	1.4 (0.07)
Denmark	r 13 (1.1)	496 (7.1)	31 (1.6)	546 (4.9)	35 (1.6)	543 (4.1)	21 (1.4)	543 (5.1)	r 2.4 (0.06)
France	s 7 (1.1)	498 (11.1)	23 (1.7)	536 (7.9)	19 (1.5)	521 (8.4)	52 (1.9)	523 (6.1)	s 3.4 (0.11)
Germany	- -	- -	- -	- -	- -	- -	- -	- -	- -
Hungary	13 (0.9)	454 (4.4)	26 (0.9)	469 (4.1)	26 (0.9)	482 (4.6)	36 (1.2)	492 (4.2)	2.9 (0.07)
Iceland	21 (1.0)	547 (4.3)	37 (1.2)	552 (3.0)	23 (1.1)	546 (4.3)	19 (1.2)	532 (4.7)	2.1 (0.05)
Italy	8 (1.1)	461 (13.9)	15 (1.6)	472 (7.5)	21 (1.6)	483 (7.2)	56 (2.4)	481 (6.2)	4.0 (0.14)
Lithuania	16 (1.7)	451 (13.7)	21 (1.1)	469 (6.3)	21 (0.9)	473 (6.4)	41 (2.0)	471 (5.5)	3.2 (0.11)
Netherlands	25 (2.2)	527 (8.0)	46 (1.4)	569 (5.2)	16 (1.6)	574 (9.9)	13 (1.3)	572 (12.6)	1.7 (0.06)
New Zealand	20 (2.0)	489 (10.1)	34 (1.9)	539 (7.1)	25 (1.4)	538 (5.2)	22 (1.1)	536 (5.8)	2.2 (0.06)
Norway	27 (1.2)	522 (5.7)	37 (1.0)	547 (5.0)	17 (1.3)	556 (5.8)	19 (1.1)	535 (6.7)	1.9 (0.05)
Russian Federation	10 (0.8)	463 (7.6)	24 (1.4)	467 (6.8)	21 (1.2)	479 (7.0)	45 (1.9)	486 (6.0)	3.5 (0.10)
Slovenia	19 (2.3)	493 (11.7)	36 (3.0)	541 (9.8)	23 (2.1)	508 (7.8)	22 (2.2)	527 (8.7)	2.2 (0.12)
South Africa	r 8 (0.8)	353 (11.9)	13 (1.5)	389 (18.3)	20 (1.5)	370 (15.9)	59 (2.2)	360 (9.2)	r 4.8 (0.17)
Sweden	28 (1.6)	533 (5.5)	34 (1.2)	575 (5.7)	20 (1.2)	565 (5.9)	19 (1.4)	560 (6.7)	1.9 (0.07)
Switzerland	28 (1.9)	520 (6.1)	34 (1.2)	544 (8.0)	21 (1.4)	535 (7.5)	17 (1.1)	545 (7.6)	2.0 (0.06)
United States	34 (1.7)	452 (3.7)	34 (1.1)	481 (4.9)	18 (0.9)	479 (5.9)	15 (1.1)	501 (7.9)	1.7 (0.06)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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† Study time is defined as the sum of time reported spent studying or doing homework in mathematics, science, and other subjects.

* See Appendix A for characteristics of the students sampled.

[1] Based on sum of responses to three questions about time spent studying or doing homework for mathematics, science, and other subjects. Categorization and 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.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

A dash (-) indicates data are not available.

Table 4.16

Students' Reports on the Hours Per Day Studying or Doing Mathematics Homework Mathematics Literacy Final Year of Secondary School*

Country	Percent Not Taking Mathematics	Hours Per Day Studying or Doing Mathematics Homework[1]: Less than One Hour		One to Two Hours		Three or More Hours		Average Hours[2]
		Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	Percent of Students	Mean Mathematics Literacy Achievement	
Australia	13 (2.2)	59 (2.2)	521 (8.3)	36 (2.2)	557 (10.2)	5 (0.8)	534 (13.4)	1.0 (0.04)
Austria	26 (3.6)	77 (1.7)	526 (5.8)	19 (1.6)	533 (9.4)	4 (0.8)	502 (13.7)	0.6 (0.04)
Canada	46 (2.6)	56 (2.1)	539 (5.1)	38 (1.9)	547 (5.0)	7 (1.0)	526 (14.6)	1.1 (0.05)
Cyprus	0 (0.0)	63 (2.1)	435 (4.3)	29 (1.8)	471 (4.8)	8 (1.3)	451 (9.0)	1.0 (0.05)
Czech Republic	5 (2.1)	92 (1.5)	464 (13.8)	8 (1.4)	482 (17.8)	0 (0.2)	~ ~	0.4 (0.03)
Denmark	22 (2.4)	68 (2.0)	571 (4.9)	28 (1.6)	563 (4.7)	4 (0.7)	562 (11.9)	0.9 (0.04)
France	0 (0.0)	59 (2.3)	517 (5.1)	35 (2.3)	539 (6.7)	5 (0.7)	505 (14.7)	1.0 (0.04)
Germany	- -	- -	- -	- -	- -	- -	- -	- -
Hungary	0 (0.0)	74 (0.9)	480 (3.2)	24 (0.8)	496 (5.5)	2 (0.2)	~ ~	0.7 (0.02)
Iceland	35 (1.0)	79 (1.1)	553 (3.2)	19 (1.1)	542 (7.0)	2 (0.4)	~ ~	0.7 (0.02)
Italy	12 (3.3)	55 (2.6)	479 (6.3)	40 (2.2)	486 (7.2)	5 (0.9)	477 (11.2)	1.0 (0.05)
Lithuania	10 (2.1)	67 (1.8)	472 (5.8)	29 (1.7)	480 (5.2)	4 (0.5)	484 (11.5)	0.8 (0.03)
Netherlands	40 (2.6)	82 (1.7)	606 (6.2)	16 (1.6)	581 (11.1)	1 (0.3)	~ ~	0.7 (0.03)
New Zealand	27 (1.8)	75 (1.4)	544 (6.1)	23 (1.4)	552 (5.9)	2 (0.3)	~ ~	0.7 (0.03)
Norway	32 (2.5)	85 (1.4)	541 (5.1)	14 (1.3)	558 (9.5)	1 (0.3)	~ ~	0.5 (0.03)
Russian Federation	0 (0.1)	56 (2.0)	463 (5.9)	33 (1.4)	484 (7.5)	11 (1.2)	494 (8.1)	1.2 (0.06)
Slovenia	5 (2.7)	72 (2.7)	521 (9.4)	25 (2.6)	518 (9.5)	2 (0.6)	~ ~	0.7 (0.05)
South Africa	31 (2.9)	33 (1.8)	394 (17.1)	51 (1.8)	375 (10.9)	17 (1.2)	344 (7.2)	1.7 (0.05)
Sweden	30 (2.0)	90 (0.9)	579 (5.4)	9 (0.9)	580 (7.8)	1 (0.2)	~ ~	0.4 (0.02)
Switzerland	39 (3.2)	67 (1.6)	569 (4.9)	28 (1.3)	550 (5.6)	5 (0.9)	522 (10.6)	0.9 (0.04)
United States	34 (1.9)	76 (1.5)	475 (3.8)	22 (1.5)	486 (5.9)	2 (0.2)	~ ~	0.7 (0.02)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Percentages based on those students reporting currently taking mathematics.

[2] Average hours computed based on: No time = 0; Less than 1 hour = .5; 1-2 hours =1.5; 3-5 hours = 4; More than 5 hours = 7.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

Students' reports about doing science homework (Table 4.17) show a similar pattern to mathematics with respect to both the amount of homework and the relationship to science literacy achievement. Although the average amount of science homework reported by students taking at least one science course is somewhat less than what was reported by mathematics students, it is still between one-half and one hour in most countries. The highest level of science homework was again reported by South African students, with an average of one and one-half hours. As was found for mathematics, most students in all countries except South Africa reported spending less than one hour, and only a small percentage reported spending three hours or more. In many countries, the average science literacy achievement was highest for students studying science between one and two hours per day.

The students were also asked about other ways they could spend their time out of school: watching television, playing computer games, spending time with friends, doing jobs at home, working at a paid job, playing sports, and reading books for enjoyment. Their reports are summarized in Table 4.18. Socializing is clearly an important activity for final-year students, with students in many countries devoting up to about two and one-half hours each day to spending time with friends – about as much time as they devote to their studies. Watching television or videos is the next most popular pastime, although final-year students report spending less time at this than fourth or eighth graders. Playing computer games is much less popular, although students in about half of the countries report spending between 20 and 30 minutes daily on average on this pastime. Sports also occupy an important role in students' lives, with students in most countries reporting more than one hour each day, but this is less than the time eighth graders reported spending on sports, perhaps reflecting final-year students' increased involvement in paid employment. The time spent on leisure activities is not additive, because students do many of these activities simultaneously (e.g., talk with friends, watch television).

Whereas students in most countries reported about one hour each day, on average, doing jobs at home, many also reported significant time working at a paid job. There was a wide range across countries in this respect, from the Russian Federation, where students reported very little working time, to the United States, where they reported spending more than three hours a day on average in paid employment. Table 4.19 presents further details, including the average mathematics and science literacy of students reporting working for different amounts of time. In about half the countries, most final-year students (more than 80%) reported working at a paid job for less than one hour each day. However, in Australia, Canada, Iceland, the Netherlands, New Zealand, Norway, and the United States, at least one-fourth of students reported working for three hours or more each day.

Table 4.17

Students' Reports on the Hours Per Day Studying or Doing Science Homework
Science Literacy
Final Year of Secondary School*

Country		Percent Not Taking Science	Hours Per Day Studying or Doing Science Homework[1]: Less than One Hour		One to Two Hours		Three or More Hours		Average Hours[2]
			Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	Percent of Students	Mean Science Literacy Achievement	
Australia		27 (3.6)	58 (1.8)	540 (9.5)	35 (1.7)	575 (6.9)	7 (1.0)	588 (33.0)	1.0 (0.04)
Austria		12 (1.7)	87 (1.4)	529 (6.0)	11 (1.4)	526 (13.8)	1 (0.3)	~ ~	0.4 (0.03)
Canada		45 (2.2)	57 (2.1)	554 (4.2)	35 (1.8)	567 (6.8)	8 (0.9)	537 (18.0)	1.1 (0.05)
Cyprus		0 (0.0)	80 (1.1)	436 (3.7)	16 (0.9)	483 (10.7)	4 (0.6)	552 (11.8)	0.5 (0.03)
Czech Republic		66 (5.7)	84 (2.6)	520 (11.6)	14 (2.3)	571 (11.5)	3 (0.5)	583 (13.6)	0.5 (0.05)
Denmark	r	58 (2.3)	73 (1.8)	555 (4.7)	25 (1.6)	570 (6.1)	3 (0.6)	565 (15.0)	0.7 (0.03)
France	s	35 (2.4)	59 (2.0)	497 (5.7)	35 (1.8)	525 (7.0)	6 (0.8)	515 (9.1)	1.0 (0.04)
Germany		- -	- -	- -	- -	- -	- -	- -	- -
Hungary		22 (1.9)	67 (1.2)	475 (3.9)	27 (0.9)	486 (4.9)	6 (0.6)	497 (11.5)	0.9 (0.03)
Iceland		37 (1.2)	87 (1.0)	566 (2.5)	12 (1.0)	575 (4.6)	1 (0.3)	~ ~	0.4 (0.01)
Italy		19 (2.8)	70 (2.8)	487 (6.3)	25 (2.5)	482 (9.7)	5 (1.2)	462 (13.9)	0.8 (0.06)
Lithuania		12 (2.4)	69 (1.5)	465 (5.5)	26 (1.3)	469 (6.5)	5 (0.6)	470 (11.4)	0.8 (0.03)
Netherlands		43 (3.3)	78 (2.8)	593 (6.4)	20 (2.9)	605 (16.9)	1 (0.4)	~ ~	0.7 (0.03)
New Zealand		32 (1.6)	80 (1.1)	551 (6.3)	18 (1.1)	581 (6.6)	3 (0.5)	553 (15.3)	0.6 (0.02)
Norway		63 (2.7)	74 (2.4)	592 (7.1)	23 (2.2)	598 (10.8)	3 (0.7)	583 (23.8)	0.7 (0.05)
Russian Federation		0 (0.1)	61 (1.6)	478 (6.0)	30 (1.3)	488 (7.0)	10 (0.8)	501 (8.0)	1.1 (0.04)
Slovenia		16 (2.8)	85 (2.0)	528 (8.1)	13 (1.9)	548 (8.9)	2 (0.6)	~ ~	0.5 (0.04)
South Africa	r	8 (1.1)	47 (1.6)	373 (15.5)	35 (1.3)	367 (12.2)	18 (1.4)	326 (7.3)	1.5 (0.05)
Sweden		57 (2.0)	81 (1.9)	599 (7.4)	17 (1.8)	632 (10.1)	2 (0.5)	~ ~	0.6 (0.03)
Switzerland		50 (2.6)	76 (2.3)	564 (6.6)	21 (2.3)	564 (10.9)	3 (0.9)	508 (29.0)	0.7 (0.04)
United States		47 (1.7)	76 (2.1)	505 (4.3)	21 (2.1)	517 (5.7)	2 (0.4)	~ ~	0.7 (0.04)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Percentages based on those students reporting currently taking at least one science course (biology, chemistry, physics, earth science, or other science).

[2] 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.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Table 4.18

Students' Reports on How They Spend Their Leisure Time on a Normal School Day† Mathematics and Science Literacy

Final Year of Secondary School*

Country	Average Hours Watching Television or Videos	Average Hours Playing Computer Games	Average Hours Spending Time with Friends Outside of School	Average Hours Doing Jobs at Home	Average Hours Working at a Paid Job	Average Hours Playing Sports	Average Hours Reading a Book for Enjoyment
Australia	1.8 (0.06)	0.3 (0.03)	1.3 (0.06)	0.8 (0.03)	1.4 (0.09)	1.1 (0.07)	0.6 (0.04)
Austria	1.5 (0.06)	0.2 (0.02)	2.3 (0.08)	0.9 (0.05)	0.5 (0.04)	1.0 (0.04)	0.8 (0.02)
Canada	1.6 (0.04)	0.2 (0.01)	2.0 (0.04)	1.4 (0.11)	2.2 (0.06)	1.1 (0.03)	0.7 (0.03)
Cyprus	1.6 (0.06)	0.2 (0.04)	1.4 (0.07)	0.7 (0.05)	0.6 (0.11)	0.8 (0.06)	0.4 (0.03)
Czech Republic	2.1 (0.07)	0.3 (0.03)	2.7 (0.14)	1.1 (0.07)	1.2 (0.13)	1.3 (0.06)	0.9 (0.05)
Denmark	1.7 (0.03)	0.3 (0.02)	1.9 (0.04)	0.9 (0.06)	1.5 (0.08)	1.3 (0.06)	0.5 (0.02)
France	1.3 (0.06)	0.2 (0.01)	1.4 (0.06)	0.9 (0.07)	0.6 (0.06)	1.0 (0.04)	0.8 (0.04)
Germany	x x	x x	x x	x x	x x	x x	x x
Hungary	2.0 (0.04)	0.4 (0.02)	2.3 (0.05)	1.5 (0.04)	- -	1.2 (0.03)	1.1 (0.03)
Iceland	1.6 (0.04)	0.2 (0.01)	2.4 (0.04)	0.9 (0.05)	1.8 (0.07)	1.1 (0.04)	0.6 (0.02)
Italy	1.5 (0.04)	0.2 (0.02)	2.3 (0.09)	1.0 (0.04)	0.6 (0.08)	0.9 (0.05)	0.7 (0.03)
Lithuania	2.2 (0.07)	0.3 (0.02)	2.4 (0.09)	1.0 (0.03)	0.8 (0.06)	0.9 (0.05)	1.1 (0.03)
Netherlands	2.2 (0.07)	0.3 (0.02)	2.4 (0.07)	0.8 (0.03)	1.8 (0.08)	1.3 (0.05)	0.6 (0.04)
New Zealand	2.1 (0.08)	0.2 (0.02)	1.5 (0.08)	0.9 (0.03)	1.7 (0.07)	1.2 (0.06)	0.7 (0.03)
Norway	1.7 (0.04)	0.2 (0.02)	2.5 (0.07)	0.8 (0.03)	s 1.8 (0.10)	1.2 (0.05)	0.5 (0.02)
Russian Federation	2.5 (0.06)	0.4 (0.03)	2.8 (0.07)	1.6 (0.06)	0.2 (0.04)	0.9 (0.04)	1.4 (0.05)
Slovenia	1.4 (0.07)	0.3 (0.03)	1.7 (0.10)	1.1 (0.09)	0.5 (0.06)	1.0 (0.06)	0.6 (0.03)
South Africa	1.2 (0.06)	r 0.2 (0.03)	1.1 (0.06)	2.2 (0.11)	r 0.9 (0.07)	1.3 (0.06)	1.3 (0.05)
Sweden	1.6 (0.03)	0.2 (0.02)	1.9 (0.05)	0.9 (0.03)	0.5 (0.04)	1.2 (0.04)	0.6 (0.02)
Switzerland	1.2 (0.05)	0.2 (0.02)	2.3 (0.08)	1.1 (0.05)	0.6 (0.06)	1.2 (0.04)	0.6 (0.03)
United States	1.7 (0.05)	0.3 (0.01)	2.3 (0.06)	1.1 (0.04)	3.1 (0.07)	1.3 (0.05)	0.6 (0.03)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 report rate.

An "x" indicates data available for <50% students.

A dash (-) indicates data are not available.

Table 4.19

Students' Reports on the Hours Per Day Spent Working at a Paid Job
Mathematics and Science Literacy
Final Year of Secondary School*

Country	Less Than One Hour		1-2 Hours		3-5 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	68 (2.0)	536 (9.1)	8 (1.1)	532 (8.4)	15 (1.4)	516 (11.3)	10 (1.3)	487 (10.0)
Austria	86 (1.5)	523 (5.3)	8 (1.3)	534 (16.8)	3 (0.4)	504 (13.2)	4 (0.5)	481 (13.2)
Canada	50 (1.3)	535 (3.7)	11 (0.9)	549 (6.5)	23 (1.2)	517 (5.8)	16 (1.0)	498 (4.4)
Cyprus	88 (1.8)	451 (3.1)	3 (0.6)	411 (18.8)	2 (0.8)	~ ~	6 (1.6)	408 (11.9)
Czech Republic	72 (2.3)	486 (11.4)	9 (0.7)	481 (9.6)	8 (1.3)	451 (9.9)	10 (1.4)	439 (4.6)
Denmark	59 (1.8)	538 (3.6)	18 (1.2)	536 (4.3)	13 (0.9)	513 (6.3)	10 (1.1)	487 (7.8)
France	83 (1.4)	512 (5.0)	10 (1.1)	488 (5.7)	4 (0.6)	474 (14.5)	3 (0.7)	463 (8.8)
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	- -	- -	- -	- -	- -	- -	- -	- -
Iceland	55 (1.3)	554 (2.5)	18 (0.9)	544 (3.8)	13 (0.9)	528 (6.1)	13 (0.8)	510 (4.7)
Italy	84 (1.6)	483 (5.5)	7 (0.8)	453 (11.4)	4 (0.5)	456 (10.4)	5 (1.0)	433 (11.9)
Lithuania	83 (1.2)	470 (5.2)	5 (0.4)	469 (12.1)	4 (0.5)	456 (13.2)	8 (0.7)	442 (12.6)
Netherlands	60 (1.6)	571 (6.5)	13 (1.1)	563 (6.4)	10 (0.9)	542 (6.6)	16 (1.0)	526 (7.0)
New Zealand	53 (1.8)	530 (6.0)	20 (1.6)	536 (7.8)	16 (1.2)	521 (10.3)	11 (0.9)	492 (9.3)
Norway	s 61 (2.1)	552 (5.0)	12 (1.0)	544 (8.4)	11 (1.1)	517 (6.6)	16 (1.3)	515 (7.0)
Russian Federation	93 (1.2)	480 (5.8)	4 (0.9)	473 (17.1)	2 (0.3)	~ ~	1 (0.3)	~ ~
Slovenia	89 (1.3)	521 (7.6)	5 (0.7)	508 (14.5)	3 (0.5)	487 (13.3)	4 (0.7)	444 (11.1)
South Africa	r 82 (1.5)	366 (11.0)	4 (0.5)	351 (16.4)	6 (0.8)	337 (10.7)	7 (0.7)	340 (11.9)
Sweden	84 (1.0)	563 (4.2)	8 (0.6)	541 (6.7)	5 (0.5)	511 (9.6)	3 (0.3)	497 (16.6)
Switzerland	83 (1.3)	537 (5.8)	9 (0.9)	532 (10.9)	4 (0.6)	505 (12.0)	4 (0.7)	463 (14.0)
United States	39 (1.3)	484 (5.0)	7 (0.5)	506 (6.8)	27 (1.1)	474 (4.6)	28 (1.1)	448 (4.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) 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 report rate.

An "x" indicates data available for <50% students.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Average mathematics and science literacy was highest among students reporting a low to moderate amount of time daily (two hours or less) working at a paid job. In almost every country, average mathematics and science literacy was lowest among those who reported working for more than five hours each day. This could reflect the fact that students working many hours have less time available for homework, but since mathematics and science literacy as assessed by TIMSS is probably acquired over many years, it also may be that less academically inclined students are choosing to place less emphasis on their studies in favor of an early start in the workplace.

Although final-year students seem to watch television less than do younger students, it still absorbs a significant part of their leisure time (Table 4.20). In many countries, about one-third of students reported watching television for less than one hour each day, and about two-thirds reported between one and five hours. Only in South Africa and Switzerland did a majority of students report watching television for less than one hour each day. In almost every country, there was a negative relationship between achievement in mathematics and science literacy and the amount of time spent watching television, with average achievement being highest among those who reported watching television for less than one hour each day. One notable exception to this pattern is South Africa, where students watching one to five hours of television per day had the highest average literacy achievement. This may reflect the generally higher socio-economic level of students able to watch television, since 57% of the students in South Africa reported watching very little television. Although only about 5% of final-year students in each country reported watching television for more than five hours each day, these were also the students with the lowest average mathematics and science literacy.

Table 4.20

Students' Reports on the Hours Per Day Spent Watching Television or Videos
Mathematics and Science Literacy
Final Year of Secondary School*

Country	Less Than One Hour		1-2 Hours		3-5 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	34 (2.1)	532 (11.0)	44 (2.2)	530 (8.9)	17 (1.5)	527 (7.3)	5 (0.6)	476 (10.5)
Austria	37 (2.2)	532 (8.2)	47 (1.8)	518 (5.0)	14 (1.0)	507 (6.8)	2 (0.4)	~ ~
Canada	38 (1.1)	531 (3.3)	44 (1.4)	528 (3.7)	15 (1.3)	512 (5.7)	3 (0.5)	502 (12.2)
Cyprus	38 (1.9)	451 (5.5)	43 (2.3)	447 (4.2)	16 (1.6)	434 (6.7)	2 (0.7)	~ ~
Czech Republic	21 (2.3)	512 (11.1)	51 (2.7)	479 (10.6)	22 (1.6)	450 (11.6)	5 (1.0)	429 (5.9)
Denmark	32 (1.4)	541 (4.4)	51 (1.3)	526 (3.5)	15 (1.1)	519 (5.9)	2 (0.3)	~ ~
France	49 (2.1)	512 (5.0)	41 (1.7)	503 (6.6)	8 (0.8)	491 (9.4)	2 (0.4)	~ ~
Germany	x x	x x	x x	x x	x x	x x	x x	x x
Hungary	31 (0.9)	505 (4.4)	44 (0.9)	475 (3.4)	19 (0.7)	451 (4.3)	6 (0.5)	426 (5.0)
Iceland	38 (1.1)	555 (4.0)	47 (1.4)	536 (2.9)	14 (1.0)	528 (4.3)	2 (0.3)	~ ~
Italy	36 (1.4)	477 (6.8)	50 (1.6)	477 (6.3)	12 (0.9)	473 (6.9)	2 (0.4)	~ ~
Lithuania	21 (1.0)	473 (6.5)	50 (1.3)	469 (5.3)	24 (1.3)	459 (7.5)	6 (0.7)	439 (12.5)
Netherlands	19 (1.4)	569 (10.4)	49 (1.6)	567 (5.0)	27 (1.7)	547 (5.9)	4 (0.7)	503 (14.0)
New Zealand	28 (1.4)	537 (6.1)	45 (1.6)	527 (4.9)	20 (1.4)	511 (9.7)	7 (1.4)	506 (12.5)
Norway	32 (1.5)	549 (5.0)	50 (1.2)	540 (4.5)	16 (1.0)	505 (5.3)	2 (0.4)	~ ~
Russian Federation	15 (1.2)	490 (8.9)	46 (1.4)	482 (6.4)	31 (1.4)	469 (6.5)	7 (0.8)	451 (8.9)
Slovenia	44 (2.6)	520 (9.2)	44 (2.3)	520 (8.2)	10 (1.1)	486 (14.4)	3 (0.6)	484 (19.0)
South Africa	57 (2.3)	345 (8.9)	29 (2.0)	377 (12.4)	11 (1.1)	389 (17.3)	3 (0.5)	342 (15.5)
Sweden	33 (1.1)	576 (5.3)	51 (1.0)	554 (4.5)	15 (0.7)	526 (7.2)	1 (0.2)	~ ~
Switzerland	55 (2.1)	545 (4.8)	36 (1.7)	521 (7.8)	8 (0.9)	505 (9.3)	2 (0.4)	~ ~
United States	40 (1.5)	483 (4.2)	39 (1.1)	473 (4.1)	15 (0.9)	458 (4.5)	5 (0.4)	424 (7.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

An "x" indicates data available for <50% students.

A tilde (~) indicates insufficient data to report achievement.

What Are Students' Negative School Experiences?

Although it is reasonable to expect schools to provide a secure and supportive environment in which students can devote their full attention to their studies, for some students school can be a threatening or worrisome place. Students' reports on how often they had negative experiences during their last month in school before the TIMSS testing are summarized in Table 4.21. In almost all countries, more than 80% of final-year students reported never having something stolen. However, more than one-fifth of the students in New Zealand, South Africa, and the United States reported having something stolen at least once during that month.

Similarly, students reported that threats from another student are not common in upper secondary schools around the world. In almost all countries, more than 80% of final-year students reported that they were never threatened by another student. The exception was South Africa, where about one-fourth of the students reported being threatened at least once during the past month.

Table 4.21

Students' Reports on How Often They Had Negative Experiences During the Past Month in School – Mathematics and Science Literacy Final Year of Secondary School*

Country	Percent of Students					
	Had Something Stolen			Was Threatened by Another Student		
	Never	Once or Twice	Three times or more	Never	Once or Twice	Three times or more
Australia	83 (1.4)	16 (1.2)	2 (0.4)	92 (0.8)	6 (0.7)	2 (0.6)
Austria	91 (1.2)	8 (1.0)	1 (0.3)	96 (0.5)	3 (0.4)	1 (0.3)
Canada	85 (1.0)	14 (1.0)	1 (0.3)	94 (0.6)	5 (0.6)	1 (0.2)
Cyprus	86 (1.9)	13 (1.8)	1 (0.5)	87 (1.8)	10 (1.7)	2 (0.6)
Czech Republic	82 (1.4)	16 (1.1)	2 (0.5)	93 (1.5)	5 (1.2)	2 (0.5)
Denmark	94 (0.9)	5 (0.8)	1 (0.3)	87 (1.0)	10 (0.8)	3 (0.6)
France	- -	- -	- -	- -	- -	- -
Germany	x x	x x	x x	x x	x x	x x
Hungary	83 (0.8)	15 (0.7)	2 (0.3)	- -	- -	- -
Iceland	97 (0.4)	3 (0.4)	0 (0.1)	98 (0.3)	1 (0.1)	1 (0.3)
Italy	87 (1.1)	11 (0.9)	2 (0.5)	97 (0.5)	2 (0.5)	1 (0.3)
Lithuania	94 (0.5)	5 (0.4)	1 (0.2)	93 (0.7)	5 (0.6)	2 (0.3)
Netherlands	- -	- -	- -	- -	- -	- -
New Zealand	78 (1.6)	20 (1.5)	2 (0.3)	92 (0.8)	7 (0.8)	1 (0.3)
Norway	92 (0.7)	8 (0.7)	0 (0.1)	97 (0.5)	3 (0.4)	1 (0.2)
Russian Federation	94 (0.8)	6 (0.7)	1 (0.2)	94 (0.6)	5 (0.6)	1 (0.2)
Slovenia	94 (1.0)	6 (0.9)	0 (0.2)	93 (1.0)	5 (0.7)	2 (0.4)
South Africa	62 (2.4)	29 (1.7)	8 (1.1)	77 (1.4)	18 (1.1)	6 (0.7)
Sweden	97 (0.3)	3 (0.3)	0 (0.1)	99 (0.2)	1 (0.2)	0 (0.1)
Switzerland	92 (0.8)	8 (0.8)	0 (0.2)	98 (0.4)	1 (0.3)	0 (0.2)
United States	76 (0.9)	21 (0.9)	3 (0.3)	89 (0.8)	8 (0.7)	2 (0.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

An "x" indicates data available for <50% students.

A dash (-) indicates data are not available.

Advanced Mathematics and Physics Achievement in the Final Year of Secondary School

Advanced Mathematics and Physics in the Final Year of Secondary School

Chapter 5

International Student Achievement in Advanced Mathematics

Chapters 5 to 7 present the results for the advanced mathematics test given in the participating countries to the final-year students who had taken advanced mathematics courses. The definition of advanced mathematics courses was left to each country, and it varied (see Appendix A). However, as a point of reference, the students involved had generally taken calculus, trigonometry, higher levels of algebra or geometry, or other advanced mathematics courses. The test questions covered primarily the content areas of equations and functions, calculus, and geometry. Students were permitted to use a calculator if they wished (see Chapter 7 for student reports on calculator use).

Chapter 5 summarizes achievement on the TIMSS advanced mathematics test overall and by gender. Different percentages of students had taken advanced mathematics courses across the participating countries, and coverage of the entire school-leaving population varied by country, as discussed in the introduction. We therefore also examine achievement in advanced mathematics in relation to the percentages of students in the school-leaving age cohort covered by the sample in each country, and provide performance estimates for the top 10% and top 5% of the entire school-leaving age cohort.

How Does Performance Compare for the Students Tested in Advanced Mathematics?

Table 5.1 presents the mean achievement in advanced mathematics for 16 countries participating in this portion of the testing for students in the final year of secondary school.[1] Countries with triangles pointing up next to their mean achievement performed significantly above the international average: France, the Russian Federation, Switzerland, Cyprus, Lithuania, and Denmark. Countries with triangles pointing down had mean achievement significantly below the international average: the Czech Republic, Germany, Austria, and the United States.

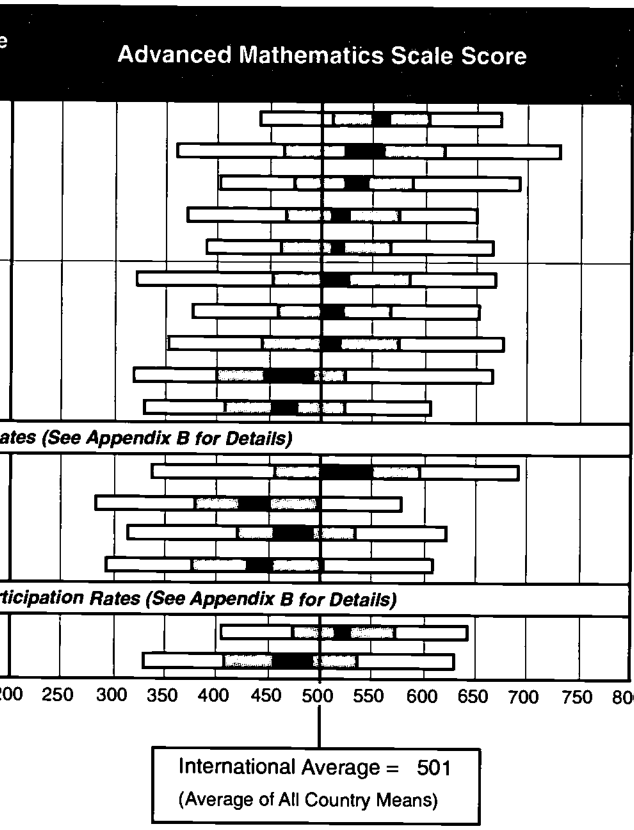
The upper part of the table shows, in decreasing order of mean achievement, the 10 countries that were judged to have met the TIMSS requirements for testing a representative sample of the students having taken advanced mathematics, in accordance with their national definitions. While some countries had more success in locating these advanced students and encouraging them to participate in the testing than they had for the entire school-leaving population, others encountered resistance from schools and students and failed to reach the overall participation rates of 75% or higher (for schools and students combined) specified in the TIMSS

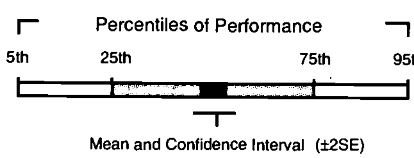
[1] The achievement results for advanced mathematics were derived from all of the advanced mathematics items scaled together. Chapter 6 contains scaled results for the three major content areas within advanced mathematics. For more detailed information about the scaling methods used, see the "IRT Scaling and Data Analysis" section of Appendix B.

Table 5.1

Distributions of Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	Mean	MTCI✦	Average Age
France	▲ 557 (3.9)	20%	18.2
[2] Russian Federation	▲ 542 (9.2)	2%	16.9
Switzerland	▲ 533 (5.0)	14%	19.5
[2] Cyprus	▲ 518 (4.3)	9%	17.7
[1] Lithuania	▲ 516 (2.6)	3%	17.9
† Greece	● 513 (6.0)	10%	17.7
Sweden	● 512 (4.4)	16%	18.9
Canada	● 509 (4.3)	16%	18.5
Czech Republic	▼ 469 (11.2)	11%	18.1
† Germany	▼ 465 (5.6)	26%	19.2
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	● 525 (11.6)	16%	17.8
[2] Austria	▼ 436 (7.2)	33%	19.1
[1] Italy	● 474 (9.6)	14%	19.1
United States	▼ 442 (5.9)	14%	18.0
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	▲ 522 (3.4)	21%	19.2
Slovenia	● 475 (9.2)	75%	18.9





SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ = Country mean significantly higher than international mean

▼ = Country mean significantly lower than international mean

● = No statistically significant difference between country mean and international mean

* See Appendix A for characteristics of students sampled.

✦ The Mathematics TIMSS Coverage Index (MTCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year advanced mathematics student sample (see Appendix B for more information).

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 5.1

Multiple Comparisons of Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics – Final Year of Secondary School*

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	France	Russian Federation	Switzerland	*Australia*	*Denmark*	Cyprus	Lithuania	Greece	Sweden	Canada	*Slovenia*	*Italy*	Czech Republic	Germany	*United States*	*Austria*
France		●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Federation	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	●		●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲
Australia	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲
Denmark	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲
Cyprus	▼	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲
Lithuania	▼	●	▼	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲
Greece	▼	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	●	●	●	●	●	●		▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	●	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●
Austria	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

guidelines (i.e., Australia, Austria, Italy, and the United States). Denmark and Slovenia also had some difficulties in implementing the prescribed sampling methods. Because clear sampling documentation was not available for Israel, Appendix D contains its unweighted results. Appendix B provides detailed information about the sampling for the advanced mathematics test in each country.

As explained in the Introduction, the Mathematics TIMSS Coverage Index (MTCI) reflects the percentage of the entire school-leaving age cohort covered by the student samples for the advanced mathematics testing. The MTCI shows the differing levels of overall sample coverage of this cohort in each country, including omissions of students who have left the educational system (e.g., by dropping out) and sampling exclusions in the three countries so footnoted (the Russian Federation, Cyprus, and Austria). In addition, the MTCI reflects the fact that a relatively small subset of the final-year students in each country have taken the advanced mathematics courses necessary to participate in this portion of the testing, and that the percentage of these students also varies across countries. In general, most participating countries tested 20% or fewer of their school-leaving age cohort in advanced mathematics. Countries with a MTCI below 10% were the Russian Federation (2%), Cyprus (9%), and Lithuania (3%). Countries with a MTCI above 30% were Slovenia (75%) and Austria (33%).

The average age of students gives some idea of the years of formal schooling in the participating countries. Students of similar age, however, have not necessarily had the same number of years of formal schooling, because of different policies regarding the age for starting school and for retention. Further, the students in the TIMSS countries have not studied the same curriculum. The reader is encouraged to consult Appendix A, which provides further detail about the students included in the advanced mathematics testing.

The results in Table 5.1, especially the visual representations of the performance distributions within each country, suggest some similarity in average performance among many of the countries, although there is variation from the top- to the bottom-performing ones. In contrast to the overlapping performance across a number of the countries in their mean achievement (shown by the dark boxes at the distribution midpoints representing the 95% confidence intervals around the means), the range in within-country performance usually was substantial (shown by the 5th and 95th percentiles, representing the extremes of lower and higher achievement).[2]

Figure 5.1 provides a method for comparing countries in terms of mean achievement in advanced mathematics. It shows whether or not the differences in mean achievement between pairs of countries are statistically significant.[3] 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.

[2] Tables of the percentile values and standard deviations for all countries are presented in Appendix E.

[3] The significance tests in Figure 5.1 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 that of another country.

The figure shows that there were essentially two groupings of countries by average performance. The top group, led by France, also included the Russian Federation, Switzerland, Australia, Denmark, Cyprus, Lithuania, Greece, Sweden, and Canada. Among these countries, the Russian Federation (2%) and Lithuania (3%) tested a rather small percentage of their school-leaving age cohort in advanced mathematics, and Australia and Denmark did not meet the TIMSS sampling guidelines. The second group of countries included Slovenia, Italy, the Czech Republic, Germany, the United States, and Austria. Here it should be noted that Slovenia tested three-fourths of its school-leaving age cohort, and Austria (33%) also had a comparatively higher MTCI than the other participants, as did Germany (26%).

How Does Performance in Advanced Mathematics Compare, Taking Differences in Population Coverage into Account?

Figure 5.2 shows the relationship between average performance and the MTCI.[4] The figure reveals that the two countries testing the highest percentages of their school-leaving age cohort (Slovenia and Austria) had lower than average performance in advanced mathematics, but then so did some countries testing smaller percentages of this cohort. Among those countries that performed above the international average, many are clustered in the upper left corner of the graph. However, the MTCI for these countries varied from 2% (the Russian Federation) to 21% (Denmark), and there appears to be little relationship between the MTCI and performance. For example, France, with the highest performance, also had one of the higher coverage indices, testing 20% of its entire school-leaving age cohort in advanced mathematics.

Table 5.2 provides a way of comparing performance in advanced mathematics for the top 10% of the school-leaving age cohort. For the 12 countries where the students tested in advanced mathematics covered more than 10% of the school-leaving age cohort, TIMSS computed the 90th percentile of performance. The 90th percentile is the point on the advanced mathematics scale that divides the higher-performing 10% of the students from the lower-performing 90%. It is used in this table because it can be reliably estimated even when scores from some members of the population are not available (that is, all of the students in the school-leaving age cohort that were not tested in advanced mathematics, including those not attending school). To compute the 90th percentile, TIMSS assumed that those students not tested in advanced mathematics would have scored below the 90th percentile, primarily because they had not taken courses in advanced mathematics. These percentages of students were added to the lower tail of the performance distribution before calculating the 90th percentile using the modified distribution. After calculating the 90th percentile, TIMSS then computed the mean achievement of the top 10% of the students. Because the students tested in Greece only covered 10% of the school-leaving age cohort, the data reflect the mean performance of all the students tested.

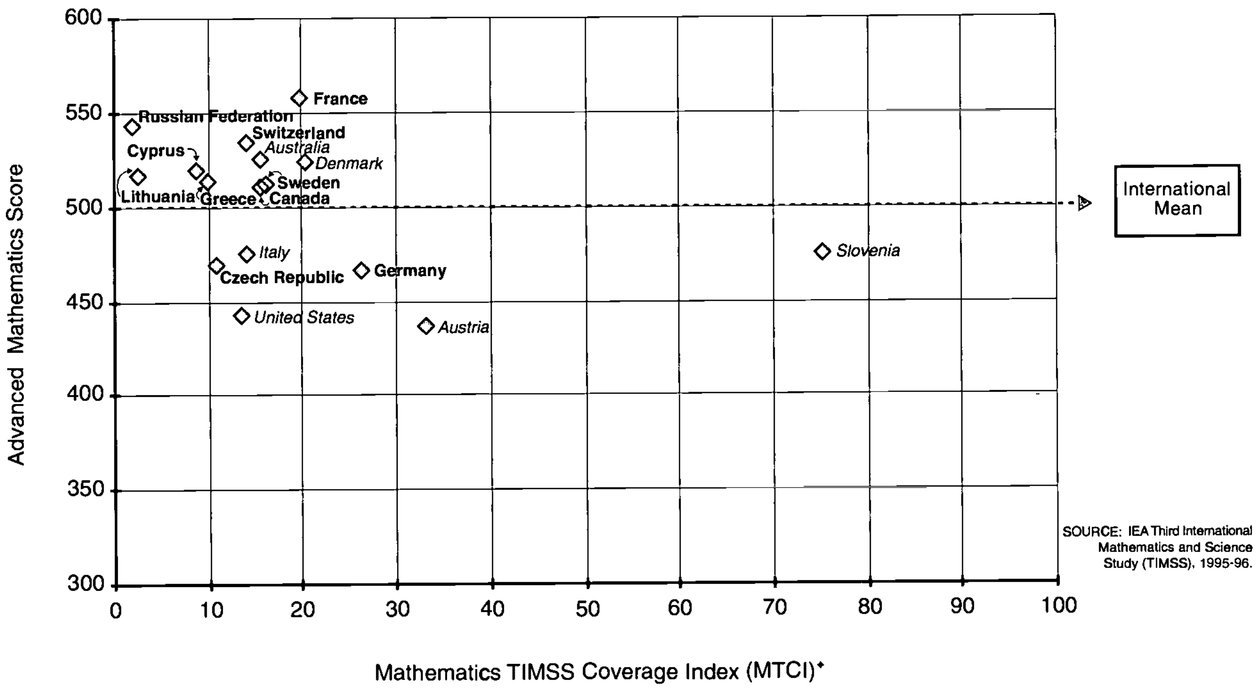
Figure 5.3 provides the country comparison information for the mean performance of the top 10% of the students in the school-leaving age cohort. Selecting a country of interest and reading across the table, a triangle pointing up indicates significantly higher performance than the country listed across the top, a dot indicates no significant difference, and a triangle pointing down indicates significantly lower performance. As shown in the figure, Slovenia and France had significantly higher performance in advanced mathematics for the top 10% of their students than other participating countries. In particular, this analysis offers an interesting view of performance for Slovenia, the country that educates three-fourths of its entire school-leaving age cohort in advanced mathematics. Even though Slovenia had difficulties in implementing the sampling guidelines, the results suggest high performance for the top end of the distribution. Similarly, France followed all of the sampling guidelines

[4] The relationship between advanced mathematics achievement and the MTCI has a correlation coefficient of – 0.37.

Figure 5.2

Mean Advanced Mathematics Achievement by TIMSS Coverage Index for Students Having Taken Advanced Mathematics

Final Year of Secondary School*



* See Appendix A for characteristics of students sampled.

♦ The Mathematics TIMSS Coverage Index (MTCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year advanced mathematics student sample (see Appendix B for more information).

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

Table 5.2

Advanced Mathematics Achievement for the Top 10 Percent@ of All Students in the School-Leaving Age Cohort*

Country	90th Percentile	Mean Achievement of the Top 10% of Students (Above 90th Percentile)	Mathematics TCI
France	558 (5.5)	612 (2.3)	20%
Switzerland	483 (7.6)	575 (3.9)	14%
Canada	473 (3.9)	567 (4.0)	16%
Sweden	487 (6.0)	564 (3.2)	16%
† Germany	489 (5.5)	550 (2.4)	26%
† Greece	- -	513 (6.0)	10%
Czech Republic	343 (11.3)	485 (9.9)	11%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	496 (11.6)	589 (5.9)	16%
2 Austria	487 (3.8)	537 (4.1)	33%
1 Italy	432 (7.7)	520 (7.0)	14%
United States	383 (6.8)	485 (6.1)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	526 (7.0)	582 (2.4)	21%
Slovenia	577 (8.3)	629 (6.0)	75%
International Average	478 (2.0)	554 (1.5)	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

@To compute the 90th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 90th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) 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. Because the students tested in Greece covered 10% of the school-leaving age cohort, the 90th percentile could not be estimated with precision.

Less than 10% of the students in the Russian Federation, Lithuania, and Cyprus took the advanced mathematics test.

Figure 5.3

Multiple Comparisons of Advanced Mathematics Achievement of the Top 10 Percent[@] of All Students in the School-Leaving Age Cohort*

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	*Slovenia*	**France**	*Australia*	*Denmark*	**Switzerland**	**Canada**	**Sweden**	**Germany**	*Austria*	*Italy*	**Greece**	*United States*	**Czech Republic**
Slovenia		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	●		●	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	●	●		●	●	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●		●	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	●	●		▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼		●	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	●		●	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲	●
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	

Countries are ordered by mean achievement across the heading and down the rows.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

[@]To compute the 90th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 90th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of students sampled.

[†] Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

Less than 10% of the students in the Russian Federation, Lithuania, and Cyprus took the advanced mathematics test.

and also has a relatively high MTCI (20%). It appears that having higher percentages of students enrolled in advanced mathematics courses need not have a negative impact on the performance of the top students in that group.

Australia, Denmark, and Switzerland performed similarly to each other, and Australia and Denmark performed better than all of the other participating countries except Slovenia and France. However, Australia and Denmark had some difficulties in achieving high participation rates. Canada and Sweden performed about the same as Switzerland. The top 10% of the school-leaving age cohort in Germany and Austria performed similarly, but below Canada, Sweden, and Switzerland. For Germany and Austria, which had comparatively large coverage indices, this represents an improvement in relative position from the results presented in Figure 5.1 for the full samples of final-year advanced mathematics students. The students in Italy performed about the same as those in Austria, and in turn, the students in Greece performed about the same as those in Italy. The United States and the Czech Republic performed below the other countries; however, a large sampling error in the Czech Republic resulted in no significant difference between its performance and that of Greece.

Table 5.3 and Figure 5.4 present the corresponding information for the 14 countries where the students tested in advanced mathematics covered 5% of the school-leaving age cohort (all except the Russian Federation and Lithuania). Figure 5.4 reveals that performance rankings by mean achievement of the top 5% of the students tended to be similar, but not identical, to those found for the top 10%. Interestingly, from the top-performing countries on down through the list of participants, the differences from one country to the next were often quite negligible. For the top 5%, Slovenia, France, and Australia had the best performance, with Switzerland performing at a level similar to that of France and Australia. Next, Canada and Denmark performed similarly to Switzerland, and in turn, Sweden performed similarly to Canada and Denmark. Greece had the next highest level of performance, followed by Germany and Cyprus, who performed similarly to Greece, and then by Austria, Italy, and the Czech Republic, who all performed similarly to Germany and Cyprus as well as to each other. The United States had significantly lower mean achievement than the other participating countries except Italy and the Czech Republic.

Despite the small difference from one country to the next, however, spanning across all the participating TIMSS countries, the performance difference from the top-performing to the bottom-performing countries was substantial (approximately 100 points, or one standard deviation on the TIMSS advanced mathematics scale). It is also interesting to note that the mean achievement internationally for the top 10% of the advanced mathematics students was 554, which increased to 601 for the top 5%. For the lower-performing countries, mean achievement in advanced mathematics for the top 5% of the final-year students more closely resembled the international mean at the 10% level.

Table 5.3

Advanced Mathematics Achievement for the Top 5 Percent® of All Students in the School-Leaving Age Cohort*

Country	95th Percentile	Mean Achievement of the Top 5% of Students (Above 95th Percentile)	Mathematics TCI
France	603 (6.3)	645 (3.0)	20%
Switzerland	559 (7.1)	629 (4.7)	14%
Canada	554 (4.0)	620 (4.0)	16%
Sweden	553 (5.1)	608 (4.0)	16%
† Greece	521 (6.7)	592 (4.2)	10%
† Germany	540 (5.9)	586 (2.6)	26%
[2] Cyprus	508 (7.5)	577 (3.9)	9%
Czech Republic	466 (15.5)	558 (10.8)	11%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	576 (12.0)	643 (6.0)	16%
[2] Austria	527 (7.0)	570 (5.2)	33%
[1] Italy	507 (9.1)	569 (8.3)	14%
United States	470 (7.4)	543 (3.7)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	574 (7.3)	616 (3.3)	21%
Slovenia	618 (8.6)	664 (6.5)	75%
International Average	541 (2.2)	601 (1.5)	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

® To compute the 95th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 95th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Less than 5% of the students in the Russian Federation and Lithuania took the advanced mathematics test.

Figure 5.4

Multiple Comparisons of Advanced Mathematics Achievement of the Top 5 Percent@ of All Students in the School-Leaving Age Cohort*

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	*Slovenia*	**France**	*Australia*	**Switzerland**	**Canada**	*Denmark*	**Sweden**	**Greece**	**Germany**	**Cyprus**	*Austria*	*Italy*	**Czech Republic**	*United States*
Slovenia		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	●		●	●	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	●	●		●	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	▼	▼	▼	●	●		●	▲	▲	▲	▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	●		●	●	▲	●	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	●		●	●	●	●	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	▲
Austria	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	▲
Italy	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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

@ To compute the 95th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 95th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

Less than 5% of the students in the Russian Federation and Lithuania took the advanced mathematics test.

How Does Performance in Advanced Mathematics Compare by Gender?

Table 5.4 presents the differences in achievement by gender. The table shows mean achievement in advanced mathematics separately for males and females for each country, as well as the difference between the means. The graphic representation of the gender difference, shown by the bar for each country, shows that the direction of the difference favored males in every country, and that the difference usually was statistically significant (indicated by a darkened bar). The gender differences were not statistically significant in Greece, Cyprus, Australia, Italy, and Slovenia. Especially large gender differences in relation to the international average difference of 37 scale-score points were found in the Czech Republic and Austria (80 points or more).

Table 5.4 also shows, by gender, the percentages of upper secondary school students who have taken advanced mathematics courses. The results reveal that many more (at least 20%) males than females have taken advanced mathematics in Greece, Cyprus, Sweden, France, Italy, and Denmark. More males than females have also taken advanced mathematics in several other countries, although the differences are not as large (Australia 10%, Switzerland 8%, and Canada 6%). The percentages are nearly identical in Lithuania, the Russian Federation, the United States, and Slovenia. In contrast, more females than males have taken advanced mathematics courses in three of the participating countries – Germany (14%), the Czech Republic (18%), and Austria (24%).

The TIMSS data on gender differences in taking advanced mathematics courses raise several serious questions. For example, why do so many more males than females take advanced mathematics in some countries? Even when females have taken advanced mathematics, why is their achievement significantly lower than that of males? The question of why males have higher achievement than females even when they have taken the same mathematics courses has been investigated to some extent, with one finding being that teachers seem to provide more encouragement to males.[5] For example, teachers tend to call on male students more frequently and praise them more for their responses. The TIMSS data suggest that, internationally, we need more encouragement for females to take advanced mathematics courses in some countries, and more support for them in all countries once they are taking these courses.

[5] Fennema, E. and Leder, G.C. (Eds.). (1990). *Mathematics and Gender.* New York: Teachers College Press.

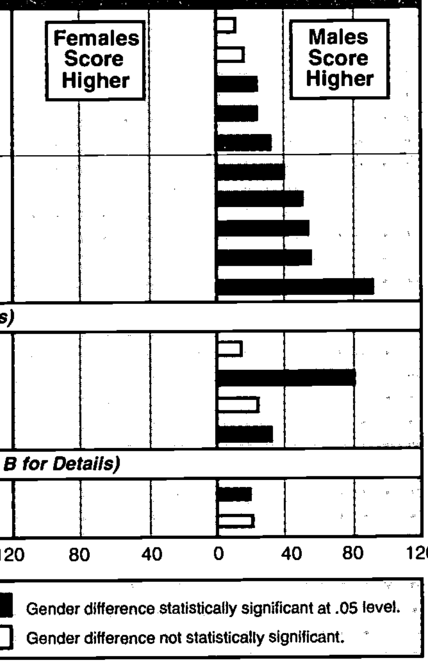
Table 5.4

Gender Differences in Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics

Final Year of Secondary School*

Country	Males: Percent of Students	Males: Mean Achievement	Females: Percent of Students	Females: Mean Achievement	Difference	MTCI
† Greece	69 (2.1)	516 (6.6)	31 (2.1)	505 (10.2)	11 (12.1)	10%
² Cyprus	61 (1.6)	524 (4.4)	39 (1.6)	509 (6.4)	15 (7.8)	9%
Sweden	69 (3.4)	519 (5.9)	31 (3.4)	496 (5.2)	23 (7.9)	16%
France	63 (2.0)	567 (5.1)	37 (2.0)	543 (5.1)	23 (7.2)	20%
† Germany	43 (2.4)	484 (6.5)	57 (2.4)	452 (6.6)	32 (9.2)	26%
Canada	53 (1.6)	528 (6.4)	47 (1.6)	489 (4.4)	39 (7.7)	16%
¹ Lithuania	51 (1.9)	542 (3.7)	49 (1.9)	490 (5.6)	51 (6.7)	3%
² Russian Federation	52 (2.4)	568 (9.7)	48 (2.4)	515 (10.2)	53 (14.1)	2%
Switzerland	54 (2.4)	559 (5.6)	46 (2.4)	503 (5.7)	56 (8.0)	14%
Czech Republic	41 (2.5)	524 (13.0)	59 (2.5)	432 (8.9)	92 (15.7)	11%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	55 (5.5)	531 (11.4)	45 (5.5)	517 (15.1)	14 (18.9)	16%
² Austria	38 (4.1)	486 (7.3)	62 (4.1)	406 (8.6)	80 (11.2)	33%
¹ Italy	61 (3.8)	484 (10.6)	39 (3.8)	460 (14.1)	24 (17.7)	14%
United States	51 (2.6)	457 (7.8)	49 (2.6)	426 (7.1)	31 (10.5)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	63 (1.8)	529 (4.4)	37 (1.8)	510 (4.6)	19 (6.3)	21%
Slovenia	50 (4.2)	484 (11.5)	50 (4.2)	464 (11.0)	20 (15.9)	75%

Gender Difference



International Averages

Males	Females	Difference
519	482	37

(Averages of All Country Means)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

How Well Did Students Having Taken Advanced Mathematics Perform in Mathematics and Science Literacy?

Table 5.5 contains the results on the mathematics and science literacy portion of the testing for students who had taken advanced mathematics. Because the students tested in literacy represented all students in their final year of secondary school, students who had taken advanced mathematics courses were necessarily included as part of the overall population. In 13 of the countries that participated in the literacy testing, it was possible to identify the students eligible for participation in the advanced mathematics testing and compute their literacy achievement.[6]

The results show that in every country students having taken advanced mathematics courses outperformed the overall population of final-year students in mathematics and science literacy. Interestingly, across the participating countries, the average difference was 70 points on the combined mathematics and science literacy test and also 70 points for the mathematics portion of the literacy test. Particularly large differences (more than 100 points, or a standard deviation on the literacy scales) were found in the Czech Republic and Sweden for both the composite mathematics and science literacy scale and the mathematics literacy scale. Understandably, the smallest differences were found in Slovenia, where a large percentage of the final-year student population has taken advanced mathematics.

[6] In addition, some students who had taken both advanced mathematics and physics courses were tested on part of the mathematics and science literacy test. Thus, it was also possible to estimate mathematics literacy, science literacy, and a composite mathematics and science literacy score for these students.

Table 5.5

Comparison Between All Students in Their Final Year of Secondary School and Final-Year Students Having Taken Advanced Mathematics in Mathematics and Science Literacy

Country	Mean Achievement: Mathematics and Science Literacy		Mean Achievement: Mathematics Literacy		Overall TCI	Mathematics TCI
	All Students	Advanced Mathematics Students	All Students	Advanced Mathematics Students		
Canada	526 (2.6)	587 (3.7)	519 (2.8)	588 (3.3)	70%	16%
[2] Cyprus	447 (2.5)	521 (6.1)	446 (2.5)	516 (6.5)	48%	9%
Czech Republic	476 (10.5)	582 (7.2)	466 (12.3)	573 (7.8)	78%	11%
France	505 (4.9)	572 (5.0)	523 (5.1)	592 (5.6)	84%	20%
† Germany	496 (5.4)	565 (4.1)	495 (5.9)	562 (4.4)	75%	26%
Sweden	555 (4.3)	664 (3.7)	552 (4.3)	661 (3.8)	71%	16%
Switzerland	531 (5.4)	618 (4.2)	540 (5.8)	619 (4.5)	82%	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	525 (9.5)	604 (8.1)	522 (9.3)	606 (7.6)	68%	16%
[2] Austria	519 (5.4)	567 (5.9)	518 (5.3)	564 (6.1)	76%	33%
[1] Italy	475 (5.3)	521 (9.5)	476 (5.5)	519 (10.4)	52%	14%
United States	471 (3.1)	554 (5.2)	461 (3.2)	551 (5.1)	63%	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	528 (3.2)	594 (2.9)	547 (3.3)	613 (3.0)	58%	21%
Slovenia	514 (8.2)	531 (7.1)	512 (8.3)	530 (6.7)	88%	75%
International Average	505 (1.6)	575 (1.6)	506 (1.7)	576 (1.7)		

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

The procedures used by Lithuania, the Russian Federation, and Denmark do not permit estimating literacy achievement for students taking advanced mathematics. Greece did not test the population of all students in their final year of secondary school.

Chapter 6

Achievement in Advanced Mathematics Content Areas

Recognizing that important curricular differences exist between and within countries is an important aspect of IEA studies, and TIMSS sought to measure achievement in different areas of advanced mathematics, which would be useful in relating achievement to curriculum. After much deliberation, the advanced mathematics test was designed to enable reporting by three content areas.[1] These three content areas are:

- Numbers, equations, and functions
- Calculus
- Geometry

The advanced mathematics test also included several items dealing with probability and statistics and several in the area of validation and structure. The results for these items were included in the scaling of the overall results, but there were too few items in these two categories to develop separate subscales.[2] The latter part of this chapter contains further information about the types of items within the advanced mathematics test, including six example items and the percentage of correct responses on those items for each of the participating TIMSS countries.

How Does Performance Compare Across Content Areas?

As discussed in Chapter 5, there were differences in achievement among the participating countries on the TIMSS advanced mathematics test. Given that the test was designed to include items from different curricular areas, it is important to examine whether the participating countries have particular strengths and weaknesses in their achievement in these areas.

Table 6.1 provides the subscale scores for the three major content areas in the advanced mathematics test. As indicated, the international averages for each of the subscales were arbitrarily set to be 500.[3] However, within those constraints the performance of each country was allowed to vary above or below the mean. Sometimes countries that did well on the overall advanced mathematics test generally did well in the three content areas for which there are separate results, and those that did poorly overall also tended to do so in each of the content areas. For example, the French students who performed above the international average overall also

[1] See the "Test Development" section of Appendix B for more information about the process used to develop the TIMSS tests. Appendix C provides an analysis of the match between the test and curriculum in the TIMSS countries and the effect of this match on the results.

[2] See the "IRT Scaling and Data Analysis" section of Appendix B for more details about the procedures used to obtain the subscales for the advanced mathematics content areas. However, the results for the three content area scales within advanced mathematics were the result of a separate multidimensional scaling effort.

[3] Final revisions of the data resulted in international averages of 501 for some of the advanced mathematics scales.

Table 6.1

Achievement in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	MTCI	Advanced Mathematics Content Areas Mean Achievement Scale Scores: Numbers & Equations (17 items)	Calculus (15 items)	Geometry (23 items)
Canada	16%	● 512 (3.9)	● 503 (3.6)	● 499 (3.8)
² Cyprus	9%	● 510 (5.7)	▲ 561 (5.2)	▲ 517 (4.9)
Czech Republic	11%	▼ 460 (11.7)	▼ 446 (9.7)	● 494 (9.8)
France	20%	▲ 548 (4.1)	▲ 560 (3.0)	▲ 544 (3.8)
† Germany	26%	▼ 457 (5.0)	▼ 454 (4.4)	● 487 (5.5)
† Greece	10%	▲ 539 (7.2)	▲ 538 (7.3)	● 498 (8.7)
¹ Lithuania	3%	▲ 547 (2.8)	● 498 (2.5)	▲ 515 (2.8)
² Russian Federation	2%	▲ 555 (8.8)	▲ 537 (9.1)	▲ 548 (9.2)
Sweden	16%	▲ 523 (4.7)	▼ 480 (4.4)	● 492 (4.4)
Switzerland	14%	● 514 (5.2)	● 512 (5.7)	▲ 547 (4.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)				
Australia	16%	● 517 (9.4)	● 530 (11.7)	● 496 (12.5)
² Austria	33%	▼ 412 (7.4)	▼ 439 (6.5)	▼ 462 (7.9)
¹ Italy	14%	▼ 460 (9.2)	● 520 (10.4)	● 480 (9.5)
United States	14%	▼ 459 (5.3)	▼ 450 (4.1)	▼ 424 (5.1)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)				
Denmark	21%	● 504 (2.7)	● 508 (3.3)	▲ 527 (3.1)
Slovenia	75%	● 491 (9.9)	▼ 471 (6.6)	▼ 476 (7.6)
International Average		501 (1.7)	501 (1.7)	500 (1.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ = Country average significantly higher than the international average for the scale

● = No significant difference between country average and international average for the scale

▼ = Country average significantly lower than the international average for the scale

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

performed above the international average in each of the three content areas. Most countries, however, showed particular strengths or weaknesses. Sweden performed above the international average in numbers and equations, below the international average in calculus, and about at the international average in geometry. Switzerland performed above the international average in geometry, but only at the international average in numbers and equations and in calculus.

Figure 6.1 presents a visual profile of performance in the advanced mathematics content areas in each country. In this profile, the comparison is with the country's overall mean achievement, so that regardless of the performance of the country relative to that of other participants, particular strengths and weaknesses within the country can be identified. The horizontal line indicates each country's overall average achievement in advanced mathematics, and the three darkened boxes indicate the 95% confidence intervals around the mean achievement in each of the three major content areas. If the darkened box is below the line, then the country performed significantly less well in that content area than it did overall. Similarly, if the darkened box is above the line, then the country performed significantly better in that content area than it did overall.

The results in Figure 6.1 reveal that students in Cyprus performed relatively less well in numbers and equations and relatively better in calculus than they did on the advanced mathematics test as a whole. Students in the Czech Republic performed better in geometry than overall, and those in France had a relative strength in calculus. Students in Germany did relatively better in geometry and relatively worse in calculus than they did overall. Whereas the Greek students had a relative weakness in geometry, the Swiss students were particularly strong in that area. Students in both Lithuania and Sweden showed relative strength in numbers and equations, but had more difficulty in calculus than they did overall. Achievement in both Austria and Denmark was relatively lower in numbers and equations, and relatively higher in geometry. Students in Italy had relatively lower achievement in numbers and equations, and relatively higher achievement in calculus. Compared to their overall mean achievement, students in the United States performed better in numbers and equations and worse in geometry. For Australia, Canada, the Russian Federation, and Slovenia, performance in the individual content areas was not significantly different from their overall advanced mathematics scores.

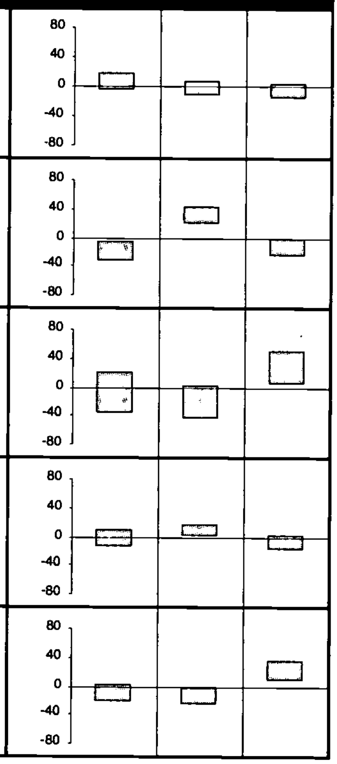
Table 6.2 shows a number of statistically significant gender differences in achievement by content areas, all favoring males rather than females. Five countries, however, showed no significant differences – Cyprus, Greece, Australia, Italy, and Slovenia. Countries showing no significant gender differences in achievement in one or two content areas included France, Sweden, the United States, and Denmark in numbers and equations, Sweden and the United States in calculus, and Germany and Denmark in geometry.

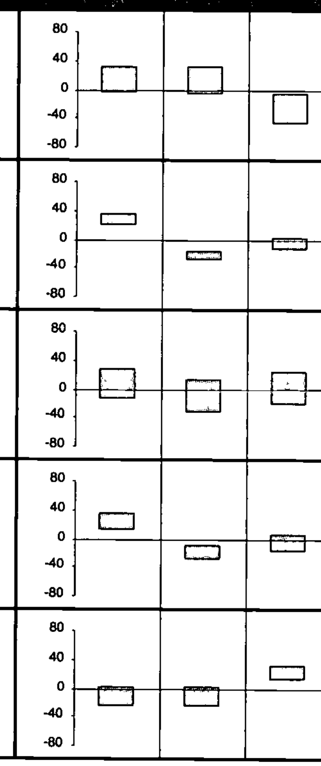
Considering the eighth-grade TIMSS results where the gender differences that did exist tended to favor boys, some of the gender differences in advanced mathematics for the final-year students might have been anticipated. Still, the eighth-grade results indicated few statistically significant differences by content area. For example, the gender differences in achievement were minimal in fractions and number sense as

Figure 6.1

Profiles of Performance in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

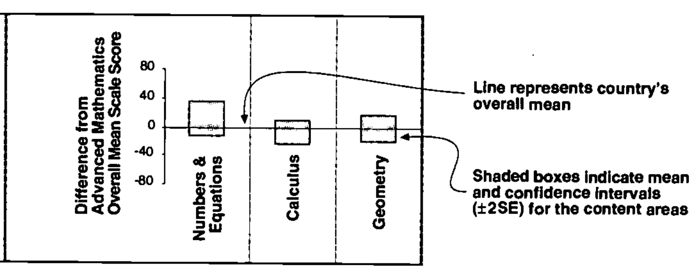
Country	MTCI
Canada	16%
² Cyprus	9%
Czech Republic	11%
France	20%
† Germany	26%
† Greece	10%
¹ Lithuania	3%
² Russian Federation	2%
Sweden	16%
Switzerland	14%





SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Legend:



* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

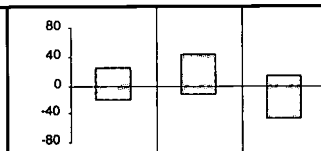
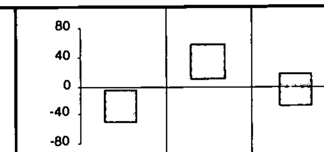
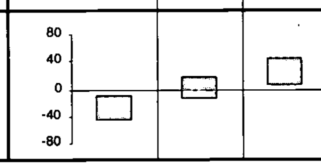
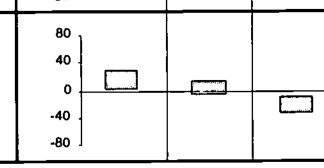
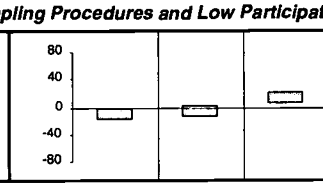
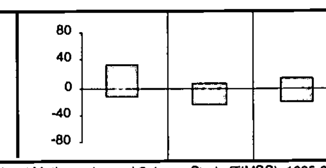
¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

Figure 6.1 (Continued)

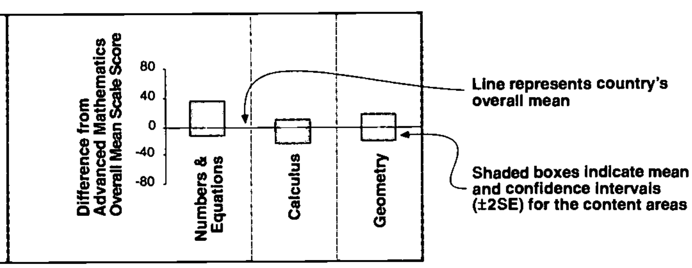
Profiles of Performance in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics

Final Year of Secondary School*

Country	MTCI	Numbers & Equations / Calculus / Geometry	Country	MTCI	Numbers & Equations / Calculus / Geometry
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):					
Australia	16%		[1] Italy	14%	
[2] Austria	33%		United States	14%	
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B):					
Denmark	21%		Slovenia	75%	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Legend:



* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

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Table 6.2

Achievement in Advanced Mathematics Content Areas by Gender for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	MTCI	Advanced Mathematics Content Areas Mean Achievement Scale Scores: Numbers & Equations (17 items)		Calculus (15 items)		Geometry (23 items)	
		Females	Males	Females	Males	Females	Males
Canada	16%	496 (4.5)	▲ 526 (5.6)	484 (4.9)	▲ 521 (5.5)	482 (4.6)	▲ 516 (5.3)
[2] Cyprus	9%	497 (7.0)	518 (6.5)	562 (8.0)	559 (5.0)	512 (8.5)	520 (5.2)
Czech Republic	11%	427 (10.5)	▲ 510 (11.3)	417 (8.3)	▲ 488 (11.0)	461 (7.2)	▲ 543 (12.1)
France	20%	544 (3.9)	551 (5.4)	544 (4.1)	▲ 569 (4.3)	529 (4.8)	▲ 555 (5.7)
† Germany	26%	446 (5.1)	▲ 475 (6.2)	442 (5.2)	▲ 471 (5.6)	480 (5.6)	498 (7.0)
† Greece	10%	537 (10.4)	540 (9.1)	536 (12.0)	540 (8.2)	485 (15.4)	505 (7.5)
[1] Lithuania	3%	526 (5.4)	▲ 568 (3.0)	478 (4.8)	▲ 518 (4.3)	491 (5.8)	▲ 539 (3.6)
[2] Russian Federation	2%	533 (9.8)	▲ 576 (9.6)	512 (10.9)	▲ 560 (8.9)	525 (10.5)	▲ 570 (8.9)
Sweden	16%	511 (5.6)	529 (6.4)	472 (4.9)	484 (6.0)	476 (5.1)	▲ 500 (5.5)
Switzerland	14%	488 (5.7)	▲ 536 (5.7)	486 (6.2)	▲ 536 (6.8)	522 (5.9)	▲ 569 (3.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	16%	511 (11.2)	523 (9.9)	525 (12.2)	533 (13.6)	485 (13.8)	505 (14.1)
[2] Austria	33%	385 (9.3)	▲ 455 (6.2)	412 (7.3)	▲ 486 (6.9)	433 (9.6)	▲ 509 (7.7)
[1] Italy	14%	441 (14.1)	472 (10.6)	521 (13.5)	520 (11.4)	472 (14.5)	485 (10.4)
United States	14%	447 (6.9)	470 (6.1)	439 (6.1)	460 (5.3)	408 (7.0)	▲ 439 (5.8)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	21%	498 (3.5)	507 (3.6)	491 (5.4)	▲ 517 (4.3)	519 (4.0)	531 (4.2)
Slovenia	75%	480 (10.8)	503 (13.0)	463 (7.9)	479 (8.2)	469 (8.9)	482 (9.6)
International Average		485 (2.1)	▲ 516 (2.0)	487 (2.0)	▲ 515 (1.9)	484 (2.2)	▲ 517 (2.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

well as in geometry. In algebra, while no differences in performance by gender were statistically significant, if anything girls may have had a slight edge. At the eighth grade, the greatest differences in performance by gender were found in measurement, where boys had higher achievement than girls in a number of countries.[4]

What Are Some Examples of Performance in Advanced Mathematics?

This section presents six example items from the advanced mathematics test, two from each of the three content areas. The performance results on each item are presented for each of the TIMSS countries, and the average across countries is also provided. The example items were chosen to illustrate the topics covered within each content area, the range of item formats used, and the range of difficulty.

Example Item 1, presented in Table 6.3, involves solving an algebraic inequality. On average across countries, almost three-fourths (73%) of the students having taken courses in advanced mathematics selected the correct answer. More than 80% of students in Cyprus, the Czech Republic, France, Greece, Lithuania, and the Russian Federation answered this question correctly.

Example Item 2 is a geometry item involving coordinates and geometric properties. There are several approaches to solving this problem. For example, students could have determined that the slopes of lines PQ and QR are negative reciprocals, and therefore are perpendicular lines creating a right angle at PQR. Students also may have plotted the triangle and either applied the Pythagorean theorem to determine the answer or simply looked at their plots. The results in Table 6.4 reveal substantial variation in performance across countries. For example, 70% or more of the students answered correctly in Lithuania, the Russian Federation, and Denmark. In contrast, fewer than half answered correctly in the Czech Republic, Greece, Australia, and the United States.

Even greater differences in performance across countries were found on Example Item 3, assessing students' understanding of combinations. Essentially, students needed to recognize that the problem involved determining how many combinations would occur from 11 examination questions taken 9 at a time, and that the choice involving the first two questions meant that the entire set of combinations for the remaining questions would occur twice. As shown in Table 6.5, 78% of the students in France answered this question correctly, compared with fewer than 40% in Germany, the Russian Federation, Italy, the United States, and Denmark.

In Example Item 4, students needed to understand that the first derivative is used to tell whether a function is increasing or decreasing, and the second derivative is used to indicate the concavity of a function. On average, 45% of the students across participating countries selected the function for which the first derivative is positive when

[4] 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: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, MA: Boston College.

x = 0 and negative when x = 1, and for which the graph of the function is always concave down (second derivative always negative). Students in Sweden had the best performance (61% correct).

Example Item 5, in which students needed to demonstrate their understanding of the integral, proved to be even more difficult. To answer the item correctly, students had to understand that if a curve lies above the x-axis, the integral represents the area under the curve, and if the curve lies below the x-axis, the integral represents the negative of the area between the curve and the x-axis. Thirty-five percent of students internationally selected the correct response, on average. The highest percentage correct was in Cyprus (51%), followed by Sweden (48%).

To solve Example Item 6, students had to use their visualization skills to recognize an application of the Pythagorean theorem. Essentially, as shown in the example response, students needed to represent the surface of the rod as a rectangle, draw the congruent segments indicating the string, calculate the length of one string segment using the Pythagorean theorem, and multiply that result by 4 for each of the segments. Most of the students responding correctly used this approach, although a handful used variations (e.g., half of surface represented as a rectangle using eight congruent segments). Students receiving partial credit used the general approach, but made numerical errors in calculating the length of string. Students in all participating countries found this problem very difficult. Only 10%, on average, provided a fully correct response, with another 2%, on average, receiving partial credit. Swedish students had the best performance, with 24% providing fully correct responses.

Figure 6.2 is a graphic representation of the relationship between performance on the TIMSS international mathematics scale and on the six example items from the advanced mathematics test.[5] Achievement on each example item is indicated both by the average percentage of fully correct responses across all countries and by the international advanced mathematics scale value, or item difficulty level. Since the scale was based on the performance of students in all countries, the international scale values apply to all countries. As can be seen, the advanced mathematics test was quite difficult for students in a number of countries. Students achieving below the international average were unlikely to provide fully correct responses to many of the example items. Still, a less difficult test would have been too easy for the top 5% of the students in some countries. For example, average achievement for the top 5% of the students in Australia, France, and Slovenia ranged from 643 to 664. These students were likely to have answered all but the most difficult items correctly.

[5] 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 6.3 Advanced Mathematics

Percent Correct for Example Item 1 for Students Having Taken Advanced Mathematics Final Year of Secondary School*

Country	Percent Correct	MTCI
Canada	68 (2.4)	16%
[2] Cyprus	81 (3.4)	9%
Czech Republic	84 (4.4)	11%
France	85 (2.1)	20%
† Germany	56 (2.6)	26%
† Greece	83 (4.0)	10%
[1] Lithuania	96 (0.7)	3%
[2] Russian Federation	86 (2.9)	2%
Sweden	58 (3.8)	16%
Switzerland	69 (3.7)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	68 (5.3)	16%
[2] Austria	43 (4.1)	33%
[1] Italy	73 (5.7)	14%
United States	68 (2.3)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	78 (2.4)	21%
Slovenia	71 (3.9)	75%
International Average Percent Correct	73 (0.9)	

Example 1

Values of X for an inequality.

Content Category:
Numbers, Equations and Functions

What are all values of x for which the inequality $5x+\frac{5}{3}\leq -2x-\frac{2}{3}$ is true?

A. $x\leq -\frac{7}{9}$

(B.) $x\leq -\frac{1}{3}$

C. $x\geq 0$

D. $x\geq \frac{7}{3}$

E. $x\geq \frac{9}{3}$

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 6.4 Advanced Mathematics

Percent Correct for Example Item 2 for Students Having Taken Advanced Mathematics Final Year of Secondary School*

Country	Percent Correct	MTCI
Canada	52 (2.0)	16%
[2] Cyprus	51 (4.3)	9%
Czech Republic	48 (3.5)	11%
France	64 (2.9)	20%
† Germany	51 (2.8)	26%
† Greece	36 (4.2)	10%
[1] Lithuania	70 (3.3)	3%
[2] Russian Federation	70 (3.9)	2%
Sweden	60 (2.8)	16%
Switzerland	62 (3.2)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	46 (4.1)	16%
[2] Austria	52 (4.2)	33%
[1] Italy	55 (6.7)	14%
United States	47 (4.6)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	71 (2.5)	21%
Slovenia	54 (3.1)	75%
International Average Percent Correct	55 (0.9)	

Example 2

Vertices right angle triangle.

Content Category: Geometry

The vertices of the triangle PQR are the points P(1, 2), Q(4, 6) and R(− 4, 12). Which one of the following statements about triangle PQR is true?

A. PQR is a right triangle with the right angle ∠P.

B. PQR is a right triangle with the right angle ∠Q.

C. PQR is a right triangle with the right angle ∠R.

D. PQR is not a right triangle.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 6.5 Advanced Mathematics

Percent Correct for Example Item 3 for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	Percent Correct	MTCI
Canada	50 (2.7)	16%
[2] Cyprus	63 (4.7)	9%
Czech Republic	42 (3.5)	11%
France	78 (3.7)	20%
† Germany	35 (2.8)	26%
† Greece	46 (3.7)	10%
[1] Lithuania	47 (2.9)	3%
[2] Russian Federation	32 (3.1)	2%
Sweden	46 (3.6)	16%
Switzerland	57 (3.5)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	70 (4.8)	16%
[2] Austria	40 (3.7)	33%
[1] Italy	27 (5.3)	14%
United States	36 (2.6)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	39 (2.9)	21%
Slovenia	51 (3.6)	75%
International Average Percent Correct	47 (0.9)	

Example 3

Contributions of examination question choices.

Content Category: Numbers, Equations and Functions

An examination consists of 13 questions. A student must answer only one of the first two questions and only nine of the remaining ones. How many choices of questions does the student have?

A. ${}^{13}C_{10} = 286$

B. ${}^{11}C_{8} = 165$

C. $2 \times {}^{11}C_{9} = 110$

D. $2 \times {}^{11}P_{2} = 220$

E. some other number

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

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Table 6.6 Advanced Mathematics

Percent Correct for Example Item 4 for Students Having Taken Advanced Mathematics Final Year of Secondary School*

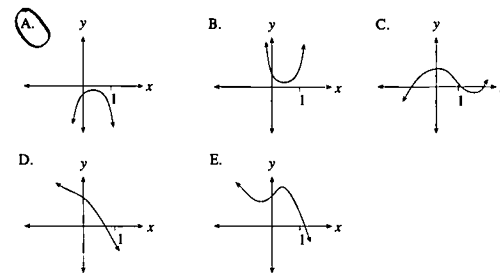
Country	Percent Correct	MTCI
Canada	47 (3.1)	16%
[2] Cyprus	36 (5.0)	9%
Czech Republic	39 (3.5)	11%
France	52 (2.7)	20%
† Germany	38 (2.5)	26%
† Greece	37 (5.2)	10%
[1] Lithuania	43 (2.9)	3%
[2] Russian Federation	48 (4.0)	2%
Sweden	61 (4.8)	16%
Switzerland	45 (4.0)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	52 (4.0)	16%
[2] Austria	42 (4.2)	33%
[1] Italy	42 (7.6)	14%
United States	47 (4.5)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	49 (3.0)	21%
Slovenia	39 (3.7)	75%
International Average Percent Correct	45 (1.1)	

Example 4

Derivatives.

Content Category: Calculus

Which of the following graphs has these features: $f'(0) > 0$, $f'(1) < 0$, and $f''(x)$ is always negative?



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

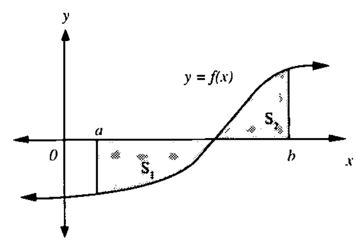
Table 6.7 Advanced Mathematics

Percent Correct for Example Item 5 for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	Percent Correct	MTCI
Canada	28 (2.8)	16%
[2] Cyprus	51 (4.3)	9%
Czech Republic	25 (4.0)	11%
France	39 (2.8)	20%
† Germany	26 (2.7)	26%
† Greece	32 (6.0)	10%
[1] Lithuania	31 (2.6)	3%
[2] Russian Federation	43 (3.8)	2%
Sweden	48 (3.4)	16%
Switzerland	44 (4.1)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	35 (3.4)	16%
[2] Austria	19 (3.0)	33%
[1] Italy	42 (7.6)	14%
United States	27 (2.1)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	39 (2.9)	21%
Slovenia	25 (3.6)	75%
International Average Percent Correct	35 (1.0)	

Example 5
Graph of y = f(x).

Content Category:
Calculus



This figure shows the graph of $y = f(x)$.
S_1 is the area enclosed by the x- axis, $x = a$ and $y = f(x)$;
S_2 is the area enclosed by the x- axis, $x = b$ and $y = f(x)$;
where $a < b$ and $0 < S_2 < S_1$.

The value of $\int_a^b f(x)dx$ is

A. $S_1 + S_2$

B. $S_1 - S_2$

(C.) $S_2 - S_1$

D. $|S_1 - S_2|$

E. $\frac{1}{2}(S_1 + S_2)$

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 6.8 Advanced Mathematics

Percent Correct for Example Item 6 for Students Having Taken Advanced Mathematics Final Year of Secondary School*

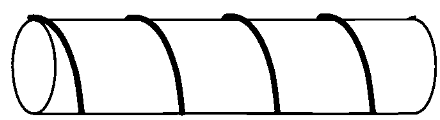
Country	Percent Partially Correct	Percent Fully Correct	MTCI
Canada	1 (0.3)	12 (1.6)	16%
[2] Cyprus	2 (1.3)	0 (0.0)	9%
Czech Republic	4 (1.3)	8 (2.0)	11%
France	2 (1.0)	4 (1.6)	20%
† Germany	1 (0.5)	8 (1.9)	26%
† Greece	1 (0.9)	5 (2.0)	10%
[1] Lithuania	1 (0.6)	18 (2.3)	3%
[2] Russian Federation	2 (1.1)	12 (2.7)	2%
Sweden	1 (0.5)	24 (4.0)	16%
Switzerland	1 (0.6)	17 (3.7)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	1 (0.9)	14 (3.1)	16%
[2] Austria	2 (1.2)	9 (2.6)	33%
[1] Italy	3 (2.3)	6 (3.5)	14%
United States	0 (0.2)	4 (0.9)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	2 (0.8)	11 (2.1)	21%
Slovenia	1 (0.6)	5 (1.3)	75%
International Average Percent Correct	2 (0.3)	10 (0.6)	

Example 6

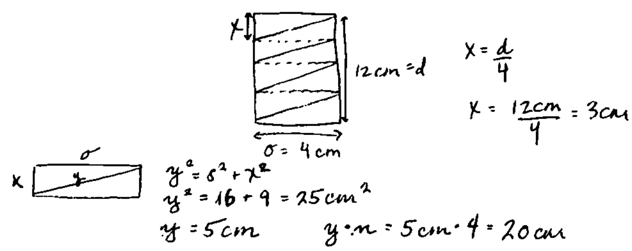
Length of string around rod.

Content Category:
Geometry

A string is wound symmetrically around a circular rod. The string goes exactly 4 times around the rod. The circumference of the rod is 4 cm and its length is 12 cm.



Find the length of the string. Show all your work.



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

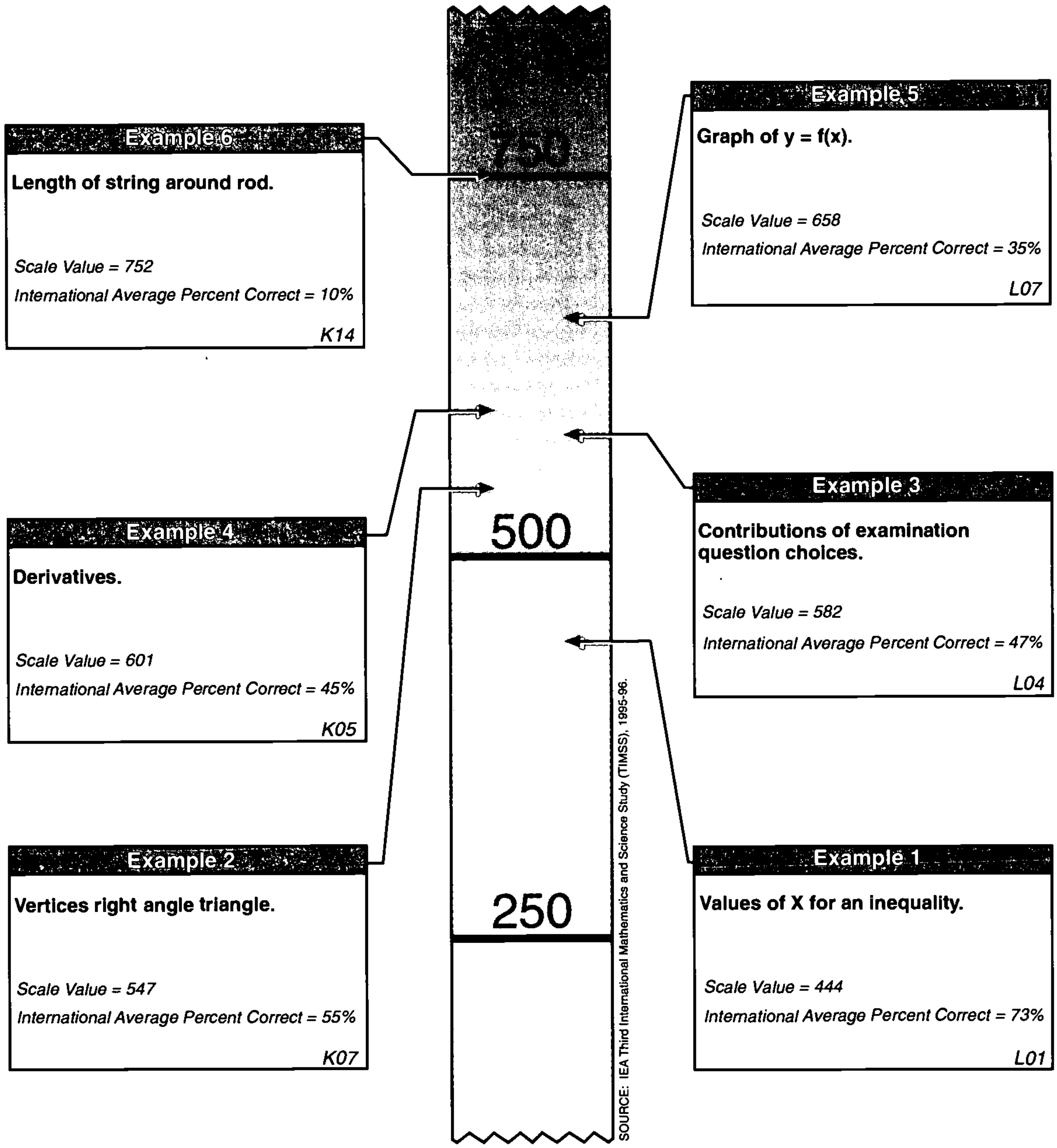
[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 6.2

International Difficulty Map for Advanced Mathematics Example Items for Students Having Taken Advanced Mathematics

Final Year of Secondary School*



* See Appendix A for characteristics of students sampled.

Note: Items are shown at the point on the TIMSS advanced mathematics scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

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Chapter 7

Contexts for Advanced Mathematics Achievement

This chapter focuses on the instructional experiences of students having taken advanced mathematics: the amount of mathematics instruction and homework they receive each week, the kinds of activities in which they engage in mathematics class, and their use of calculators and computers. This chapter also presents advanced mathematics students' reports on the educational level of their parents, and describes students' own plans for future study and employment.

What Are the Instructional Practices in Advanced Mathematics Classes?

As shown in Table 7.1, the amount of instructional time per week reported by students taking advanced mathematics in their final year varied considerably across countries. Although the majority of students in many TIMSS countries reported receiving from three to five hours of mathematics instruction each week, in Austria and Sweden more than 60% of the students had less than three hours each week, and in Australia, Canada, Cyprus, France, Greece, and the Russian Federation, the majority of students had five hours or more. In some countries, courses are scheduled by semesters rather than full years, so some students who had studied advanced mathematics prior to their final year or during the first semester might not have been taking a mathematics class at the time they completed the TIMSS questionnaire. About 20% of the students in Austria and Canada as well as 8% in the United States reported that they were not currently taking mathematics.

For students taking mathematics, there was considerable variation across countries in the relationship between mathematics achievement and amount of weekly instruction. Although the most common was a curvilinear relationship, with the highest achievement associated with the middle amounts of instruction reported by students, sometimes the students receiving five hours or more of weekly mathematics instruction were those with the highest average achievement.

Table 7.2 reveals that the amount of homework assigned to final-year students taking advanced mathematics also varies considerably from country to country. At one extreme, more than 40% of the students in the Czech Republic and Sweden reported that they were assigned mathematics homework less than once a week, while at the other extreme, more than 80% of the students in Australia, Canada, Cyprus, Greece, Lithuania, the Russian Federation, and the United States reported having homework assigned three or more times a week. Although the relationship between amount of homework assigned and mathematics achievement was not consistent across countries, in about half of them average achievement was highest among students who reported that mathematics homework was assigned three or more times a week.

Table 7.1

Advanced Mathematics Students' Reports on the Amount of Mathematics Instruction They Are Currently Receiving Each Week – Advanced Mathematics
Final Year of Secondary School*

Country	Not Currently Taking Mathematics		Amount of Mathematics Instruction Per Week[1]							
			Less Than 3 Hours		3 to Less Than 4 Hours		4 to Less Than 5 Hours		5 Hours or More	
	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	0 (0.1)	~ ~	1 (0.4)	~ ~	16 (3.3)	455 (17.3)	17 (2.4)	469 (24.5)	66 (3.8)	557 (9.7)
Austria	21 (3.2)	405 (18.6)	73 (3.7)	437 (8.6)	6 (2.8)	488 (32.7)	7 (2.3)	490 (19.6)	14 (2.5)	438 (12.9)
Canada	19 (1.4)	491 (10.0)	4 (0.9)	497 (18.3)	14 (2.1)	481 (6.7)	15 (2.3)	539 (10.9)	67 (2.6)	516 (4.6)
Cyprus	0 (0.0)	~ ~	1 (0.6)	~ ~	1 (0.5)	~ ~	1 (0.4)	~ ~	97 (0.9)	520 (4.5)
Czech Republic	0 (0.0)	~ ~	48 (5.2)	416 (8.4)	37 (4.3)	485 (8.6)	10 (2.0)	565 (22.9)	5 (1.8)	648 (31.4)
[2] *Denmark*	1 (0.3)	~ ~	0 (0.0)	~ ~	100 (0.0)	523 (3.5)	0 (0.0)	~ ~	0 (0.0)	~ ~
France	0 (0.0)	~ ~	1 (0.4)	~ ~	1 (0.3)	~ ~	2 (0.6)	~ ~	97 (0.7)	559 (3.9)
Germany	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Greece	0 (0.0)	~ ~	0 (0.0)	~ ~	0 (0.0)	~ ~	0 (0.0)	~ ~	100 (0.0)	515 (5.9)
Italy	0 (0.0)	~ ~	46 (6.1)	475 (17.8)	29 (7.8)	473 (15.9)	19 (7.4)	475 (9.4)	5 (1.7)	465 (30.4)
Lithuania	0 (0.2)	~ ~	0 (0.1)	~ ~	15 (1.3)	528 (5.2)	64 (1.5)	523 (4.1)	20 (1.3)	488 (6.3)
Russian Federation	0 (0.1)	~ ~	14 (3.1)	448 (19.8)	8 (2.1)	505 (17.6)	24 (4.4)	537 (14.9)	54 (4.4)	573 (10.1)
Slovenia	0 (0.0)	~ ~	20 (3.2)	390 (8.9)	77 (3.3)	498 (8.7)	3 (1.1)	465 (30.6)	0 (0.2)	~ ~
Sweden	2 (1.2)	~ ~	64 (5.7)	513 (4.8)	29 (5.1)	522 (9.3)	6 (1.3)	503 (17.5)	1 (0.4)	~ ~
Switzerland	1 (0.4)	~ ~	16 (4.2)	504 (11.6)	63 (4.3)	520 (6.3)	8 (1.4)	594 (8.1)	12 (1.6)	607 (11.6)
United States	8 (1.3)	390 (16.5)	7 (0.8)	413 (12.9)	36 (4.4)	460 (9.5)	46 (4.2)	447 (8.1)	12 (1.1)	445 (8.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking mathematics. Hours of instruction computed from lessons per week and minutes per lesson.

[2] Data for Denmark obtained from ministry.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

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Table 7.2

Advanced Mathematics Students' Reports on How Often They Are Assigned Mathematics Homework – Advanced Mathematics

Final Year of Secondary School*

Country	Not Currently Taking Mathematics		How Often Mathematics Homework Is Assigned[1]					
			Less Than Once a Week		Once or Twice a Week		3 or More Times a Week	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	0 (0.1)	~ ~	5 (1.4)	525 (25.1)	8 (1.1)	529 (21.8)	87 (2.0)	525 (12.4)
Austria	21 (3.2)	405 (18.6)	11 (2.7)	415 (27.9)	47 (3.8)	442 (7.1)	41 (4.1)	464 (8.3)
Canada	19 (1.4)	491 (10.0)	5 (1.1)	562 (28.5)	11 (1.7)	522 (13.0)	84 (2.6)	510 (4.4)
Cyprus	0 (0.0)	~ ~	1 (0.5)	~ ~	1 (0.5)	~ ~	98 (0.8)	519 (4.2)
Czech Republic	0 (0.0)	~ ~	41 (5.0)	455 (15.3)	37 (3.3)	472 (13.3)	21 (3.4)	491 (15.2)
Denmark	1 (0.3)	~ ~	3 (0.6)	507 (22.8)	32 (2.4)	520 (5.5)	65 (2.6)	526 (4.1)
France	0 (0.0)	~ ~	16 (2.2)	568 (7.4)	23 (2.2)	547 (5.6)	61 (2.4)	559 (3.8)
Germany	- -	- -	- -	- -	- -	- -	- -	- -
Greece	0 (0.0)	~ ~	7 (2.0)	505 (39.3)	6 (1.5)	527 (23.0)	87 (2.6)	515 (6.9)
Italy	0 (0.0)	~ ~	10 (2.4)	468 (18.7)	21 (2.8)	465 (15.6)	69 (4.3)	478 (9.7)
Lithuania	0 (0.2)	~ ~	8 (0.7)	554 (12.0)	9 (1.4)	524 (10.7)	83 (1.5)	512 (3.7)
Russian Federation	0 (0.1)	~ ~	2 (1.0)	~ ~	9 (1.9)	528 (32.2)	89 (2.2)	541 (8.1)
Slovenia	0 (0.0)	~ ~	20 (3.2)	451 (17.6)	23 (2.7)	446 (14.6)	57 (4.7)	495 (8.9)
Sweden	2 (1.2)	~ ~	46 (4.2)	521 (7.4)	51 (4.3)	507 (6.0)	4 (0.8)	488 (11.5)
Switzerland	1 (0.4)	~ ~	17 (3.2)	533 (10.0)	44 (3.3)	529 (5.7)	40 (4.2)	541 (9.4)
United States	8 (1.3)	390 (16.5)	3 (0.7)	410 (34.0)	7 (1.2)	409 (13.3)	90 (1.5)	453 (5.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking mathematics.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

To examine instructional activities in their classrooms, advanced mathematics students were asked how often they are asked to do reasoning tasks, apply mathematics to everyday problems, solve equations, apply models to data, and use computers to do exercises or solve problems. Reasoning tasks appear to be universally required in mathematics class (see Table 7.3), with almost all students in all countries reporting such tasks in at least some lessons. In almost every country, the students with the highest achievement were those that reported engaging in reasoning tasks most frequently.

Applying mathematics to everyday problems happens less frequently in mathematics classes in most of the TIMSS countries (see Table 7.4). One-third or more of the students in Austria, the Czech Republic, France, Germany, Greece, Italy, Lithuania, Sweden, and Switzerland reported that they are never or almost never asked to do this. However, more than one-third of the students in Australia, Canada, and the United States reported that they apply mathematics to everyday problems in most or all lessons. In almost every country, the relationship between mathematics achievement and frequency of applying mathematics to everyday problems was curvilinear, with the highest average achievement occurring among those applying mathematics to everyday problems in some or most lessons. This may reflect a tendency by instructors to spend more time on concrete applications with the less advanced students.

Algebra is an essential component of mathematics in upper secondary school, and students in every country reported that they are often asked to solve equations in mathematics class (see Table 7.5). Countries where this activity was reported to be most frequent included Australia, Canada, Cyprus, Germany, and the United States. In these countries, 50% or more of the advanced mathematics students reported being asked to solve equations in every lesson. Spending time working on equations is also an indicator of high achievement in mathematics; in almost every country, the final-year students with the highest average achievement were those who reported spending the most time solving equations.

In contrast, students in most countries reported that they are asked to apply models to data only in some lessons, or never (Table 7.6). This activity was reportedly least common in Austria, the Czech Republic, and Denmark. Countries where mathematics classes were reported to include modeling data most frequently included Cyprus, France, Greece, Italy, Sweden, and the United States, where upwards of 30% of students reported this activity in most or all lessons. There was no consistent relationship between mathematics achievement and reported frequency of applying models to data.

Final-year advanced mathematics students reported that the use of computers to do exercises or solve problems in mathematics class is comparatively rare. In eight countries, Austria, Canada, the Czech Republic, France, Germany, Lithuania, the Russian Federation, and Switzerland, 80% or more of the students reported never or almost never using computers in mathematics classes (see Table 7.7). Only in Cyprus and Slovenia did more than 20% of students report using a computer in most or all mathematics lessons. There was no consistent relationship between computer use in mathematics class and mathematics achievement.

Table 7.3

Advanced Mathematics Students' Reports on How Often They Are Asked to Do Reasoning Tasks in Their Mathematics Lessons[1] – Advanced Mathematics

Final Year of Secondary School*

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	1 (0.6)	~ ~	15 (2.4)	511 (15.2)	51 (2.5)	517 (12.5)	34 (3.5)	544 (14.4)
Austria	r 4 (0.7)	405 (30.0)	30 (2.8)	440 (10.9)	49 (2.7)	452 (7.9)	17 (1.9)	444 (10.1)
Canada	0 (0.1)	~ ~	15 (0.8)	490 (8.8)	53 (1.4)	506 (4.7)	32 (1.3)	525 (7.3)
Cyprus	1 (0.0)	~ ~	8 (1.4)	490 (16.0)	40 (2.2)	509 (6.0)	52 (2.0)	531 (6.0)
Czech Republic	0 (0.0)	~ ~	11 (1.3)	422 (10.3)	56 (2.5)	465 (8.2)	34 (2.7)	491 (20.1)
Denmark	2 (0.5)	~ ~	17 (1.4)	508 (6.9)	59 (1.3)	524 (4.6)	23 (1.2)	531 (5.8)
France	0 (0.2)	~ ~	10 (1.0)	542 (7.3)	56 (1.5)	561 (5.4)	33 (1.4)	558 (4.5)
Germany	1 (0.3)	~ ~	18 (1.4)	459 (11.3)	49 (1.9)	467 (5.4)	31 (1.2)	470 (6.3)
Greece	0 (0.3)	~ ~	4 (1.1)	477 (33.8)	37 (1.9)	481 (10.5)	59 (2.3)	540 (6.5)
Italy	2 (0.6)	~ ~	19 (2.3)	442 (13.1)	47 (3.6)	470 (11.3)	33 (4.0)	501 (12.8)
Lithuania	1 (0.3)	~ ~	18 (1.6)	494 (6.8)	60 (1.8)	518 (4.7)	21 (1.7)	531 (7.9)
Russian Federation	1 (0.4)	~ ~	23 (2.1)	486 (7.8)	48 (1.6)	544 (10.6)	27 (2.2)	590 (9.8)
Slovenia	5 (0.8)	391 (15.2)	42 (1.9)	459 (8.7)	43 (1.9)	490 (9.7)	10 (1.3)	520 (17.3)
Sweden	0 (0.0)	~ ~	12 (1.1)	498 (12.8)	51 (2.3)	507 (4.5)	37 (2.2)	523 (6.8)
Switzerland	0 (0.1)	~ ~	13 (1.3)	495 (5.1)	55 (1.3)	533 (5.4)	32 (1.4)	549 (8.3)
United States	0 (0.1)	~ ~	11 (0.9)	403 (12.4)	46 (1.5)	435 (5.6)	43 (1.7)	464 (6.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[1] Based on most frequent response for: explain reasoning behind an idea; represent and analyze relationship using tables, charts, or graphs; work on problems for which there is no immediately obvious method solution; and write equations to represent relationships.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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. A tilde (~) indicates insufficient data to report achievement.

Table 7.4

Advanced Mathematics Students' Reports on How Often They Are Asked to Apply Mathematics to Everyday Problems in Their Mathematics Lessons – Advanced Mathematics Final Year of Secondary School*

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	11 (1.6)	508 (20.0)	42 (2.3)	532 (12.9)	35 (2.5)	523 (11.7)	12 (1.7)	524 (19.5)
Austria	r 33 (3.4)	426 (9.3)	46 (3.0)	456 (8.2)	16 (1.6)	463 (9.9)	5 (1.3)	403 (30.7)
Canada	14 (1.0)	484 (10.5)	48 (1.1)	513 (4.9)	26 (1.1)	522 (5.9)	11 (0.8)	492 (8.2)
Cyprus	28 (2.7)	515 (6.5)	52 (2.4)	525 (6.8)	15 (2.0)	510 (12.5)	5 (1.2)	498 (15.2)
Czech Republic	38 (3.0)	449 (14.3)	54 (2.9)	483 (9.2)	8 (0.8)	462 (16.2)	0 (0.2)	~ ~
Denmark	27 (1.8)	513 (5.3)	52 (1.6)	529 (4.6)	20 (1.5)	525 (6.5)	2 (0.4)	~ ~
France	34 (1.7)	556 (4.9)	50 (1.4)	564 (5.5)	10 (1.1)	546 (9.4)	6 (0.7)	536 (10.7)
Germany	45 (2.8)	451 (6.6)	44 (2.5)	482 (5.7)	9 (1.2)	473 (7.7)	2 (0.5)	~ ~
Greece	34 (2.5)	512 (8.9)	54 (2.0)	520 (7.3)	9 (1.3)	513 (19.3)	3 (0.8)	469 (27.5)
Italy	67 (3.5)	472 (7.9)	26 (2.9)	483 (16.7)	5 (1.2)	465 (21.1)	3 (0.7)	417 (17.7)
Lithuania	46 (1.8)	511 (4.2)	40 (1.7)	521 (5.8)	11 (1.1)	525 (8.6)	3 (0.8)	529 (17.9)
Russian Federation	23 (1.3)	531 (9.8)	58 (1.4)	549 (9.9)	15 (1.1)	538 (11.2)	4 (0.5)	531 (37.4)
Slovenia	25 (1.8)	448 (9.2)	56 (2.4)	487 (9.9)	16 (1.2)	478 (11.6)	3 (0.5)	472 (12.6)
Sweden	36 (2.7)	498 (6.5)	53 (2.5)	524 (6.5)	10 (1.2)	503 (14.1)	1 (0.4)	~ ~
Switzerland	43 (2.4)	514 (6.5)	49 (2.3)	545 (6.3)	7 (0.9)	573 (13.2)	1 (0.4)	~ ~
United States	15 (1.4)	438 (13.1)	42 (1.3)	449 (7.6)	27 (1.4)	447 (5.3)	16 (1.1)	427 (7.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

Table 7.5

Advanced Mathematics Students' Reports on How Often They Are Asked to Solve Equations in Their Mathematics Lessons – Advanced Mathematics

Final Year of Secondary School*

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	2 (0.8)	~ ~	9 (1.1)	488 (16.6)	39 (3.1)	529 (14.8)	50 (2.9)	530 (12.8)
Austria	r 7 (1.7)	371 (15.2)	26 (2.6)	438 (7.5)	50 (3.5)	449 (9.1)	17 (2.1)	475 (11.5)
Canada	1 (0.2)	~ ~	9 (0.7)	490 (8.2)	37 (1.5)	506 (5.5)	53 (1.3)	517 (5.8)
Cyprus	2 (0.5)	~ ~	10 (1.4)	491 (14.9)	38 (1.9)	509 (8.1)	50 (2.2)	534 (7.2)
Czech Republic	0 (0.2)	~ ~	36 (1.8)	456 (10.4)	46 (1.8)	475 (11.3)	17 (1.8)	482 (23.0)
Denmark	2 (0.6)	~ ~	17 (1.5)	511 (7.7)	58 (1.8)	524 (4.1)	23 (1.5)	531 (5.6)
France	1 (0.4)	~ ~	21 (1.4)	549 (5.5)	52 (1.7)	560 (4.7)	25 (1.3)	559 (5.0)
Germany	1 (0.2)	~ ~	12 (1.5)	458 (6.8)	37 (1.5)	463 (6.3)	51 (2.3)	472 (6.2)
Greece	1 (0.5)	~ ~	14 (1.9)	467 (17.5)	40 (2.4)	514 (8.0)	46 (2.8)	533 (7.6)
Italy	2 (0.6)	~ ~	20 (2.6)	451 (11.5)	38 (2.9)	464 (11.0)	40 (3.3)	500 (13.6)
Lithuania	1 (0.2)	~ ~	10 (1.4)	499 (12.7)	57 (1.9)	512 (6.0)	33 (1.8)	528 (5.8)
Russian Federation	0 (0.2)	~ ~	10 (1.4)	484 (13.7)	49 (1.8)	530 (9.2)	41 (2.6)	570 (9.5)
Slovenia	2 (0.4)	~ ~	26 (1.9)	446 (12.7)	49 (2.0)	480 (9.2)	24 (1.9)	502 (10.4)
Sweden	0 (0.2)	~ ~	13 (1.4)	494 (11.1)	52 (1.4)	505 (5.1)	35 (1.9)	531 (6.5)
Switzerland	2 (0.6)	~ ~	18 (1.5)	510 (5.4)	54 (1.9)	529 (5.8)	26 (1.6)	561 (10.2)
United States	0 (0.1)	~ ~	6 (0.8)	415 (12.8)	28 (1.2)	437 (6.2)	66 (1.2)	450 (5.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

Table 7.6

Advanced Mathematics Students' Reports on How Often They Are Asked to Apply Models to Data in Their Mathematics Lessons – Advanced Mathematics Final Year of Secondary School*

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	24 (3.2)	514 (15.8)	51 (3.4)	529 (10.9)	22 (3.2)	532 (20.2)	3 (0.9)	513 (34.0)
Austria	r 60 (2.5)	441 (8.2)	29 (2.5)	449 (9.6)	9 (1.1)	473 (12.4)	2 (0.7)	~ ~
Canada	30 (1.7)	488 (5.7)	43 (1.7)	513 (5.4)	20 (1.5)	524 (6.0)	7 (0.6)	543 (15.6)
Cyprus	18 (1.7)	515 (10.9)	41 (2.3)	519 (8.1)	25 (1.9)	521 (9.7)	16 (2.0)	522 (10.6)
Czech Republic	76 (2.1)	468 (12.8)	22 (1.9)	475 (10.6)	2 (0.5)	~ ~	0 (0.2)	~ ~
Denmark	56 (2.5)	519 (4.2)	38 (2.4)	531 (4.8)	5 (0.9)	512 (12.5)	1 (0.3)	~ ~
France	10 (1.0)	561 (9.7)	39 (1.7)	555 (5.1)	37 (1.9)	563 (5.8)	14 (1.6)	547 (6.7)
Germany	43 (1.3)	455 (6.6)	38 (1.3)	475 (6.1)	14 (1.2)	480 (6.2)	5 (0.6)	466 (9.4)
Greece	23 (3.0)	507 (11.1)	42 (2.3)	513 (9.5)	25 (2.3)	522 (10.0)	10 (1.7)	525 (16.8)
Italy	28 (2.4)	461 (10.7)	42 (2.5)	466 (12.3)	20 (2.2)	497 (13.9)	10 (1.7)	506 (30.1)
Lithuania	30 (2.5)	518 (8.8)	42 (2.6)	516 (5.6)	22 (1.4)	523 (8.2)	6 (0.9)	497 (7.2)
Russian Federation	25 (1.3)	547 (11.8)	52 (1.9)	543 (9.0)	20 (1.7)	535 (16.3)	4 (0.5)	539 (16.0)
Slovenia	36 (2.1)	443 (9.3)	48 (2.0)	492 (9.2)	13 (1.6)	504 (16.5)	3 (0.5)	492 (19.5)
Sweden	27 (1.9)	502 (10.0)	44 (2.0)	519 (5.6)	23 (1.5)	508 (7.4)	7 (1.3)	525 (11.2)
Switzerland	33 (1.8)	513 (5.5)	41 (1.7)	547 (7.3)	21 (1.6)	536 (12.5)	5 (0.7)	544 (19.1)
United States	23 (1.3)	424 (9.8)	45 (1.5)	450 (7.1)	24 (1.2)	448 (5.0)	8 (0.8)	447 (9.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

Table 7.7

Advanced Mathematics Students' Reports on How Often in Mathematics Lessons They Are Asked to Use Computers to Solve Exercises or Problems – Advanced Mathematics Final Year of Secondary School*

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	72 (3.4)	531 (10.8)	20 (3.6)	490 (20.5)	3 (1.3)	544 (16.8)	5 (1.9)	574 (31.4)
Austria	r 84 (3.2)	442 (7.3)	14 (3.2)	466 (15.0)	1 (0.3)	~ ~	1 (0.4)	~ ~
Canada	80 (1.6)	511 (4.7)	17 (1.6)	504 (7.5)	2 (0.4)	~ ~	2 (0.4)	~ ~
Cyprus	54 (2.2)	522 (6.0)	16 (1.7)	506 (10.2)	20 (1.9)	518 (8.9)	11 (1.3)	516 (14.4)
Czech Republic	97 (0.9)	468 (11.3)	2 (0.9)	~ ~	0 (0.2)	~ ~	0 (0.1)	~ ~
Denmark	67 (2.4)	519 (4.6)	30 (2.3)	534 (5.6)	2 (0.4)	~ ~	0 (0.2)	~ ~
France	88 (1.1)	560 (3.9)	7 (0.8)	546 (10.7)	3 (0.6)	537 (13.8)	2 (0.6)	~ ~
Germany	89 (1.4)	465 (5.3)	8 (1.2)	491 (15.3)	2 (0.3)	~ ~	2 (0.5)	~ ~
Greece	68 (2.1)	522 (7.1)	23 (2.4)	504 (15.0)	6 (1.3)	494 (17.5)	3 (0.9)	487 (36.4)
Italy	44 (4.3)	481 (7.7)	37 (3.5)	477 (14.6)	11 (1.8)	447 (22.7)	8 (2.3)	463 (20.7)
Lithuania	86 (1.2)	510 (3.5)	11 (0.9)	557 (9.3)	2 (0.4)	~ ~	2 (0.5)	~ ~
Russian Federation	83 (1.4)	537 (8.7)	14 (1.4)	559 (13.4)	2 (0.6)	~ ~	1 (0.3)	~ ~
Slovenia	13 (1.4)	504 (16.0)	34 (2.1)	474 (9.5)	38 (1.9)	471 (10.3)	15 (1.5)	462 (12.6)
Sweden	79 (4.0)	505 (5.2)	20 (3.8)	538 (7.8)	1 (0.4)	~ ~	1 (0.3)	~ ~
Switzerland	84 (2.6)	525 (5.2)	14 (2.1)	577 (11.1)	2 (0.7)	~ ~	1 (0.4)	~ ~
United States	66 (1.9)	443 (5.8)	23 (1.7)	446 (9.4)	7 (0.5)	451 (11.5)	4 (0.5)	434 (13.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

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As noted in Chapter 4, final-year students in general reported frequent calculator use at school, home, or anywhere else. Final-year students taking advanced mathematics used calculators even more extensively, as shown in Table 7.8. In Australia, Canada, Cyprus, Denmark, Sweden, and the United States, more than 80% of students reported using a calculator at least daily, and in several other countries more than half of the students reported this level of use. The lowest levels of calculator use among advanced mathematics students were reported in the Czech Republic and Greece, where about one-fourth of the students reported using a calculator once a month or less. Similar to final-year students in general, the advanced mathematics students with the highest average achievement were those who reported the highest level of calculator use. In almost every country, students who reported daily calculator use performed better on the TIMSS mathematics assessment than those who reported less frequent use.

Since students use calculators so frequently in many countries, final-year students were given the option of using a calculator when doing the TIMSS tests. Table 7.9 summarizes students' reports on how frequently they used a calculator during the testing session. Like final-year students in general, most of the advanced mathematics students made moderate use (for up to 10 questions) of a calculator on the TIMSS test; smaller percentages reported using a calculator quite a lot. In Greece, Italy, Lithuania, and the Russian Federation, more than one-third of the students reported not using a calculator at all. In general, the students who reported that they did not use a calculator on the test did not do as well as those who reported using one, although the extent of calculator use was not consistently related to achievement in every country.

Table 7.8

Advanced Mathematics Students' Reports on How Often They Use a Calculator at School, Home, or Anywhere Else – Advanced Mathematics Final Year of Secondary School*

Country	Rarely or Never		Monthly		Weekly		Daily	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	0 (0.1)	~ ~	0 (0.3)	~ ~	7 (1.6)	496 (36.9)	93 (1.8)	527 (11.3)
Austria	4 (1.4)	389 (32.3)	3 (0.7)	391 (30.4)	33 (2.5)	427 (10.0)	60 (2.6)	447 (7.6)
Canada	1 (0.4)	~ ~	1 (0.2)	~ ~	11 (1.2)	487 (10.3)	87 (1.5)	513 (4.2)
Cyprus	2 (0.7)	~ ~	1 (0.4)	~ ~	9 (1.4)	502 (11.9)	88 (1.5)	522 (5.0)
Czech Republic	11 (2.6)	414 (13.3)	14 (2.5)	430 (21.4)	44 (2.7)	456 (8.1)	31 (3.3)	525 (13.0)
Denmark	0 (0.2)	~ ~	0 (0.2)	~ ~	10 (1.1)	510 (10.8)	89 (1.2)	525 (3.4)
France	1 (0.4)	~ ~	2 (0.5)	~ ~	19 (1.4)	545 (6.7)	77 (1.3)	562 (3.9)
Germany	5 (0.6)	399 (9.4)	4 (0.6)	396 (12.0)	33 (1.8)	451 (7.0)	57 (2.1)	486 (5.9)
Greece	22 (1.9)	482 (17.8)	6 (1.3)	505 (22.9)	28 (2.3)	508 (11.7)	44 (2.9)	538 (7.6)
Italy	6 (2.1)	432 (23.3)	4 (1.2)	432 (19.7)	37 (3.1)	473 (14.0)	53 (3.1)	483 (9.6)
Lithuania	3 (0.6)	476 (18.6)	2 (0.6)	~ ~	19 (1.1)	494 (5.8)	75 (1.2)	525 (4.1)
Russian Federation	9 (0.8)	512 (12.6)	6 (1.0)	521 (18.6)	28 (1.6)	538 (14.1)	57 (1.9)	551 (8.1)
Slovenia	2 (0.4)	~ ~	3 (0.7)	468 (26.3)	28 (2.0)	466 (10.0)	67 (2.4)	480 (10.2)
Sweden	0 (0.2)	~ ~	0 (0.2)	~ ~	10 (1.5)	499 (16.4)	89 (1.6)	514 (4.2)
Switzerland	1 (0.3)	~ ~	1 (0.3)	~ ~	27 (1.8)	508 (8.9)	72 (1.9)	544 (4.4)
United States	3 (0.4)	381 (17.4)	2 (0.5)	~ ~	13 (1.0)	418 (10.7)	82 (1.5)	452 (6.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

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Table 7.9

Advanced Mathematics Students' Reports on the Frequency of Calculator Use During the TIMSS Test – Advanced Mathematics Final Year of Secondary School*

Country	Did Not Use a Calculator		Used a Calculator Very Little (<5 Questions)		Used a Calculator Somewhat (5-10 Questions)		Used a Calculator Quite a Lot (>10 Questions)	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	10 (1.8)	488 (25.0)	55 (2.2)	533 (15.4)	28 (1.8)	526 (12.7)	6 (1.2)	527 (17.5)
Austria	20 (2.7)	391 (16.1)	47 (2.3)	447 (9.8)	29 (2.7)	451 (6.0)	4 (0.8)	426 (14.5)
Canada	7 (0.7)	478 (12.8)	59 (1.6)	515 (5.4)	29 (1.5)	505 (5.6)	5 (0.8)	520 (12.7)
Cyprus	30 (2.1)	504 (8.4)	58 (2.4)	525 (6.0)	10 (1.8)	512 (17.2)	1 (0.4)	~ ~
Czech Republic	13 (1.6)	452 (16.1)	64 (1.7)	473 (11.8)	21 (1.3)	472 (15.1)	1 (0.4)	~ ~
Denmark	7 (0.9)	475 (9.9)	55 (1.4)	529 (3.7)	33 (1.5)	525 (5.0)	6 (0.7)	519 (9.2)
France	13 (1.6)	547 (8.5)	56 (2.4)	561 (4.2)	25 (1.7)	557 (6.8)	5 (0.7)	571 (12.6)
Germany	15 (1.6)	414 (8.0)	58 (1.7)	479 (6.0)	23 (1.0)	478 (6.3)	4 (0.6)	457 (14.2)
Greece	86 (2.2)	509 (6.6)	13 (2.0)	539 (14.6)	1 (0.4)	~ ~	0 (0.2)	~ ~
Italy	38 (5.1)	468 (18.9)	47 (3.6)	485 (9.6)	13 (2.8)	466 (11.2)	2 (0.5)	~ ~
Lithuania	r 40 (1.7)	516 (4.5)	50 (2.1)	524 (7.1)	8 (1.3)	539 (24.2)	1 (0.5)	~ ~
Russian Federation	r 50 (2.4)	551 (12.2)	41 (2.0)	556 (9.3)	8 (1.0)	506 (9.9)	1 (0.3)	~ ~
Slovenia	26 (2.4)	435 (10.1)	64 (2.4)	492 (9.8)	10 (1.3)	479 (12.1)	1 (0.4)	~ ~
Sweden	3 (0.7)	474 (21.0)	39 (2.0)	509 (7.3)	46 (2.1)	515 (4.9)	11 (1.2)	526 (10.1)
Switzerland	7 (0.9)	484 (12.3)	57 (1.6)	546 (5.8)	32 (1.3)	524 (5.8)	4 (0.5)	532 (18.2)
United States	14 (1.6)	388 (10.6)	55 (2.0)	443 (6.1)	26 (1.8)	459 (9.8)	5 (0.8)	497 (18.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

What Are Secondary School Students' Educational Resources and Plans?

Chapter 4 describes the strong relationship between parental education and mathematics and science literacy among final-year students in each country. Table 7.10 presents similar information for final-year students taking advanced mathematics. Results are presented for the same three educational levels: finished university, finished upper secondary school but not university, and finished primary school but not upper secondary. The modifications that were made by some countries are those described in Figure 4.6. The clear positive relationship between parents' education and mathematics and science literacy for final-year students in general (see Table 4.6) is also apparent in Table 7.10 for students taking advanced mathematics. The major difference is that the advanced mathematics students reported much higher levels of parental education. Whereas in only five countries did as many as 30% of final-year students in general indicate that at least one parent had finished university, among advanced mathematics students this figure was reached in all but two countries (Austria and Italy). More than half the advanced mathematics students in Canada, Lithuania, the Russian Federation, and the United States reported that at least one parent had completed university.

It is clear from the discussion in Chapter 4 that although many final-year students were planning a university career, there were also many who planned to follow a vocational, technical, or other postsecondary course, or to continue no further with their education. Among final-year students taking advanced mathematics, however, the majority in every country reported that they plan to attend university, and in ten countries – Australia, Canada, Cyprus, the Czech Republic, Greece, Lithuania, the Russian Federation, Sweden, Switzerland, and the United States – the percentage planning a university career exceeded 80% (see Table 7.11). Countries where 10% or more of the students planned to choose a vocationally oriented program included Austria, France, Germany, the Russian Federation, and Slovenia. Very few of the advanced mathematics students reported that they planned not to continue their education. Only in Austria, Denmark, and Italy did more than 10% of students state that intention. In most countries, the students planning to attend university had higher average mathematics achievement than the other groups.

Students who have studied advanced mathematics in upper secondary school have many areas for further study available to them. Table 7.12 presents students' reports of their choices for further study, including mathematics, computer or information sciences, engineering, business, health sciences or related occupations, and the sciences. An "other" category was provided for students whose preferred area of study was not included. It is noteworthy that in almost half of the countries, more students indicated that they planned to study some area other than the choices provided.

The most popular areas were business, health sciences or related occupations, and engineering. Of the specific choices available, business was the area chosen most often by advanced mathematics students in Austria, the Czech Republic, Denmark, Germany, Lithuania, the Russian Federation, and Slovenia, and was one of the two most popular in Australia and Switzerland. Health sciences and related occupations

Table 7.10

Advanced Mathematics Students' Reports on the Highest Level of Education of Either Parent† – Advanced Mathematics
Final Year of Secondary School*

Country	Finished University[1]		Finished Upper Secondary but Not University[2]		Finished Primary but Not Upper Secondary[3]		Do Not Know	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	47 (4.0)	551 (9.8)	31 (3.5)	512 (16.4)	19 (2.8)	480 (17.2)	4 (0.9)	541 (39.8)
Austria	21 (1.7)	465 (10.1)	68 (2.5)	429 (8.5)	9 (1.3)	433 (14.4)	2 (0.8)	~ ~
Canada	53 (2.1)	527 (5.4)	37 (1.6)	490 (4.9)	8 (0.9)	487 (10.1)	3 (0.7)	508 (17.0)
Cyprus	43 (2.1)	534 (6.3)	37 (1.5)	511 (8.4)	18 (1.8)	498 (15.1)	2 (0.8)	~ ~
Czech Republic	49 (1.8)	493 (15.5)	39 (1.6)	452 (10.2)	11 (0.9)	432 (7.0)	0 (0.1)	~ ~
Denmark	36 (1.9)	531 (5.0)	55 (2.1)	520 (4.4)	7 (0.9)	510 (10.0)	3 (0.5)	519 (13.1)
France	31 (3.3)	573 (5.0)	44 (2.5)	557 (4.1)	22 (2.5)	541 (7.1)	3 (0.6)	540 (10.6)
Germany	50 (2.0)	479 (6.3)	47 (1.8)	455 (5.3)	2 (0.4)	~ ~	- -	- -
Greece	34 (3.1)	537 (8.2)	44 (2.5)	512 (9.1)	20 (2.6)	490 (14.6)	2 (0.8)	~ ~
Italy	16 (3.3)	531 (19.0)	52 (2.1)	474 (9.7)	31 (4.0)	448 (10.9)	1 (0.6)	~ ~
Lithuania	67 (1.3)	531 (3.4)	30 (1.4)	486 (5.7)	2 (0.4)	~ ~	1 (0.5)	~ ~
Russian Federation	65 (2.4)	566 (7.9)	33 (2.5)	500 (12.4)	1 (0.4)	~ ~	1 (0.2)	~ ~
Slovenia	30 (2.2)	510 (11.6)	59 (2.1)	462 (9.5)	10 (1.0)	450 (10.0)	1 (0.3)	~ ~
Sweden	43 (2.1)	523 (7.1)	40 (2.4)	512 (9.5)	7 (1.0)	492 (12.3)	10 (1.1)	489 (11.1)
Switzerland	34 (1.7)	539 (5.7)	61 (1.6)	531 (5.6)	4 (0.7)	528 (15.0)	2 (0.4)	~ ~
United States	58 (2.0)	472 (6.3)	37 (1.5)	411 (5.8)	4 (0.8)	390 (7.6)	1 (0.3)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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 4.6 for country modifications to the definitions of educational levels.

* See Appendix A for characteristics of the students sampled.

[1] In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

[2] 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.

[3] Finished primary or some secondary school not equivalent to completion of upper secondary.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

Table 7.11

Advanced Mathematics Students' Reports on Their Plans for Future Education† – Advanced Mathematics

Final Year of Secondary School*

Country	University[1]		Vocationally Oriented Programs[2]		Other Postsecondary Education[3]		Does Not Intend to Continue Education	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	94 (1.2)	528 (11.3)	2 (0.5)	~ ~	2 (0.8)	~ ~	1 (0.8)	~ ~
Austria	66 (2.2)	454 (7.6)	13 (1.7)	372 (17.2)	5 (0.9)	412 (13.4)	15 (1.9)	429 (10.9)
Canada	84 (1.3)	515 (3.9)	4 (0.4)	425 (8.4)	11 (1.4)	502 (13.7)	1 (0.2)	~ ~
Cyprus	91 (1.4)	522 (4.7)	5 (1.0)	466 (25.8)	4 (1.0)	498 (21.1)	1 (0.5)	~ ~
Czech Republic	93 (0.7)	475 (11.5)	5 (0.7)	375 (12.2)	1 (0.3)	~ ~	1 (0.4)	~ ~
Denmark	r 67 (1.6)	537 (4.6)	8 (0.9)	493 (8.5)	11 (1.0)	501 (9.8)	14 (1.5)	512 (8.1)
France	76 (1.8)	564 (3.9)	13 (1.6)	540 (8.1)	10 (1.2)	544 (10.5)	1 (0.3)	~ ~
Germany	72 (2.5)	474 (6.0)	21 (2.1)	440 (5.8)	3 (0.6)	486 (19.6)	4 (0.6)	448 (17.0)
Greece	85 (1.6)	534 (5.6)	7 (1.1)	400 (27.3)	7 (1.2)	427 (26.3)	2 (0.6)	~ ~
Italy	73 (3.1)	489 (11.0)	3 (0.8)	451 (9.9)	11 (2.6)	445 (14.6)	13 (1.9)	417 (17.5)
Lithuania	90 (1.3)	523 (2.9)	3 (0.8)	445 (17.2)	7 (1.1)	464 (11.6)	0 (0.2)	~ ~
Russian Federation	86 (1.7)	555 (8.1)	10 (1.4)	460 (16.9)	3 (0.5)	489 (13.6)	1 (0.4)	~ ~
Slovenia	80 (2.2)	492 (8.9)	13 (1.9)	412 (13.0)	2 (0.4)	~ ~	5 (0.6)	383 (12.4)
Sweden	93 (1.2)	519 (4.8)	2 (0.6)	~ ~	3 (0.7)	424 (20.2)	1 (0.4)	~ ~
Switzerland	88 (1.1)	538 (4.9)	2 (0.4)	~ ~	5 (0.7)	497 (11.2)	5 (0.7)	493 (15.5)
United States	93 (0.9)	448 (5.3)	2 (0.5)	~ ~	5 (0.7)	391 (9.4)	0 (0.2)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Educational options were defined by each country to conform to their national systems and may not be comparable across countries. See Figure 4.2 for definitions and any national adaptations of the international options in each category.

* See Appendix A for characteristics of the students sampled.

[1] In most countries, defined as at least a 3-year degree program at a university or an equivalent institute of higher education.

[2] Defined in most countries as vocational or technical courses at a tertiary institution not equivalent to a university degree program (e.g., trade or business school, junior or community college, and other shorter vocational programs), but may also include higher-level upper secondary vocational programs in some countries.

[3] Includes other postsecondary education defined in each country. Includes categories such as academic courses at junior or community college, short university or polytechnic courses, and college-preparatory courses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

A tilde (~) indicates insufficient data to report achievement.

Table 7.12

Advanced Mathematics Students' Reports on the Area They Intend to Study After Secondary School – Advanced Mathematics Final Year of Secondary School*

Country		Percent of Students						
		Mathematics	Computer or Information Sciences	Engineering	Business	Health Sciences or Related Occupations	Sciences[1]	Other
Australia		3 (1.2)	9 (1.3)	18 (1.9)	21 (3.1)	21 (2.2)	12 (1.4)	17 (2.1)
Austria	r	2 (0.6)	3 (1.3)	6 (1.2)	17 (2.0)	13 (1.8)	10 (1.9)	48 (3.0)
Canada		3 (0.5)	6 (.8)	17 (1.2)	16 (1.0)	25 (1.5)	16 (1.2)	17 (0.8)
Cyprus		9 (1.2)	9 (1.3)	15 (2.4)	5 (0.9)	27 (2.1)	16 (2.1)	19 (1.6)
Czech Republic		4 (0.8)	7 (1.3)	3 (0.6)	20 (1.9)	12 (1.5)	17 (1.4)	37 (4.1)
Denmark	r	3 (0.6)	6 (0.8)	16 (1.3)	18 (1.6)	16 (1.3)	15 (1.5)	26 (1.3)
France		12 (1.2)	6 (0.8)	14 (1.8)	6 (1.0)	19 (1.3)	29 (2.2)	13 (1.7)
Germany		2 (0.3)	3 (0.6)	10 (1.0)	26 (1.6)	13 (1.4)	11 (1.2)	36 (1.4)
Greece		4 (0.9)	25 (2.2)	36 (2.9)	2 (0.8)	1 (0.5)	16 (1.9)	17 (1.9)
Italy		2 (1.3)	4 (1.4)	22 (3.8)	18 (2.5)	13 (4.0)	12 (3.8)	29 (2.8)
Lithuania	s	2 (0.4)	13 (2.1)	4 (0.8)	23 (1.8)	7 (1.2)	6 (1.0)	46 (2.0)
Russian Federation		6 (1.3)	23 (1.9)	9 (1.1)	32 (1.5)	5 (0.5)	8 (1.3)	17 (1.5)
Slovenia		2 (0.4)	9 (1.9)	11 (2.1)	28 (2.9)	9 (1.8)	11 (1.6)	31 (2.8)
Sweden		2 (0.5)	12 (2.4)	41 (2.8)	5 (0.7)	10 (1.7)	16 (2.0)	14 (1.5)
Switzerland		1 (0.4)	2 (0.5)	8 (1.2)	17 (1.4)	17 (1.8)	14 (1.0)	42 (2.3)
United States		3 (0.4)	5 (0.7)	16 (1.1)	15 (1.1)	24 (1.1)	11 (0.8)	26 (1.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

[1] Includes biological sciences, chemistry, earth sciences, and physics.

( ) 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.

represented the area of choice in Canada, Cyprus, and the United States, and were also popular in Australia and Switzerland. Engineering was reported most often by advanced mathematics students in Greece, Italy, and Sweden. Only in France did the most students indicate the sciences, which included biology, physics, chemistry, and earth science. France was also the only country where more than 10% of advanced mathematics students chose mathematics as their future area of study. In no country did students report computer or information sciences as the most popular choice, but more than 20% of students in Greece and the Russian Federation indicated it as their preferred area.

The results in Table 7.13 reveal substantial differences between males and females in their plans for further study. Among students choosing engineering or computer or information sciences, males outnumbered females by a wide margin in most countries, while in mathematics, business, and the sciences, the numbers were more even. Females outnumbered males in choosing health sciences and related occupations in nearly all countries. Among students choosing the "other" category there were more females than males in most countries, suggesting that many females who have taken advanced mathematics will pursue further studies in areas unrelated to mathematics.

Table 7.13

Advanced Mathematics Students' Reports on the Area They Intend to Study After Secondary School by Gender – Advanced Mathematics
Final Year of Secondary School*

Country		Percent of Students							
		Mathematics		Computer or Information Sciences		Engineering		Business	
		Males	Females	Males	Females	Males	Females	Males	Females
Australia		1 (1.1)	4 (1.7)	14 (2.5)	3 (0.9)	28 (3.4)	6 (1.8)	16 (2.4)	26 (5.7)
Austria	r	2 (1.0)	2 (0.7)	7 (2.9)	1 (0.6)	10 (2.3)	4 (1.4)	26 (2.7)	11 (2.2)
Canada		4 (0.8)	2 (0.8)	9 (1.2)	2 (.8)	27 (2.1)	7 (0.8)	17 (1.5)	15 (1.3)
Cyprus		6 (1.8)	14 (2.9)	13 (2.2)	5 (1.8)	21 (3.3)	6 (2.1)	5 (0.9)	4 (1.7)
Czech Republic		6 (1.5)	2 (0.8)	17 (2.7)	0 (0.0)	4 (1.1)	1 (0.5)	21 (2.4)	19 (2.0)
Denmark	r	2 (0.7)	4 (1.2)	10 (1.3)	1 (0.6)	22 (1.7)	5 (1.3)	21 (2.2)	13 (2.2)
France		12 (1.8)	12 (2.0)	9 (1.3)	1 (0.4)	21 (2.5)	4 (1.1)	7 (1.3)	6 (1.4)
Germany		2 (0.5)	2 (0.3)	5 (1.2)	1 (0.3)	18 (2.1)	4 (0.7)	28 (3.1)	25 (1.4)
Greece		2 (0.7)	10 (3.1)	28 (2.7)	17 (3.1)	36 (4.1)	35 (3.4)	2 (1.1)	1 (0.5)
Italy		1 (0.9)	3 (2.4)	7 (2.2)	1 (0.7)	34 (5.9)	8 (4.2)	21 (3.3)	14 (4.7)
Lithuania	s	2 (0.8)	2 (0.3)	25 (4.0)	1 (0.5)	6 (1.7)	2 (0.4)	21 (2.4)	25 (2.8)
Russian Federation		5 (1.0)	7 (2.2)	35 (2.3)	9 (1.5)	15 (1.6)	2 (0.7)	23 (2.3)	41 (2.3)
Slovenia		2 (0.5)	1 (0.5)	17 (3.3)	1 (1.0)	20 (3.0)	4 (2.3)	25 (2.6)	31 (4.6)
Sweden		2 (0.5)	2 (1.0)	16 (2.9)	1 (0.6)	48 (2.8)	28 (2.9)	4 (1.0)	5 (1.2)
Switzerland		1 (0.3)	1 (0.7)	4 (0.9)	0 (0.0)	13 (2.0)	2 (0.8)	22 (1.8)	10 (1.6)
United States		2 (0.5)	4 (0.7)	7 (1.3)	2 (0.6)	26 (2.0)	6 (1.0)	16 (1.5)	14 (1.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) 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.

Table 7.13 (Continued)

Advanced Mathematics Students' Reports on the Area They Intend to Study After Secondary School by Gender – Advanced Mathematics
Final Year of Secondary School*

Country	Percent of Students: Health Sciences or Related Occupations – Males	Health Sciences or Related Occupations – Females	Sciences[1] – Males	Sciences[1] – Females	Other – Males	Other – Females
Australia	16 (3.2)	27 (3.8)	10 (2.1)	14 (2.6)	15 (2.1)	19 (3.1)
Austria	9 (2.1)	17 (2.7)	10 (2.8)	10 (2.2)	37 (3.7)	57 (3.8)
Canada	16 (1.9)	34 (2.0)	14 (1.7)	18 (2.2)	13 (1.3)	21 (1.6)
Cyprus	23 (2.5)	34 (4.0)	14 (2.7)	18 (3.5)	18 (2.1)	20 (3.5)
Czech Republic	9 (1.6)	15 (1.8)	17 (2.2)	17 (1.7)	25 (4.4)	46 (4.1)
Denmark	10 (1.1)	28 (2.6)	13 (1.5)	19 (2.7)	23 (1.7)	30 (2.9)
France	11 (1.5)	33 (2.5)	27 (2.9)	32 (2.3)	13 (1.7)	13 (1.9)
Germany	7 (1.3)	17 (1.8)	11 (1.5)	10 (1.6)	28 (2.6)	41 (1.1)
Greece	1 (0.6)	1 (0.6)	14 (2.2)	20 (4.7)	17 (2.2)	17 (3.8)
Italy	6 (2.4)	21 (6.4)	11 (5.0)	13 (4.7)	21 (3.4)	39 (6.7)
Lithuania	5 (0.9)	10 (2.4)	7 (1.5)	5 (1.5)	35 (2.1)	56 (3.8)
Russian Federation	2 (0.5)	8 (1.0)	7 (1.0)	8 (2.7)	12 (1.7)	24 (2.1)
Slovenia	5 (1.5)	12 (2.8)	10 (2.2)	11 (2.1)	22 (2.6)	39 (3.8)
Sweden	6 (1.5)	20 (2.4)	12 (2.1)	26 (2.9)	12 (1.7)	18 (2.1)
Switzerland	12 (2.0)	22 (2.8)	18 (1.6)	11 (1.4)	31 (2.3)	54 (3.5)
United States	17 (2.4)	31 (1.7)	12 (1.2)	11 (1.2)	19 (1.6)	33 (2.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).
[1] Includes biological sciences, chemistry, earth sciences, and physics.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

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Even though not many students chose mathematics as their preferred area of study, the majority of the students in 10 of the countries agreed that they would like a job that involved using mathematics (see Table 7.14). Only in Austria, the Czech Republic, Germany, Italy, Slovenia, and Switzerland did a majority of advanced mathematics students report that they would not like such a job. In Austria, 55% of advanced mathematics students strongly disagreed that they would like a job that involved mathematics. Not surprisingly, high achievement in mathematics went hand in hand with wanting a job that involved using mathematics. In every country, there was a direct relationship between higher achievement and the strength of agreement in wanting a job that involved using mathematics.

In general, among those agreeing that they would like a job in mathematics there were more males than females, with more females than males disagreeing with that statement (see Table 7.15). Since females also had lower average achievement than males, it is unclear whether female students' relative lack of enthusiasm for a job involving mathematics reflects their lower average achievement, or whether the latter is partly the result of less interest in mathematical pursuits.

Table 7.14

Advanced Mathematics Students' Reports That They Would Like a Job That Involved Using Mathematics – Advanced Mathematics
Final Year of Secondary School*

Country	Strongly Agree		Agree		Disagree		Strongly Disagree	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	8 (1.5)	580 (21.6)	50 (2.7)	545 (11.8)	30 (3.2)	502 (16.6)	13 (1.4)	481 (12.6)
Austria	5 (0.8)	490 (17.0)	15 (1.4)	489 (10.2)	26 (2.2)	461 (9.8)	55 (2.7)	410 (6.9)
Canada	15 (1.2)	566 (6.4)	48 (1.7)	517 (5.2)	25 (1.4)	483 (6.8)	11 (0.9)	459 (9.3)
Cyprus	25 (2.5)	545 (13.0)	42 (3.1)	520 (6.1)	21 (1.8)	502 (7.9)	12 (2.3)	496 (10.0)
Czech Republic	9 (1.5)	600 (20.0)	23 (1.4)	529 (13.8)	33 (1.4)	456 (7.9)	35 (2.6)	411 (7.9)
Denmark	20 (1.5)	557 (6.2)	45 (1.7)	531 (4.5)	26 (1.6)	504 (5.1)	9 (0.9)	471 (7.3)
France	16 (1.3)	599 (7.1)	40 (1.7)	571 (4.9)	27 (1.6)	535 (6.4)	17 (1.3)	523 (5.8)
Germany	10 (1.0)	532 (10.0)	22 (1.0)	500 (7.4)	25 (0.9)	481 (6.3)	43 (1.2)	428 (5.4)
Greece	21 (2.3)	554 (12.9)	51 (2.8)	528 (8.4)	20 (2.3)	484 (9.7)	8 (1.5)	441 (21.4)
Italy	8 (1.2)	556 (16.1)	35 (4.4)	496 (11.2)	28 (3.2)	461 (10.5)	29 (4.4)	437 (11.2)
Lithuania	12 (1.3)	537 (8.6)	49 (2.1)	528 (3.9)	28 (1.6)	499 (5.2)	11 (1.1)	489 (7.2)
Russian Federation	16 (1.3)	574 (13.7)	49 (1.9)	561 (8.9)	25 (1.3)	507 (11.6)	9 (1.2)	487 (9.2)
Slovenia	6 (1.2)	531 (20.9)	29 (2.0)	513 (10.8)	33 (1.7)	467 (9.7)	31 (2.3)	438 (11.0)
Sweden	12 (1.6)	571 (7.0)	47 (1.6)	532 (4.5)	30 (1.6)	483 (6.1)	10 (1.1)	441 (10.4)
Switzerland	10 (1.0)	612 (7.2)	21 (1.6)	575 (6.9)	31 (1.8)	529 (6.5)	38 (2.3)	493 (7.2)
United States	17 (1.1)	500 (9.1)	43 (1.3)	450 (5.3)	26 (1.4)	424 (7.6)	13 (1.3)	391 (11.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 7.15

Advanced Mathematics Students' Reports That They Would Like a Job That Involved Using Mathematics by Gender – Advanced Mathematics Final Year of Secondary School*

Country	Strongly Agree				Agree			
	Males		Females		Males		Females	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	7 (2.0)	585 (25.3)	8 (2.0)	574 (29.8)	56 (3.8)	546 (10.6)	42 (4.2)	545 (20.6)
Austria	6 (1.2)	530 (17.7)	3 (0.9)	444 (23.4)	20 (2.2)	524 (14.8)	11 (1.7)	452 (12.0)
Canada	20 (1.9)	581 (9.7)	11 (1.2)	534 (14.3)	51 (3.1)	530 (7.4)	45 (2.7)	501 (5.9)
Cyprus	24 (3.4)	560 (13.8)	27 (3.4)	524 (17.4)	45 (3.9)	522 (8.4)	37 (2.7)	517 (9.2)
Czech Republic	13 (2.1)	630 (24.3)	6 (1.5)	561 (21.5)	33 (2.2)	560 (14.2)	16 (1.6)	487 (14.7)
Denmark	22 (1.9)	565 (7.9)	17 (2.3)	539 (9.0)	49 (2.3)	534 (5.0)	39 (2.3)	525 (7.4)
France	18 (1.7)	604 (8.2)	13 (2.1)	589 (9.3)	45 (2.0)	579 (5.5)	33 (3.0)	557 (6.7)
Germany	13 (1.7)	547 (11.3)	8 (1.1)	519 (11.8)	28 (2.0)	514 (7.9)	18 (1.2)	483 (11.4)
Greece	20 (2.2)	575 (16.9)	23 (4.4)	511 (20.6)	51 (3.4)	536 (8.7)	53 (4.7)	512 (13.7)
Italy	10 (1.9)	573 (21.0)	5 (2.7)	504 (17.9)	35 (4.1)	500 (12.0)	36 (6.2)	491 (16.7)
Lithuania	11 (1.6)	558 (10.5)	12 (1.7)	516 (12.4)	56 (2.0)	552 (5.1)	42 (3.2)	496 (7.7)
Russian Federation	16 (1.3)	611 (14.9)	16 (2.0)	534 (21.7)	52 (2.3)	584 (10.5)	46 (2.6)	533 (8.7)
Slovenia	7 (1.3)	531 (30.0)	5 (1.4)	530 (20.5)	35 (3.0)	523 (12.7)	23 (1.8)	498 (13.6)
Sweden	13 (2.0)	575 (8.3)	11 (1.8)	562 (11.9)	51 (1.7)	538 (5.5)	39 (2.9)	514 (5.7)
Switzerland	15 (2.1)	627 (10.9)	4 (0.9)	548 (14.9)	26 (1.7)	595 (8.1)	15 (2.2)	538 (10.3)
United States	22 (1.6)	514 (10.8)	12 (1.4)	475 (15.7)	48 (2.3)	462 (6.7)	39 (1.9)	436 (7.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 7.15 (Continued)

Advanced Mathematics Students' Reports That They Would Like a Job That Involved Using Mathematics by Gender – Advanced Mathematics

Final Year of Secondary School*

Country	Disagree				Strongly Disagree			
	Males		Females		Males		Females	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	28 (4.6)	513 (23.0)	32 (4.6)	491 (17.8)	9 (1.8)	484 (24.6)	17 (2.2)	479 (13.1)
Austria	32 (3.3)	490 (10.3)	22 (2.7)	433 (16.2)	41 (3.5)	459 (8.5)	64 (3.0)	391 (8.0)
Canada	22 (2.0)	496 (13.3)	28 (2.4)	473 (5.9)	7 (1.0)	468 (13.9)	16 (1.8)	453 (11.7)
Cyprus	21 (2.5)	512 (13.1)	21 (3.0)	487 (14.7)	10 (2.6)	498 (16.2)	15 (3.3)	493 (11.3)
Czech Republic	28 (1.9)	504 (9.5)	36 (2.1)	431 (8.2)	26 (2.9)	458 (11.4)	41 (2.8)	392 (7.5)
Denmark	21 (1.6)	506 (7.4)	35 (2.7)	502 (6.2)	8 (1.1)	476 (12.5)	10 (1.7)	464 (8.2)
France	21 (2.0)	542 (10.5)	36 (3.7)	528 (6.6)	16 (1.9)	531 (6.5)	18 (2.2)	511 (12.2)
Germany	26 (2.3)	490 (9.1)	24 (1.4)	473 (8.6)	34 (2.4)	436 (7.2)	50 (2.0)	424 (6.8)
Greece	20 (2.9)	472 (11.1)	18 (4.4)	517 (15.6)	9 (2.0)	429 (26.9)	6 (1.8)	487 (23.2)
Italy	29 (3.9)	474 (12.1)	27 (6.5)	439 (19.3)	27 (3.1)	439 (15.0)	32 (8.1)	434 (15.7)
Lithuania	25 (2.1)	526 (8.0)	31 (2.6)	476 (6.5)	7 (1.6)	498 (19.8)	15 (1.6)	484 (13.2)
Russian Federation	24 (1.9)	532 (10.2)	27 (2.3)	485 (16.4)	8 (1.4)	494 (15.7)	11 (1.8)	481 (10.6)
Slovenia	31 (2.7)	474 (14.6)	35 (2.3)	460 (10.8)	27 (2.2)	439 (11.8)	36 (3.3)	437 (16.0)
Sweden	26 (2.0)	491 (9.9)	39 (2.5)	471 (10.6)	10 (1.3)	435 (14.5)	11 (1.9)	454 (13.4)
Switzerland	32 (2.8)	540 (6.4)	29 (2.4)	515 (9.5)	27 (1.7)	508 (9.7)	52 (3.5)	484 (7.9)
United States	22 (1.7)	430 (11.0)	31 (2.1)	419 (8.9)	9 (1.0)	404 (10.7)	17 (2.0)	385 (15.5)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.5).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Chapter 8

International Student Achievement in Physics

Chapters 8 through 10 present the results for the physics test given to the subpopulation of students having taken physics. Chapter 8 summarizes achievement on the TIMSS physics test for each of the participating countries. Because resource limitations precluded studying all branches of science at the same level of detail, one was chosen for particular attention. Participating countries in TIMSS chose physics for detailed study because it is the branch of science most closely associated with mathematics, and because for many participants physics came closest to embodying the essential elements of natural science. The physics test was designed to measure learning of physics concepts and knowledge among final-year students having studied physics.

Comparisons are provided for the subpopulations of final-year physics students tested in each country. The relationship between achievement and the population of students tested is examined from several perspectives, because not all countries could provide complete coverage of the entire cohort of school-leaving age students. Comparisons are also provided by gender.

How Does Performance Compare for Students Tested in Physics?

Table 8.1 presents the mean (or average) achievement for 16 countries that participated in the physics study for students in their final year of secondary school.[1] The 11 countries shown in 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 the final-year students having taken physics as described by their national definitions of this subpopulation.

As explained in the Introduction, in many of the countries not all of the school-leaving age cohort is still attending school, primarily because a number of students have dropped out. Additionally, in many countries, only a relatively small subset of the final-year students have taken the physics courses that would make them eligible for the physics study. Also, some countries, like the Russian Federation where all students in the general secondary schools take physics, defined only those students having taken advanced physics courses. The proportion of the entire school-leaving age cohort that participated in the physics study is indicated by the Physics TIMSS Coverage Index (PTCI). If the PTCI also reflects exclusion of part of the final-year student population, the country is footnoted (i.e., Austria, Cyprus, and the Russian Federation). Although for several countries the PTCI was approximately 15%, it varied from as little as 2% to 3% in the Russian Federation, Latvia (LSS), and Denmark to 33% in Austria and 39% in Slovenia.

[1] The achievement results for physics were derived from all of the physics items scaled together. Chapter 9 contains scaled results for the five physics content areas. See the "IRT Scaling and Data Analysis" section of Appendix B.

Although countries tried very hard to meet the TIMSS sampling requirements, many encountered resistance from schools, teachers, and students, and thus did not have the participation rates for both schools and students of 85% or higher (or a combined rate of 75%) specified in the TIMSS guidelines. Obtaining the voluntary participation of secondary school students who are taking demanding courses is particularly challenging because these students have many calls on their time. Beyond the problem of inducing students to attend the testing sessions, several countries encountered various difficulties in implementing the prescribed methods for sampling schools or students within schools, usually because of the organization of the education system. Because Israel did not clearly document its procedures for sampling schools, its achievement results are presented in Appendix D. Italy's sample size for the physics test was very small and so its results are presented in Appendix D. A full discussion of the sampling procedures and outcomes for each country can be found in Appendix B.

Despite the complications in sampling, the results reveal differences in average physics achievement between the top- and bottom-performing countries, although most countries fell somewhere in the middle ranges. Table 8.1 indicates whether the country averages were significantly above or below the international average of 501. In Norway, Sweden, the Russian Federation, and Denmark, the country average was significantly above the international average, while in six countries, Switzerland, Canada, France, the Czech Republic, Austria, and the United States it was significantly below the international average. Note that the PTCI was low in Norway (8%), and particularly in Denmark (3%), indicating that physics students in these countries are a very select group. In addition, the sampling of physics students in Denmark did not fully comply with the TIMSS sampling guidelines.

To illustrate the broad range of achievement both across and within countries, Table 8.1 graphically represents the distribution of student performance. Achievement for each country is shown for the 25th and 75th percentiles as well as for the 5th and 95th percentiles.[2] Each percentile point indicates the percentages of students performing below and above that point on the scale. For example, 25% of the 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 lower and higher achievement. The dark boxes at the midpoints of the distributions are the 95% confidence intervals around the achievement mean.[3]

[2] Tables of the percentile values and standard deviations for all countries are presented in Appendix E.

[3] See the "IRT Scaling and Data Analysis" section of Appendix B for more details about calculating standard errors and confidence intervals for the TIMSS statistics.

Comparisons can be made across the means and percentiles. For example, average performance in Norway was comparable to or even exceeded performance at the 75th percentile in the lower-performing countries such as France, the Czech Republic, Austria, and the United States. Also, the differences between the extremes in performance were very large within most countries.

Figure 8.1 allows comparison of overall mean achievement between countries.[4] It 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, and a triangle pointing down indicates significantly lower performance. Countries shown in italics failed to satisfy one or more guidelines for sample participation rates or student sampling (see Appendix B for details).

In terms of average physics achievement, three clusters of countries can be identified. In the first cluster, Norway and Sweden, each with many triangles pointing up, had performance similar to each other and significantly higher average physics achievement than the other participating countries, although the Russian Federation, with a wide confidence interval for its mean, did not differ significantly from either Sweden or Norway. In the second cluster, there are relatively small differences from one country to the next, with most countries having lower mean achievement than some countries, about the same mean achievement as some countries, and higher mean achievement than other countries. Included in this group are Denmark, Slovenia, Germany, Australia, Cyprus, Switzerland, Latvia (LSS), Greece, and Canada. In the third cluster are France, the Czech Republic, Austria, and the United States. These countries had lower average physics achievement than the other countries. Within this cluster, France had higher achievement than Austria and the United States, and the Czech Republic had higher achievement than the United States. Latvia (LSS), like the Russian Federation, had a wide confidence interval for its mean, and so its mean was not significantly different from that of most other countries.

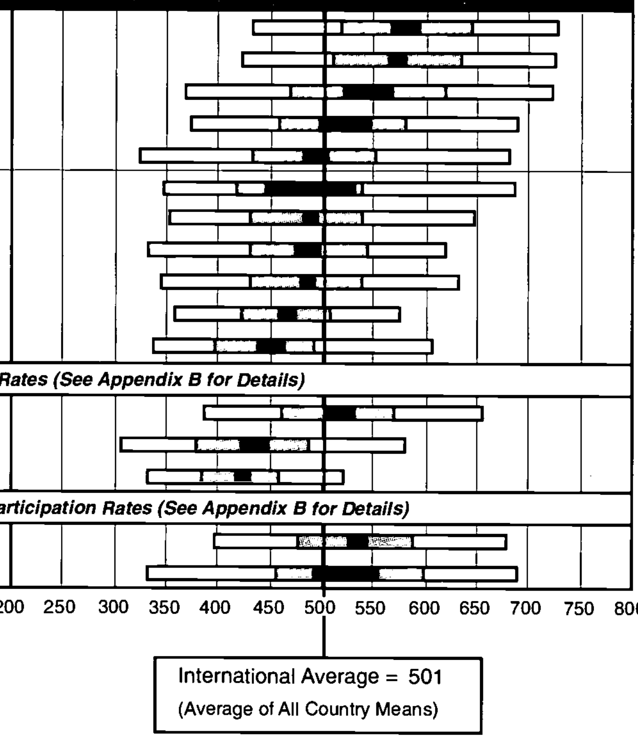
[4] The significance tests in Figure 8.1 are based on a Bonferroni procedure for multiple comparisons that holds to 5% the probability of erroneously declaring the mean of one country to be different from that of another country.

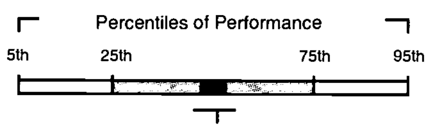
Table 8.1

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Country	Mean	PTCI✦	Average Age
† Norway	▲ 581 (6.5)	8%	19.0
Sweden	▲ 573 (3.9)	16%	18.9
[2] Russian Federation	▲ 545 (11.6)	2%	16.9
† Germany	● 522 (11.9)	8%	19.1
[2] Cyprus	● 494 (5.8)	9%	17.7
[1] Latvia (LSS)	● 488 (21.5)	3%	18.0
Switzerland	▼ 488 (3.5)	14%	19.5
† Greece	● 486 (5.6)	10%	17.7
Canada	▼ 485 (3.3)	14%	18.6
France	▼ 466 (3.8)	20%	18.2
Czech Republic	▼ 451 (6.2)	11%	18.1
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	● 518 (6.2)	13%	17.7
[2] Austria	▼ 435 (6.4)	33%	19.1
United States	▼ 423 (3.3)	14%	18.0
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	▲ 534 (4.2)	3%	19.1
Slovenia	● 523 (15.5)	39%	18.8

Physics Scale Score





▲ = Country mean significantly higher than international mean

▼ = Country mean significantly lower than international mean

● = No statistically significant difference between country mean and international mean

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

✦ The Physics TIMSS Coverage Index (PTCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year physics student sample (see Appendix B for more information).

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 8.1

Multiple Comparisons of Physics Achievement for Students Having Taken Physics

Final Year of Secondary School*

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	**Norway**	**Sweden**	*Russian Federation*	**Denmark**	*Slovenia*	**Germany**	*Australia*	**Cyprus**	**Switzerland**	**Latvia (LSS)**	**Greece**	**Canada**	**France**	**Czech Republic**	*Austria*	*United States*
Norway		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Federation	●	●		●	●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	●		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲
Germany	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲
Australia	▼	▼	●	●	●	●		●	▲	●	▲	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	●	●	▼	●		●	●	●	▲	▲	▲	▲
Latvia (LSS)	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	▲
Greece	▼	▼	▼	▼	●	●	▼	●	●	●		●	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●	▼	▼	●	●	●	●		▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼		●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●		●	▲
Austria	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●		●
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	

Countries are ordered by mean achievement across the heading and down the rows.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

How Does Performance in Physics Compare, Taking Differences in Population Coverage into Account?

Figure 8.2 shows the relationship between physics achievement and the PTCI.[5] Most countries that took part in the TIMSS physics study considered that between 10% and 20% of the school-leaving age cohort were eligible for testing. The countries with PTCIs in this range showed wide differences in average achievement, with 150 scale-score points separating the average physics scores of Sweden at the high end from the United States at the low end. The six countries with less than 10% of the age cohort having taken physics had average scores at or above the international mean. Of the countries with the largest coverage indices, Slovenia was near the international average, and Austria below it.

Table 8.2 provides another way of examining performance, regardless of whether or not countries may have tested only their elite students. The 90th percentile is the point on the physics scale that divides the higher-performing 10% of the students from the lower-performing 90%. Table 8.2 shows the 90th percentile of performance for each country, and the mean achievement for the top 10% of the students in the entire school-leaving age cohort for each country. This analysis attempts to compare the achievement of the best physics students in each country, regardless of the extent to which the TIMSS test covered the entire cohort.

The 90th percentile 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 (that is, those students in the school-leaving age cohort not included in the testing).[6] As shown by the PTCI, the physics students tested in most countries represented at least 10% of the school-leaving age cohort. Countries where the coverage was less than 10% were excluded from the analysis in Table 8.2.

Notwithstanding the additional difficulties in calculating achievement for the entire school-leaving age cohort for each country rather than for the students actually tested, the results for the top 10% of the students in each country appear quite consistent with those obtained from the tested students. However, the countries in Table 8.2 most likely to improve their standing were those with the largest coverage index, since they were least likely to have tested just the elite students. That this proved to be the case is shown in Figure 8.3. Slovenia has joined Sweden at the top of the chart, despite having difficulties with low sampling participation and unapproved sampling procedures. These two countries had higher average physics achievement for the top 10% than any of the other countries. Austria also improved its relative position, moving from the lowest-scoring cluster of countries in Figure 8.1 to the middle group in Figure 8.3. The other countries generally maintained their standing.

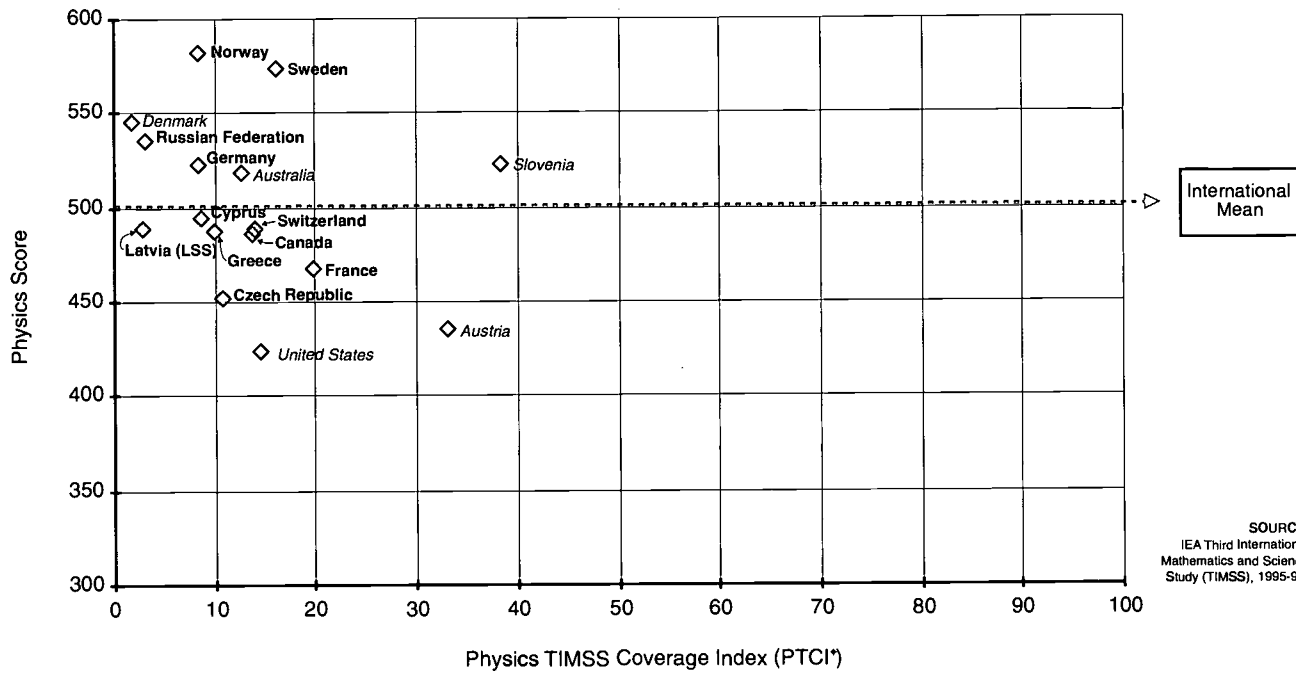
[5] The relationship between physics achievement and the PTCI has a correlation coefficient of – 0.28.

[6] To compute the 90th percentile, TIMSS assumed that those students in the school-leaving age cohort not tested would score below the 90th percentile, primarily because they had not taken physics. The percentages of these students were added to the lower tail of the distribution before calculating the 90th percentile using the modified distribution.

Figure 8.2

Mean Physics Achievement by TIMSS Coverage Index for Students Having Taken Physics

Final Year of Secondary School*



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

* The Physics TIMSS Coverage Index (PTCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year physics student sample (see Appendix B for more information).

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 8.2

Physics Achievement for the Top 10 Percent® of All Students in the School-Leaving Age Cohort*

Country	90th Percentile	Mean Achievement of Top 10% of Students (Above 90th Percentile)	Physics TCI
Sweden	549 (5.5)	630 (3.1)	16%
Switzerland	440 (4.7)	528 (3.8)	14%
Canada	433 (2.7)	522 (3.1)	14%
France	465 (3.4)	518 (3.0)	20%
† Greece	- -	486 (5.6)	10%
Czech Republic	355 (7.0)	464 (6.1)	11%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	451 (8.5)	547 (4.6)	13%
[1] Austria	471 (10.8)	532 (6.1)	33%
United States	394 (3.6)	451 (2.6)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Slovenia	595 (15.1)	652 (13.9)	39%
International Average	462 (2.3)	533 (1.9)	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

® To compute the 90th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 90th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Less than 10% of the students in the Russian Federation, Norway, Germany, Cyprus, Latvia (LSS), and Denmark took the physics test.

A dash (-) indicates data are not available. Because the students tested in Greece covered 10% of the school-leaving age cohort, the 90th percentile could not be estimated with precision.

Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Figure 8.3

Multiple Comparisons of Physics Achievement for the Top 10 Percent[@] of All Students in the School-Leaving Age Cohort*

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	*Slovenia*	**Sweden**	*Australia*	*Austria*	**Switzerland**	**Canada**	**France**	**Greece**	**Czech Republic**	*United States*
Slovenia		●	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼		●	▲	▲	▲	▲	▲	▲
Austria	▼	▼	●		●	●	●	▲	▲	▲
Switzerland	▼	▼	▼	●		●	●	▲	▲	▲
Canada	▼	▼	▼	●	●		●	▲	▲	▲
France	▼	▼	▼	●	●	●		▲	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼		●	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	●		●
United States	▼	▼	▼	▼	▼	▼	▼	▼	●	

Countries are ordered by mean achievement across the heading and down the rows.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

[@] To compute the 90th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 90th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of the students sampled.

[†] Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

Less than 10% of the students in the Russian Federation, Norway, Germany, Cyprus, Latvia (LSS), and Denmark took the physics test.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 8.3

Physics Achievement for the Top 5 Percent[@] of All Students in the School-Leaving Age Cohort*

Country	95 th Percentile	Mean Achievement of Top 5% of Students (Above 95 th Percentile)	Physics TCI
Sweden	619 (6.1)	678 (4.2)	16%
† Norway	557 (6.5)	640 (3.4)	8%
Switzerland	512 (7.8)	582 (3.7)	14%
† Germany	498 (16.6)	582 (6.4)	8%
Canada	510 (4.3)	574 (4.8)	14%
[1] Cyprus	475 (8.8)	562 (5.2)	9%
† Greece	495 (6.9)	555 (3.4)	10%
France	508 (3.1)	550 (3.5)	20%
Czech Republic	448 (6.1)	520 (7.4)	11%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	539 (9.5)	598 (6.3)	13%
[1] Austria	519 (9.1)	572 (7.4)	33%
United States	442 (6.2)	485 (3.2)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Slovenia	641 (25.6)	689 (12.7)	39%
International Average	520 (3.0)	583 (1.7)	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

@ To compute the 95th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 95th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Less than 5% of the students in the Russian Federation, Latvia (LSS), and Denmark took the physics test.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Figure 8.4

Multiple Comparisons of Physics Achievement for the Top 5 Percent[@] of All Students in the School-Leaving Age Cohort*

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	*Slovenia*	**Sweden**	**Norway**	*Australia*	**Switzerland**	**Germany**	**Canada**	*Austria*	**Cyprus**	**Greece**	**France**	**Czech Republic**	*United States*
Slovenia		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	▼		●	●	▲	●	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	●		●	●	●	▲	▲	▲	▲	▲
Germany	▼	▼	▼	●	●		●	●	●	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●	●		●	●	▲	▲	▲	▲
Austria	▼	▼	▼	●	●	●	●		●	●	●	▲	▲
Cyprus	▼	▼	▼	▼	▼	●	●	●		●	●	▲	▲
Greece	▼	▼	▼	▼	▼	▼	▼	●	●		●	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	●	●	●		▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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

[@]To compute the 95th percentile, TIMSS assumed that the students in the school-leaving age cohort not tested would have scored below the 95th percentile and added them to the lower tail of the distribution.

* See Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

Less than 5% of the students in the Russian Federation, Latvia (LSS), and Denmark took the physics test.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A very similar pattern emerges from a consideration of the top 5% of physics students in each country. Table 8.3 shows the 95th percentile of performance, and the mean achievement for the top 5% of the students in the entire school-leaving age cohort, for each country. Norway and Cyprus are included in this table, since only countries with less than 5% coverage were excluded. As shown in Figure 8.4, Slovenia and Sweden again have higher average physics achievement than the other countries, and the United States has the lowest average achievement.

How Does Performance in Physics Compare by Gender?

Table 8.4, which shows the differences in physics achievement by gender, reveals that males had significantly higher achievement than females in all but one of the participating countries. The table presents mean physics achievement separately for males and females for each country, as well as the difference between the means. The gender difference for each country, shown by a bar, indicates the amount of the difference, whether the direction of difference favors females or males, and whether the difference is statistically significant (a darkened bar). As can be seen, all of the differences favored males rather than females, and all but one of the differences were statistically significant. Only in Latvia (LSS) was the average physics score for males not significantly greater than that for females, and this may be partly the result of the larger than usual sampling error mentioned earlier.

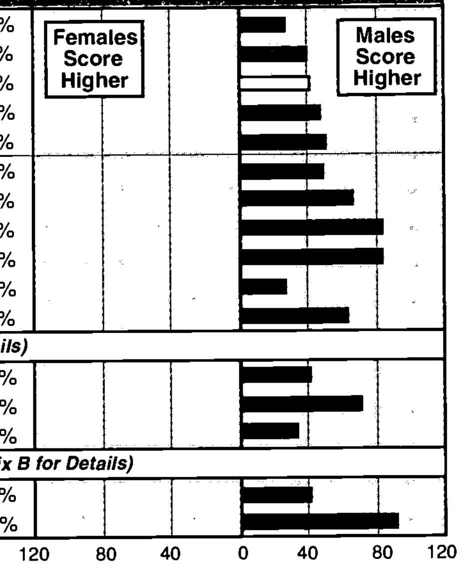
Although the proportions of males and females taking physics were about equal in Latvia (LSS), Canada, the Russian Federation, Switzerland, and the United States, in several countries males outnumbered females by two or three to one. The disparity was greatest in Denmark, where 80% of the physics students were male and only 20% female. Only in Austria and the Czech Republic were there more female than male physics students. However, as previously observed, the difference in the proportions of males and females taking science courses does not explain, of itself, the gender differences in physics achievement. If it did, gender differences would be expected to be less in countries with greater proportions of female physics students, and that is not supported by the results in Table 8.4.

Table 8.4

Gender Differences in Physics Achievement for Students Having Taken Physics
Final Year of Secondary School*

Country	Males: Percent of Students	Males: Mean Achievement	Females: Percent of Students	Females: Mean Achievement	Difference	PTCI
France	61 (2.0)	478 (4.2)	39 (2.0)	450 (5.6)	28 (7.0)	20%
² Cyprus	63 (2.5)	509 (8.9)	37 (2.5)	470 (7.1)	40 (11.4)	9%
¹ Latvia (LSS)	51 (3.7)	509 (19.0)	49 (3.7)	467 (22.6)	42 (29.5)	3%
Canada	57 (3.2)	506 (6.0)	43 (3.2)	459 (6.3)	47 (8.7)	14%
† Norway	74 (1.8)	594 (6.3)	26 (1.8)	544 (9.3)	51 (11.2)	8%
Sweden	67 (3.4)	589 (5.1)	33 (3.4)	540 (5.3)	49 (7.4)	16%
² Russian Federation	54 (2.0)	575 (9.9)	46 (2.0)	509 (15.3)	66 (18.2)	2%
Czech Republic	38 (2.4)	503 (8.8)	62 (2.4)	419 (3.9)	83 (9.7)	11%
Switzerland	51 (1.8)	529 (5.2)	49 (1.8)	446 (3.6)	83 (6.3)	14%
† Greece	68 (2.1)	495 (6.1)	32 (2.1)	468 (8.1)	28 (10.1)	10%
† Germany	69 (3.0)	542 (14.3)	31 (3.0)	479 (9.1)	64 (17.0)	8%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	66 (3.8)	532 (6.7)	34 (3.8)	490 (8.4)	42 (10.8)	13%
² Austria	38 (3.5)	479 (8.1)	62 (3.5)	408 (7.4)	71 (11.0)	33%
United States	52 (2.4)	439 (4.3)	48 (2.4)	405 (3.1)	33 (5.3)	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	80 (2.3)	542 (5.2)	20 (2.3)	500 (8.1)	42 (9.6)	3%
Slovenia	72 (3.7)	546 (16.3)	28 (3.7)	455 (18.7)	91 (24.8)	39%

Gender Difference



International Averages		
Males	Females	Difference
523	469	54

(Averages of All Country Means)

■ Gender difference statistically significant at .05 level.
□ Gender difference not statistically significant.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).
¹ National Desired Population does not cover all of International Desired Population (see Table B.4).
² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.

How Well Did Students Having Taken Physics Perform in Mathematics and Science Literacy?

The PTCI provides one indicator of the percentage of a country's school-leaving age cohort that has taken physics, and confirms that in most of the TIMSS countries, physics in upper secondary school is taken by only a small proportion of students. Table 8.5 provides further information on these students by comparing their performance on the science literacy test, and on the composite mathematics and science literacy test, with the performance of final-year students in general. It is clear from this table that students having taken physics generally come from the high end of the achievement continuum. As might be expected, there was a tendency for achievement differences to be greatest in countries where the coverage index was least. The science literacy difference ranged from 49 in Slovenia (PTCI of 39%) to 124 in Norway (PTCI of 8%).

Table 8.5

Comparison Between All Students in Their Final Year of Secondary School and Final-Year Students Having Taken Physics in Mathematics and Science Literacy

Country	Mean Achievement: Mathematics and Science Literacy		Mean Achievement: Science Literacy		Overall TCI	Physics TCI
	All Students	Physics Students	All Students	Physics Students		
Canada	526 (2.6)	594 (5.5)	532 (2.6)	596 (5.5)	70%	14%
[1] Cyprus	447 (2.5)	521 (6.1)	448 (3.0)	526 (6.2)	48%	9%
Czech Republic	476 (10.5)	582 (7.2)	487 (8.8)	591 (6.8)	78%	11%
France	505 (4.9)	572 (5.0)	487 (5.1)	553 (4.9)	84%	20%
† Germany	496 (5.4)	591 (7.3)	497 (5.1)	586 (7.5)	75%	8%
† Norway	536 (4.0)	658 (6.7)	544 (4.1)	668 (8.0)	84%	8%
Sweden	555 (4.3)	664 (3.7)	559 (4.4)	668 (4.1)	71%	16%
Switzerland	531 (5.4)	618 (4.2)	523 (5.3)	617 (4.5)	82%	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	525 (9.5)	610 (7.7)	527 (9.8)	610 (8.9)	68%	13%
[1] Austria	519 (5.4)	567 (5.9)	520 (5.6)	570 (6.2)	76%	33%
United States	471 (3.1)	548 (5.2)	480 (3.3)	553 (5.7)	63%	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	528 (3.2)	610 (6.7)	509 (3.6)	592 (7.3)	58%	3%
Slovenia	514 (8.2)	563 (8.0)	517 (8.2)	566 (8.7)	88%	39%
International Average	510 (1.6)	592 (1.7)	510 (1.6)	592 (1.8)		

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

The procedures used by Latvia (LSS) and Russian Federation do not permit estimating literacy achievement for students taking physics.

Greece did not test the population of all students in their final year of secondary school.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Chapter 9

Achievement in Physics Content Areas

TIMSS measured achievement in different content areas of physics in order to gather more information about what each country's population of physics students know and can do than an overall physics score would provide. The physics test for final year students was designed to enable reporting by five content areas.[1] These are:

- Mechanics
- Electricity and magnetism
- Heat
- Wave phenomena
- Modern physics: particle, quantum and astrophysics, and relativity

This chapter summarizes student performance across countries in the five physics content areas, and goes on to provide further information about the type of items in each area, including six example items and the percentage of correct responses on those items for each TIMSS country.

How Does Performance Compare Across Content Areas?

As well as scaling the complete physics item pool to obtain an overall physics scale, TIMSS scaled each of the five content areas separately to facilitate analyses at the content level. Table 9.1 summarizes the country means and standard errors on each content scale for each country, and also provides the Physics TIMSS Coverage Index. The international averages of each of the subscales was arbitrarily set to be 500.[2] In general, countries' performance in the physics content areas resembles their performance on the test overall, although few countries performed equally well or poorly in all five areas. Among the highest performers, Norway and Sweden fell above the international average in all five physics content areas. In contrast, Austria and the United States performed below the international mean in all five. Every other country except Latvia (LSS) scored significantly above or below the international mean in at least one content area, and about at the mean in others.

Figure 9.1 graphically depicts each country's strengths and weaknesses in the physics content areas compared with their average performance across all five content areas. The horizontal line indicates each country's overall average achievement in physics, and the five darkened boxes indicate the 95% confidence intervals around the mean achievement in each of the five content areas. If the darkened box is below the line, then the country performed significantly less well in that content area than it did overall. Similarly, if the darkened box is above the line, then the

[1] See the "Test Development" section of Appendix B for more information about the process used to develop the TIMSS tests. Appendix C 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] Final revisions of the data resulted in international averages of 501 for some of the physics scales.

Table 9.1

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Country	PTCI	Physics Content Areas Mean Achievement Scale Scores: Mechanics (16 items)	Electricity and Magnetism (16 items)	Heat (9 items)	Wave Phenomena (10 items)	Modern Physics: Particle, Quantum and Astrophysics, and Relativity (14 items)
Canada	14%	▼ 473 (3.6)	▼ 485 (3.7)	● 508 (4.2)	▼ 488 (3.2)	● 494 (2.7)
² Cyprus	9%	▲ 530 (6.6)	● 502 (6.3)	▼ 476 (6.7)	● 507 (6.5)	▼ 434 (5.2)
Czech Republic	11%	▼ 469 (6.0)	▼ 465 (5.5)	● 488 (4.7)	▼ 447 (5.4)	▼ 453 (4.9)
France	20%	▼ 457 (4.3)	● 494 (4.1)	● 491 (3.4)	▼ 463 (3.6)	▼ 474 (3.4)
† Germany	8%	● 495 (9.4)	● 512 (9.9)	● 496 (6.4)	▲ 530 (10.3)	▲ 545 (13.1)
† Greece	10%	● 514 (6.5)	● 520 (6.6)	● 481 (7.2)	▼ 453 (5.3)	▼ 447 (4.9)
¹ Latvia (LSS)	3%	● 489 (18.1)	● 485 (17.4)	● 504 (21.4)	● 498 (17.6)	● 488 (19.0)
† Norway	8%	▲ 572 (6.4)	▲ 565 (6.2)	▲ 536 (4.3)	▲ 560 (5.4)	▲ 576 (5.3)
² Russian Federation	2%	▲ 537 (9.3)	▲ 549 (9.2)	▲ 530 (10.4)	● 515 (9.4)	▲ 542 (9.9)
Sweden	16%	▲ 563 (4.0)	▲ 570 (3.3)	▲ 522 (4.3)	▲ 560 (4.7)	▲ 560 (3.5)
Switzerland	14%	▼ 482 (3.5)	▼ 480 (4.5)	● 509 (3.6)	● 498 (3.1)	▼ 488 (3.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	13%	● 507 (6.1)	● 512 (4.4)	▲ 517 (4.3)	● 519 (6.9)	▲ 521 (5.8)
² Austria	33%	▼ 420 (4.9)	▼ 432 (6.3)	▼ 445 (5.6)	▼ 468 (7.3)	▼ 480 (6.0)
United States	14%	▼ 420 (2.8)	▼ 420 (3.0)	▼ 477 (3.0)	▼ 451 (2.2)	▼ 456 (2.5)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	3%	▲ 529 (4.9)	● 513 (3.8)	● 512 (4.3)	▲ 537 (5.5)	▲ 544 (4.9)
Slovenia	39%	▲ 552 (17.3)	● 509 (14.6)	● 521 (10.4)	● 514 (11.5)	● 511 (15.1)
International Average		501 (2.1)	501 (2.0)	501 (2.0)	500 (1.9)	501 (2.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ = Country average significantly higher than the international average for the scale

● = No significant difference between country average and international average for the scale

▼ = Country average significantly lower than the international average for the scale

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

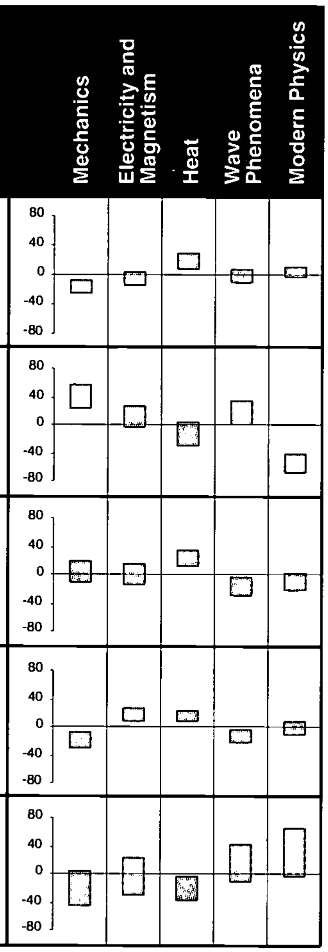
country performed significantly better in that content area than it did overall. Most countries did relatively better in some areas and less well in others. Students in Canada performed relatively less well in mechanics and relatively better in heat than they did on the physics test as a whole. In Cyprus, students performed better in mechanics and wave phenomena, and less well in modern physics. Students in the Czech Republic performed relatively better in heat, and relatively less well in wave phenomena than they did on the test overall. French students performed relatively better in electricity and magnetism and heat, and relatively less well in mechanics and in wave phenomena, whereas students in Germany performed relatively less well in heat. Students in Greece performed better in mechanics and electricity and magnetism, and less well in wave phenomena and modern physics. Whereas students in Norway and Sweden, both countries with high average performance on the physics test, had a relative weakness in heat, students in Switzerland had a relative strength in this area. Students in Norway performed relatively better in modern physics, whereas students in Sweden did relatively better in electricity and magnetism. Students in Switzerland had relatively lower achievement in mechanics and electricity and magnetism. Austrian students showed relative strengths in wave phenomena and modern physics, and relative weakness in mechanics. Students in Denmark also had relatively higher achievement in modern physics, but relatively lower achievement in electricity and magnetism and heat. Compared with their overall mean achievement, students in the United States performed better in heat, wave phenomena, and modern physics, and less well in mechanics, and electricity and magnetism. For Latvia (LSS), the Russian Federation, Australia, and Slovenia, performance in the individual content areas was not significantly different from their overall physics scores.

It was evident from Chapter 8 that male students outperformed female students on the overall physics test in all countries but one. Table 9.2 provides further information on this issue by presenting gender differences for each country on each physics content area scale. The international average for males was significantly higher than the average for females on each of the content area scales, with the difference between males and females ranging from 31 scale points in electricity and magnetism to 58 scale point in mechanics. Significant gender differences favoring males were found in more countries in the areas of mechanics (15 countries), wave phenomena (11 countries), and modern physics (12 countries) than in electricity and magnetism (8 countries) or heat (7 countries). Apart from Latvia (LSS), which showed no significant gender differences on any content scale, the countries with significant gender differences on the fewest content scales were Cyprus, Greece, and Denmark. Significant gender differences on all five content scales were shown in the Czech Republic, Switzerland, and Austria.

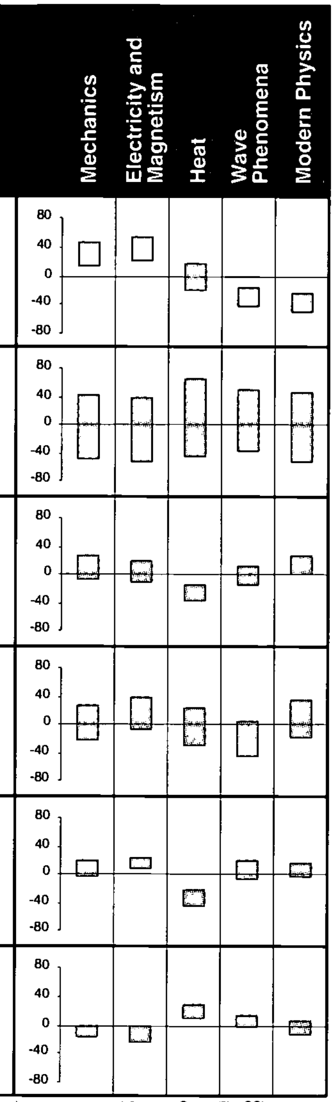
Figure 9.1

Profiles of Performance in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Country	PTCI
Canada	14%
[2] Cyprus	9%
Czech Republic	11%
France	20%
† Germany	8%

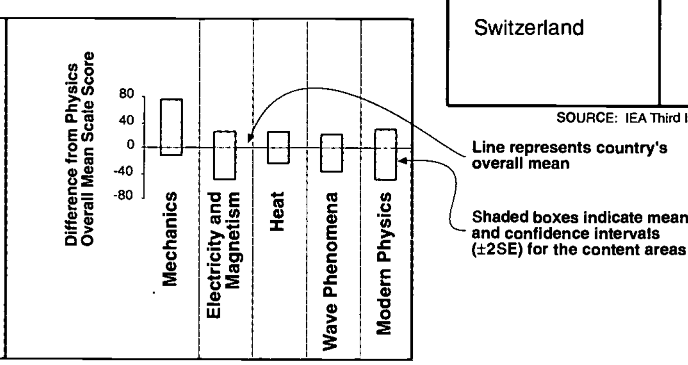


Country	PTCI
† Greece	10%
[1] Latvia (LSS)	3%
† Norway	8%
[2] Russian Federation	2%
Sweden	16%
Switzerland	14%



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Legend:



* See Appendix A for characteristics of students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvia Speaking School only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

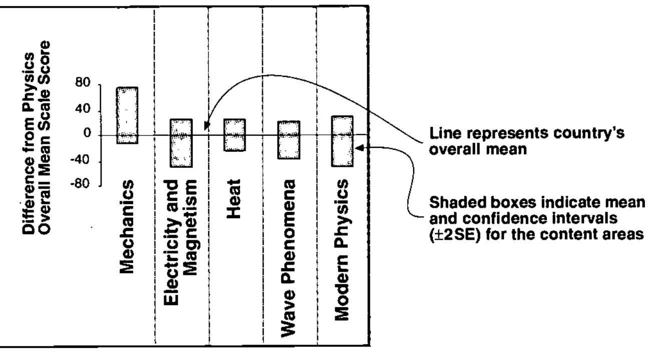
Figure 9.1 (Continued)

Profiles of Performance in Physics Content Areas for Students Having Taken Physics
Final Year of Secondary School*

Country	PTCI	Country	PTCI
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	13%	United States	14%
[2] Austria	33%		
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B):			
Denmark	3%	Slovenia	39%

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Legend:



* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

1 National Desired Population does not cover all of International Desired Population (see Table B.4).

2 National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

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Table 9.2

Achievement in Physics Content Areas by Gender for Students Having Taken Physics Final Year of Secondary School*

Country	PTCI	Mechanics (16 items)		Electricity and Magnetism (16 items)		Heat (9 items)	
		Females	Males	Females	Males	Females	Males
Canada	14%	440 (5.7)	▲ 499 (6.6)	468 (6.5)	▲ 497 (6.2)	492 (8.1)	520 (5.2)
² Cyprus	9%	496 (10.3)	▲ 551 (9.6)	494 (7.4)	507 (8.5)	461 (11.2)	484 (9.8)
Czech Republic	11%	440 (4.8)	▲ 514 (8.4)	443 (3.3)	▲ 501 (8.7)	472 (4.5)	▲ 513 (6.6)
France	20%	437 (5.5)	▲ 470 (5.6)	491 (5.2)	495 (4.2)	487 (5.7)	496 (4.0)
† Germany	8%	453 (10.6)	▲ 515 (9.6)	491 (7.7)	522 (12.1)	461 (10.6)	▲ 513 (6.3)
† Greece	10%	489 (7.2)	▲ 525 (7.0)	515 (11.0)	522 (6.5)	460 (10.5)	490 (8.1)
¹ Latvia (LSS)	3%	468 (19.8)	509 (15.2)	474 (18.4)	496 (16.8)	484 (23.4)	523 (17.8)
† Norway	8%	523 (9.0)	▲ 589 (6.1)	549 (10.0)	570 (6.2)	511 (7.0)	▲ 545 (4.4)
² Russian Federation	2%	507 (12.3)	▲ 563 (7.4)	519 (12.9)	▲ 575 (7.7)	501 (14.8)	▲ 555 (7.5)
Sweden	16%	517 (4.4)	▲ 586 (4.6)	551 (4.7)	▲ 579 (4.8)	507 (5.3)	529 (5.8)
Switzerland	14%	444 (3.5)	▲ 519 (5.3)	452 (4.5)	▲ 507 (7.1)	480 (5.7)	▲ 538 (4.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	13%	474 (6.8)	▲ 524 (7.8)	488 (8.3)	▲ 525 (6.7)	503 (6.2)	524 (5.0)
² Austria	33%	399 (6.3)	▲ 459 (6.6)	409 (6.9)	▲ 468 (9.1)	420 (6.8)	▲ 485 (8.0)
United States	14%	393 (2.8)	▲ 446 (3.5)	409 (3.6)	▲ 430 (3.5)	474 (2.7)	480 (4.2)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	3%	483 (10.2)	▲ 540 (5.5)	498 (7.8)	515 (4.5)	487 (9.6)	517 (5.3)
Slovenia	39%	487 (21.7)	▲ 576 (17.5)	470 (13.8)	522 (16.6)	470 (18.7)	▲ 538 (13.1)
International Average		466 (2.6)	▲ 524 (2.2)	483 (2.3)	▲ 514 (2.2)	479 (2.7)	▲ 516 (2.0)

Physics Content Areas — Mean Achievement Scale Scores

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 9.2 (Continued)

Achievement in Physics Content Areas by Gender for Students Having Taken Physics

Final Year of Secondary School*

Country	PTCI	Physics Content Areas Mean Achievement Scale Scores: Wave Phenomena (10 items)		Modern Physics: Particle, Quantum and Astrophysics, and Relativity (14 items)	
		Females	Males	Females	Males
Canada	14%	476 (6.4)	497 (4.3)	471 (5.1)	▲ 513 (6.0)
² Cyprus	9%	486 (8.4)	519 (10.4)	411 (9.9)	▲ 450 (7.7)
Czech Republic	11%	419 (4.9)	▲ 491 (7.2)	425 (4.6)	▲ 498 (6.9)
France	20%	448 (4.6)	▲ 475 (5.6)	457 (4.1)	▲ 485 (4.3)
† Germany	8%	485 (10.1)	▲ 551 (12.7)	508 (13.5)	561 (15.3)
† Greece	10%	444 (7.2)	457 (7.4)	426 (5.7)	▲ 456 (6.4)
¹ Latvia (LSS)	3%	480 (16.2)	515 (17.3)	470 (20.8)	505 (16.6)
† Norway	8%	519 (10.2)	▲ 575 (4.9)	549 (9.9)	▲ 585 (5.0)
² Russian Federation	2%	487 (12.4)	▲ 539 (7.9)	520 (13.9)	561 (7.9)
Sweden	16%	528 (5.9)	▲ 576 (6.1)	538 (6.2)	▲ 570 (3.3)
Switzerland	14%	460 (4.4)	▲ 533 (4.8)	457 (4.4)	▲ 519 (5.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)					
Australia	13%	498 (7.2)	529 (9.0)	497 (7.8)	▲ 533 (6.7)
² Austria	33%	444 (9.7)	▲ 506 (7.3)	465 (6.1)	▲ 505 (9.9)
United States	14%	442 (3.0)	▲ 460 (2.6)	446 (2.3)	▲ 466 (3.6)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)					
Denmark	3%	493 (10.0)	▲ 547 (6.3)	529 (7.4)	546 (6.0)
Slovenia	39%	446 (13.4)	▲ 538 (11.9)	458 (14.1)	▲ 528 (18.7)
International Average		472 (2.3)	▲ 519 (2.2)	477 (2.4)	▲ 518 (2.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

What Are Some Examples of Performance in Physics?

This section presents six example items from the physics test, including the performance on each item for each TIMSS country. The example items were chosen to illustrate the topics covered within each content area and to show the range of difficulty. Example Item 1, presented in Table 9.3, requires students to indicate why boiling a small volume of water produces a large volume of steam. On average across countries, about two-thirds of the students having taken courses in physics selected the correct answer to this question, demonstrating an understanding of the relationship between the increased volume and the relative distance between water molecules in the liquid and gaseous states. Three-fourths or more of the students in Norway, Sweden, Australia, Denmark, and Slovenia answered this question correctly.

Example Item 2, from modern physics, asked students to apply their knowledge of special relativity to determine the length of a spaceship traveling at close to the speed of light as seen by a stationary observer. In order to solve this problem, students needed to correctly apply the mathematical equation for relativistic length contraction ($L = L_0(1 - v^2/c^2)^{1/2}$). As shown in Table 9.4, fewer than half of the students on average internationally responded correctly. There was considerable variation in performance across countries, with the proportion of students responding correctly ranging from about one-fourth to nearly three-fourths. More than 60% of the students in Norway, the Russian Federation, and Sweden answered this item correctly. An additional 20% of students internationally selected option A, indicating some knowledge that the length of the moving spaceship would appear contracted relative to its length at rest, but made an incorrect calculation by omitting the square-root operation.

Example Item 3, from wave phenomena, proved more difficult for students internationally. This item required an understanding of the refraction of light as it passes through a semicircular glass block into air. As presented in Table 9.5, about 37% of the students internationally, on average, correctly identified the direction in which the refracted ray of light would travel after leaving the glass block. The highest performance was in Norway, the Russian Federation, and Sweden, where slightly more than half of the students chose the correct answer; the lowest performance was in Greece, where fewer than 20% chose the correct answer. Internationally, about one-fourth of the students, on average, selected option C, showing the refracted beam that would occur if the ray of light were traveling from air into glass rather than glass into air. The selection of this option indicates some understanding of refraction at a glass/air interface but an incorrect application to the problem presented.

Example Item 4, from the content area electricity and magnetism, was also difficult for most students. Students were provided with a diagram representing electrons moving at a given velocity and entering a perpendicular uniform electric field, and were asked to identify the path taken by the electrons in the electric field. About one-third of students on average identified the correct path, showing deflection of the electron away from the negative charge and toward the positive charge in the electric field (see Table 9.6). The highest performance was in France, Norway, and Sweden, where the majority of students chose the correct answer, and the lowest was in the Czech Republic, Austria, and the United States, each with less than 15% correct. Another third of students internationally selected the incorrect option B, showing deflection of the electron in the opposite direction, toward the negative charge. In fact, this was the most frequent response chosen in several countries. This response indicates some understanding that the path of the electrons will be deflected in an electric field but a misinterpretation of the direction of negative and positive charges as shown by the electric field vector in the diagram.

Example Item 5, from mechanics, was quite difficult for students in most countries. In this item, students were shown a pictorial representation of an amusement park ride in which a rider is pressed against the wall of a rotating cylinder. As seen in Table 9.7, only 20% of the students on average could correctly identify the three real forces acting on the rider. The wall exerts a centripetal force inward toward the center that keeps the rider moving in a circular path, while two balanced vertical forces (gravitational and frictional) keep the rider stationary with respect to the wall. Cyprus was the only country where as many as half of the students identified the correct answer. The item was most difficult for students in the Czech Republic, Germany, and Austria, where fewer than 10% of the students selected the correct response. Internationally, more than half of the students selected option B, indicating the commonly held misconception that centrifugal force resulting from rotation pushes the rider outward from the center.

The final example, Item 6, was a free-response item from modern physics related to the Rutherford scattering experiment. Students were asked to explain why most of a stream of alpha particles directed at a very thin sheet of gold will pass through it. Table 9.8 presents the percentage of students in each country that provided partially and fully correct answers. A fully correct response to this item required the student to explain that alpha particles may be scattered or deflected only by interacting with the nuclei in the gold atoms, and that the distance between the gold nuclei (diameter of a gold atom) is very large compared to the diameter of the nucleus or of an alpha particle. Although on average only 10% of students internationally provided fully correct answers, a further 14% provided at least a partially correct response referencing the general idea of relative size or empty space within the gold atom. The highest percentages of fully correct answers were from Germany and Slovenia (more than 20%). In more than half of the countries, however, 25% or more of the students received partial or full credit, and in Germany, Norway, and Australia, the proportion of students with partial or full credit was more than one-third.

Figure 9.2 shows the relationship between performance on the TIMSS international physics scale and achievement on the six example items from the physics test.[3] The international achievement on each example item is indicated both by the average percentage of fully correct responses across all countries, and by the international physics scale value, or item difficulty level. Since the scale was based on the performance of students in all countries, the international scale values apply to all countries. As illustrated by the example items, the physics test was relatively difficult for students in a number of countries. Students achieving below the international average were unlikely to provide fully correct responses to many of the items.

[3] 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 9.3 Physics

Percent Correct for Example Item 1 for Students Having Taken Physics Final Year of Secondary School*

Country	Percent Correct	PTCI
Canada	73 (3.0)	14%
² Cyprus	54 (4.5)	9%
Czech Republic	39 (3.0)	11%
France	50 (3.0)	20%
† Germany	64 (5.7)	8%
† Greece	62 (5.2)	10%
¹ Latvia (LSS)	43 (8.3)	3%
† Norway	81 (2.1)	8%
² Russian Federation	68 (5.0)	2%
Sweden	83 (2.8)	16%
Switzerland	66 (3.8)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	80 (3.4)	13%
² Austria	40 (4.8)	33%
United States	60 (2.3)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	79 (3.2)	3%
Slovenia	89 (3.1)	39%
International Average Percent Correct	64 (1.1)	

Example 1

Volume of steam.

Content Category: Heat

When a small volume of water is boiled, a large volume of steam is produced. Why?

(A.) The molecules are further apart in steam than in water.

B. Water molecules expand when heated and make the molecules bigger than the water molecules.

C. The change from water to steam causes the number of molecules to increase.

D. Atmospheric pressure works more on water molecules than on steam molecules.

E. Water molecules repel each other when heated.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 9.4 Physics

Percent Correct for Example Item 2 for Students Having Taken Physics

Final Year of Secondary School*

Country	Percent Correct	PTCI
Canada	47 (3.5)	14%
² Cyprus	25 (4.0)	9%
Czech Republic	53 (3.4)	11%
France	25 (3.1)	20%
† Germany	45 (4.5)	8%
† Greece	28 (4.4)	10%
¹ Latvia (LSS)	55 (4.8)	3%
† Norway	67 (2.8)	8%
² Russian Federation	62 (5.1)	2%
Sweden	73 (3.4)	16%
Switzerland	35 (3.8)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	36 (5.3)	13%
² Austria	32 (3.6)	33%
United States	34 (2.3)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	38 (4.5)	3%
Slovenia	56 (6.3)	39%
International Average Percent Correct	44 (1.0)	

Example 2

Length of spaceship in flight

Content Category:
Modern Physics: Particle, Quantum and Astrophysics, and Relativity

A spaceship passes an observer at a speed of 0.9 c. The observer knows that the length of the spaceship, measured at rest before it took off, was 100 m.

What is the length of the spaceship in flight as seen by the observer?

A. 19 m

B. 44 m

C. 229 m

D. 526 m

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

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Table 9.5 Physics

Percent Correct for Example Item 3 for Students Having Taken Physics
Final Year of Secondary School*

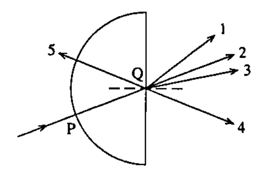
Country	Percent Correct	PTCI
Canada	42 (3.6)	14%
² Cyprus	47 (6.2)	9%
Czech Republic	34 (4.0)	11%
France	24 (2.6)	20%
† Germany	40 (4.6)	8%
† Greece	18 (3.5)	10%
¹ Latvia (LSS)	41 (6.0)	3%
† Norway	52 (2.9)	8%
² Russian Federation	51 (3.0)	2%
Sweden	53 (5.6)	16%
Switzerland	34 (4.3)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	42 (4.9)	13%
² Austria	29 (4.2)	33%
United States	27 (2.8)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	32 (3.8)	3%
Slovenia	30 (5.7)	39%
International Average Percent Correct	37 (1.1)	

Example 3

Direction refracted ray of light.

Content Category:
Wave Phenomena

This item refers to the following diagram.



A ray of light passes from P to Q through a semicircular glass block in air.

Which arrow shows the direction in which the refracted ray of light would travel after leaving Q?

(A.) 1

B. 2

C. 3

D. 4

E. 5

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 9.6 Physics

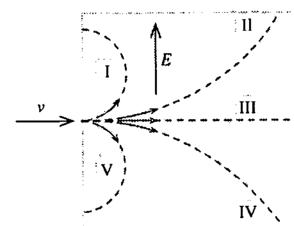
Percent Correct for Example Item 4 for Students Having Taken Physics
Final Year of Secondary School*

Country	Percent Correct	PTCI
Canada	17 (2.1)	14%
[2] Cyprus	24 (4.3)	9%
Czech Republic	12 (2.2)	11%
France	54 (4.4)	20%
† Germany	35 (5.1)	8%
† Greece	49 (5.9)	10%
[1] Latvia (LSS)	23 (8.6)	3%
† Norway	50 (3.4)	8%
[2] Russian Federation	32 (3.3)	2%
Sweden	52 (3.6)	16%
Switzerland	30 (3.7)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	25 (6.3)	13%
[2] Austria	11 (2.7)	33%
United States	12 (1.6)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	41 (4.8)	3%
Slovenia	40 (7.5)	39%
International Average Percent Correct	32 (1.2)	

Example 4
Path of electrons in electric field.

Content Category:
Electricity & Magnetism

Electrons enter a uniform electric field E with a velocity v as shown in the figure. The velocity v is perpendicular to the electric field E.



Which one of the dashed paths (I, II, III, IV or V) best represents the path of the electrons in the electric field?

A. I

B. II

C. III

(D.) IV

E. V

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).
[1] National Desired Population does not cover all of International Desired Population (see Table B.4).
[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 9.7 Physics

Percent Correct for Example Item 5 for Students Having Taken Physics Final Year of Secondary School*

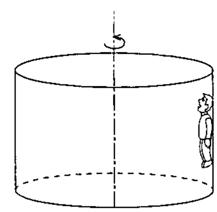
Country	Percent Correct	PTCI
Canada	21 (2.7)	14%
[2] Cyprus	51 (4.3)	9%
Czech Republic	8 (4.3)	11%
France	14 (2.2)	20%
† Germany	9 (3.0)	8%
† Greece	20 (3.0)	10%
[1] Latvia (LSS)	18 (5.7)	3%
† Norway	29 (3.4)	8%
[2] Russian Federation	13 (3.1)	2%
Sweden	28 (3.3)	16%
Switzerland	15 (3.7)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):		
Australia	27 (4.9)	13%
[2] Austria	5 (1.4)	33%
United States	15 (2.2)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):		
Denmark	23 (3.7)	3%
Slovenia	22 (6.0)	39%
International Average Percent Correct	20 (0.9)	

Example 5

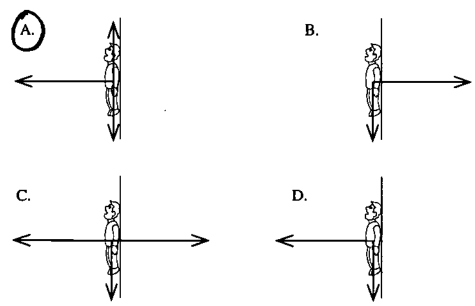
Direction of forces in amusement park ride.

Content Category: Mechanics

The figure below shows a special sort of amusement park ride. As the ride starts to rotate about its central vertical axis the floor drops slowly but the rider does not. The rider is pressed against the rough inside wall of the rotating cylinder and remains at rest with respect to the wall. The rider's feet are not in contact with the floor.



Which one of the following diagrams best represents the real forces acting on the rider?



SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table 9.8 Physics

Percent Correct for Example Item 6 for Students Having Taken Physics

Final Year of Secondary School*

Country	Percent Partially Correct	Percent Fully Correct	PTCI
Canada	19 (3.2)	12 (2.6)	14%
² Cyprus	18 (2.4)	7 (2.4)	9%
Czech Republic	7 (2.0)	1 (0.8)	11%
France	11 (2.0)	5 (1.8)	20%
† Germany	11 (3.8)	24 (4.2)	8%
† Greece	4 (1.8)	2 (0.7)	10%
¹ Latvia (LSS)	11 (3.2)	8 (2.2)	3%
† Norway	23 (3.1)	17 (2.6)	8%
² Russian Federation	8 (2.0)	17 (3.1)	2%
Sweden	23 (3.9)	7 (2.1)	16%
Switzerland	15 (2.4)	13 (1.9)	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):			
Australia	29 (4.4)	8 (3.2)	13%
² Austria	17 (3.3)	5 (1.5)	33%
United States	11 (1.7)	2 (0.7)	14%
Countries with Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details):			
Denmark	8 (1.7)	7 (2.2)	3%
Slovenia	4 (1.9)	21 (6.7)	39%
International Average Percent Correct	14 (0.7)	10 (0.7)	

Example 6

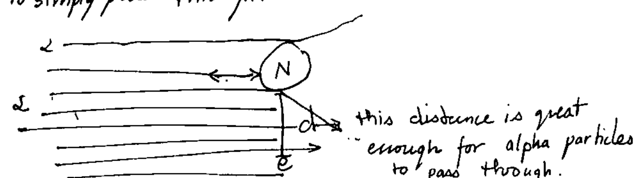
Alpha particles passing through gold.

Content Category:
Modern Physics: Particle, Quantum and Astrophysics, and Relativity

A stream of alpha particles is directed at a thin sheet of gold 80 atoms thick.

Explain why most of the alpha particles pass through the sheet.

Most alpha particles pass through the sheet because, of the size of the alpha particle, compared to the nucleus is very small. Because there is a vast amount of space between the nucleus and the electrons orbiting it, there is lots of room for alpha particles to simply pass through.



Even if some of the alpha particles hit the edge of the nucleus, they would deflect off with an angle, but still pass through.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

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* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

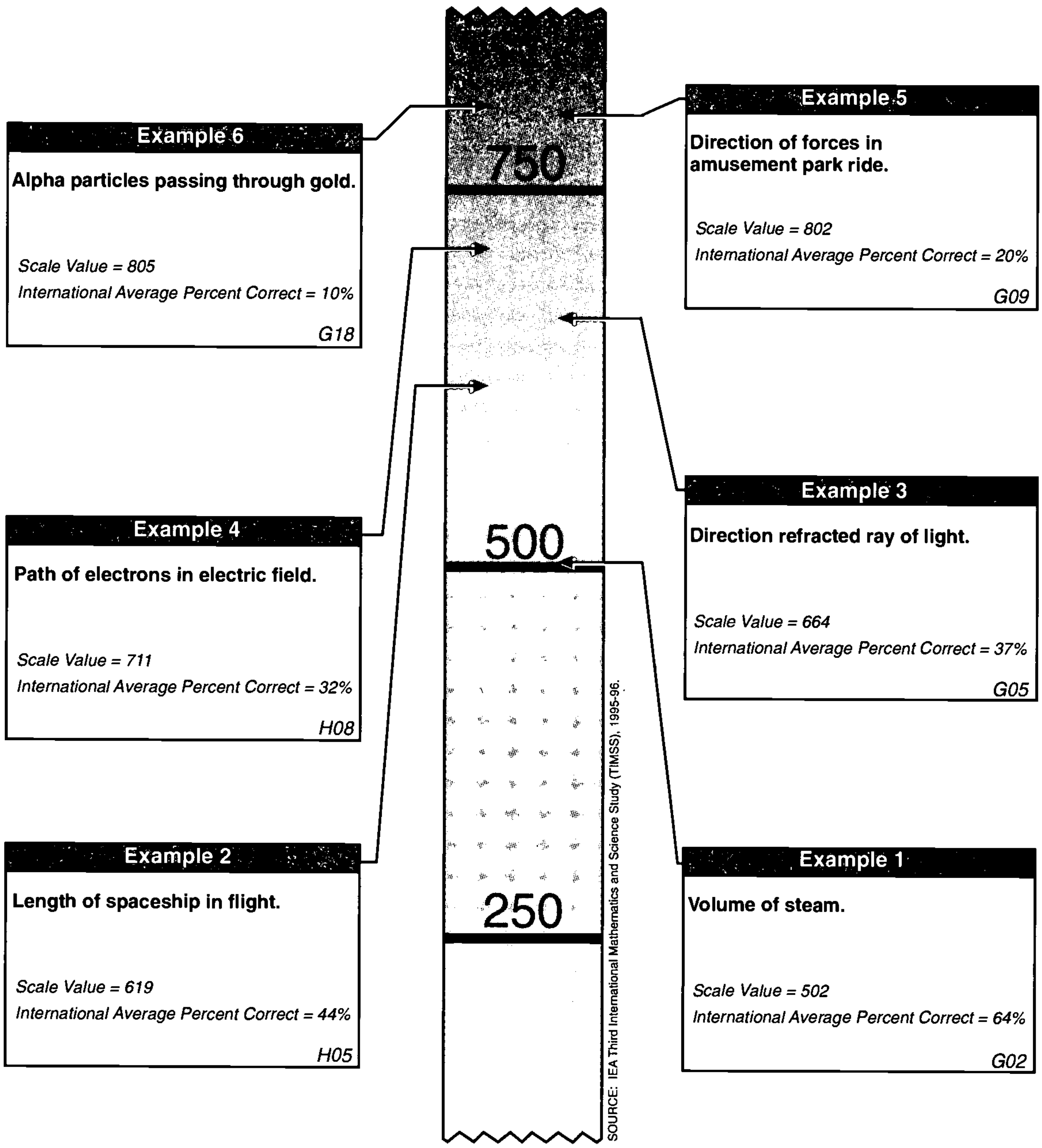
¹ National Desired Population does not cover all of International Desired Population (see Table B.4).

² National Defined Population covers less than 90 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 9.2

International Difficulty Map for Physics Example Items for Students Having Taken Physics
Final Year of Secondary School*



* See Appendix A for characteristics of students sampled.

Note: Items are shown at the point on the TIMSS physics scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

Chapter 10

Contexts for Physics Achievement

Physics is often considered to be among the most demanding of the sciences, and, because of its reliance on mathematical models and methods, the science most closely allied to mathematics. The students who take courses in physics at the end of upper secondary school are frequently also those who take advanced mathematics at that time. In countries with clearly defined tracks at the upper secondary level, the mathematics and physics tracks are often one and the same. This chapter focuses on the instructional experiences of final-year physics students, including the amount of instruction and homework they receive each week, the kinds of activities they engage in in physics class, and their use of calculators. In addition, this chapter presents physics students' reports on the educational level of their parents, and on their plans for future study.

What Are the Instructional Practices in Physics Classes?

The amount of physics instruction received by students in physics classes in their final year varied considerably across countries, but in general was less than five hours per week (see Table 10.1). Students in Australia, the Russian Federation, and the United States mostly reported between three and five hours of physics instruction per week, while in Canada, about half of the students then taking physics reported having five hours or more of physics instruction each week. In Cyprus, Denmark, Greece, and Norway, almost all physics students reported between three and four hours of instruction per week, whereas less than three hours was the norm for students in the Czech Republic, Germany, Latvia (LSS), Sweden, and Switzerland.

Significant percentages of students who met the TIMSS definition for a physics student in Austria, Canada, Slovenia, Switzerland, and the United States reported that they were not taking physics at the time of testing. For example, in Switzerland and other European countries, physics instruction is distributed across three to four years of secondary education (e.g., two lessons a week for three years). In the United States, physics can be taken before the final year of school. Also, in some countries, courses are scheduled by semesters rather than full years. Thus, there are several reasons why students may have completed their physics instruction before the TIMSS testing. Further it should be noted that such different instructional arrangements for secondary school physics also will influence the results in Table 10.1. The relationship between physics achievement and amount of instruction also varied across countries; the most common was a curvilinear relationship, with the highest achievement associated with between three and five hours of instruction.

The assignment of homework to final-year physics students is also something that varies considerably from country to country, as may be seen in Table 10.2. On one hand, most students taking physics in Austria, the Czech Republic, Latvia (LSS), and Slovenia reported that they were assigned physics homework less than once a week, while on the other, most students in Australia, Canada, Cyprus, Greece,

Table 10.1

Physics Students' Reports on the Amount of Physics Instruction They Are Currently Receiving Each Week – Physics
Final Year of Secondary School*

Country		Not Currently Taking Physics		Amount of Physics Instruction Per Week[1]: Less Than 3 Hours		3 to Less Than 4 Hours		4 to Less Than 5 Hours		5 Hours or More	
		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		2 (0.6)	~ ~	1 (0.6)	~ ~	39 (4.9)	507 (9.5)	46 (5.4)	530 (9.1)	13 (2.1)	551 (10.0)
Austria		44 (2.6)	413 (7.5)	- -	- -	- -	- -	- -	- -	- -	- -
Canada		31 (2.2)	463 (5.3)	4 (0.8)	465 (18.6)	22 (3.0)	507 (9.7)	23 (3.0)	516 (13.1)	52 (3.6)	487 (5.2)
Cyprus		0 (0.0)	~ ~	1 (0.4)	~ ~	92 (1.6)	496 (6.6)	3 (1.1)	483 (17.9)	5 (1.0)	464 (28.9)
Czech Republic	r	9 (3.9)	436 (11.9)	81 (3.1)	448 (6.0)	17 (2.9)	529 (22.9)	1 (0.6)	~ ~	0 (0.4)	~ ~
[2]*Denmark*	r	0 (0.0)	~ ~	0 (0.0)	~ ~	100 (0.0)	535 (5.0)	0 (0.0)	~ ~	0 (0.0)	~ ~
France		0 (0.0)	~ ~	- -	- -	- -	- -	- -	- -	- -	- -
Germany		8 (4.1)	421 (20.5)	52 (5.2)	489 (8.1)	42 (5.0)	580 (8.6)	6 (1.5)	558 (10.6)	1 (0.5)	~ ~
Greece	r	0 (0.0)	~ ~	0 (0.0)	~ ~	100 (0.0)	492 (5.8)	0 (0.0)	~ ~	0 (0.0)	~ ~
Latvia (LSS)		2 (1.1)	~ ~	53 (7.6)	453 (11.2)	10 (5.4)	599 (27.1)	33 (5.0)	501 (14.2)	5 (3.8)	494 (12.6)
Norway		0 (0.2)	~ ~	0 (0.2)	~ ~	98 (0.5)	585 (6.3)	0 (0.0)	~ ~	1 (0.4)	~ ~
Russian Federation		0 (0.1)	~ ~	22 (3.9)	485 (21.7)	23 (3.9)	527 (15.5)	44 (5.3)	569 (12.4)	11 (2.7)	610 (14.7)
Slovenia		17 (4.0)	394 (9.5)	42 (8.8)	527 (15.0)	53 (8.3)	567 (17.4)	3 (1.2)	578 (135.2)	2 (0.5)	~ ~
Sweden		0 (0.1)	~ ~	65 (3.5)	579 (4.3)	26 (3.2)	568 (7.5)	7 (1.5)	569 (19.1)	2 (0.5)	~ ~
Switzerland		22 (3.9)	452 (8.4)	72 (4.2)	485 (5.5)	24 (4.1)	535 (10.4)	3 (0.8)	544 (13.7)	0 (0.1)	~ ~
United States		23 (2.3)	421 (5.1)	9 (0.8)	396 (6.8)	26 (4.9)	429 (8.3)	49 (4.6)	425 (5.7)	17 (2.9)	423 (3.5)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking physics. Hours of instruction computed from lessons per week and minutes per lesson.

[2] Data for Denmark obtained from ministry.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Norway, the Russian Federation, and the United States reported physics homework assignments three or more times a week. No clear relationship between amount of homework assigned and physics achievement was evident across countries. In several countries the highest achievement was associated with a modest amount of homework; possibly in these countries homework is primarily a remedial device assigned to those who need it.

To provide information about instructional practices, students were asked how often in their physics lessons they are asked to do reasoning tasks, apply science to everyday problems, conduct laboratory experiments, and use computers to do exercises or solve problems. As shown in Table 10.3, virtually all students in every country except Austria reported being asked to do reasoning tasks in at least some lessons. Whereas the students in advanced mathematics classes who reported doing reasoning tasks most frequently were those with the highest achievement, the relationship between physics achievement and frequency of doing reasoning tasks was not consistent; only in a few countries was the average achievement highest among those asked to do such tasks every day.

Students reported that applying science to everyday problems is a frequent activity in physics classes. As may be seen in Table 10.4, most students in every country reported that they are asked to do this in some or most lessons. The practice was reportedly least common in Sweden, where 30% of physics students reported that they were never, or almost never, asked in class to apply science to everyday problems. This approach to physics instruction was most common in the United States, where 23% of the physics students reported being asked to apply science to everyday problems during every lesson. In many countries, the relationship between physics achievement and frequency of applying science to everyday problems was curvilinear, with the highest average achievement shown by those applying science to everyday problems in some or most lessons.

Although experimentation is the cornerstone of at least some branches of physics and might be expected to play a central role in physics classes for students in the final year of upper secondary school, students' reports indicate a wide range of approaches (see Table 10.5). In Austria, Germany, and Greece, the majority of the students reported that they never or almost never conduct laboratory experiments, whereas one-fourth or more of the students in Canada, Cyprus, Denmark, France, Switzerland, and the United States reported conducting experiments in most or all lessons. In about half of the countries, the majority of students reported conducting experiments in some lessons. There was no consistent relationship between frequency of conducting laboratory experiments in class and physics achievement.

The use of computers to do exercises or solve problems is reportedly no more common in physics classes than in advanced mathematics classes. In eight countries, Australia, Austria, the Czech Republic, Latvia (LSS), Norway, the Russian Federation, Sweden, and Switzerland, 80% or more of the students reported never or almost never using computers in physics classes (see Table 10.6). Only in Cyprus and Slovenia did more than 20% of the physics students report using a computer in every lesson. There was no consistent relationship between computer use in class and physics achievement.

Table 10.2

Physics Students' Reports on How Often They Are Assigned Physics Homework Physics Final Year of Secondary School*

Country	Not Currently Taking Physics		How Often Physics Homework Is Assigned[1]: Less Than Once a Week		Once or Twice a Week		3 or More Times a Week	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	2 (0.6)	~ ~	12 (2.8)	529 (14.5)	27 (2.6)	525 (10.6)	60 (3.8)	518 (7.7)
Austria	44 (2.6)	413 (7.5)	97 (1.2)	450 (9.1)	3 (1.2)	454 (21.7)	0 (0.3)	~ ~
Canada	31 (2.2)	463 (5.3)	6 (1.3)	535 (16.0)	25 (3.1)	514 (9.1)	68 (3.9)	487 (4.9)
Cyprus	0 (0.0)	~ ~	2 (0.5)	~ ~	6 (1.1)	508 (24.9)	92 (1.0)	493 (6.9)
Czech Republic	r 9 (3.9)	436 (11.9)	84 (2.5)	459 (7.9)	15 (2.4)	480 (12.2)	1 (0.4)	~ ~
Denmark	r 0 (0.0)	~ ~	7 (1.4)	531 (13.4)	45 (3.0)	525 (7.3)	48 (3.4)	545 (8.4)
France	0 (0.0)	~ ~	- -	- -	- -	- -	- -	- -
Germany	8 (4.1)	421 (20.5)	41 (4.7)	507 (13.4)	40 (3.3)	538 (6.7)	18 (3.3)	579 (15.6)
Greece	0 (0.0)	~ ~	8 (1.9)	465 (20.5)	10 (1.4)	488 (17.0)	82 (2.2)	496 (5.6)
Latvia (LSS)	2 (1.1)	~ ~	53 (4.8)	482 (23.0)	30 (3.4)	497 (20.2)	17 (3.3)	473 (16.9)
Norway	0 (0.2)	~ ~	10 (2.1)	595 (20.8)	15 (2.6)	589 (7.8)	75 (3.6)	581 (6.9)
Russian Federation	0 (0.1)	~ ~	6 (1.1)	554 (22.8)	20 (2.6)	541 (24.2)	74 (2.9)	546 (12.6)
Slovenia	17 (4.0)	394 (9.5)	67 (4.6)	559 (15.3)	29 (4.1)	535 (20.2)	3 (1.1)	506 (37.6)
Sweden	0 (0.1)	~ ~	33 (3.8)	569 (7.2)	64 (3.8)	577 (4.9)	3 (0.9)	551 (18.5)
Switzerland	22 (3.9)	452 (8.4)	41 (3.1)	475 (7.4)	51 (2.9)	514 (6.0)	7 (1.2)	529 (15.3)
United States	23 (2.3)	421 (5.1)	13 (2.2)	418 (7.6)	36 (2.3)	422 (4.6)	51 (2.7)	425 (4.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking physics.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Table 10.3

Physics Students' Reports on How Often They Are Asked to Do Reasoning Tasks in Their Physics Lessons† – Physics

Final Year of Secondary School*

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		0 (0.3)	~ ~	22 (1.6)	504 (10.8)	57 (2.8)	531 (9.4)	21 (2.1)	514 (9.2)
Austria		15 (3.3)	418 (25.5)	42 (3.4)	445 (10.9)	33 (3.3)	467 (10.1)	11 (2.0)	466 (11.8)
Canada		1 (0.2)	~ ~	16 (1.0)	495 (10.6)	56 (2.1)	496 (6.6)	28 (2.0)	501 (5.7)
Cyprus		1 (0.5)	~ ~	8 (1.5)	498 (30.0)	42 (2.3)	499 (10.6)	49 (2.8)	490 (6.3)
Czech Republic	r	0 (0.1)	~ ~	16 (1.7)	440 (9.9)	53 (3.2)	466 (11.2)	31 (3.5)	473 (7.6)
Denmark	r	2 (0.7)	~ ~	23 (2.9)	515 (7.4)	65 (2.9)	538 (6.6)	11 (1.6)	557 (14.1)
France		1 (0.4)	~ ~	14 (1.2)	459 (6.4)	52 (1.6)	470 (4.7)	33 (1.4)	465 (4.6)
Germany		1 (0.2)	~ ~	19 (1.5)	506 (13.7)	57 (2.1)	541 (9.5)	23 (2.3)	535 (16.6)
Greece		1 (0.4)	~ ~	8 (1.5)	463 (10.6)	45 (2.7)	492 (7.7)	46 (3.2)	500 (7.6)
Latvia (LSS)		3 (0.9)	482 (36.7)	52 (3.3)	476 (20.2)	41 (3.4)	495 (21.3)	5 (0.9)	490 (15.9)
Norway		1 (0.3)	~ ~	48 (1.9)	571 (8.6)	45 (2.0)	596 (6.3)	6 (0.8)	594 (16.7)
Russian Federation		1 (0.3)	~ ~	26 (2.3)	517 (11.6)	54 (1.8)	551 (12.7)	19 (1.5)	568 (16.8)
Slovenia		2 (0.8)	~ ~	43 (4.3)	546 (26.5)	43 (4.1)	552 (11.6)	12 (1.6)	577 (12.9)
Sweden		0 (0.2)	~ ~	26 (1.9)	576 (8.9)	58 (2.1)	571 (4.2)	16 (1.6)	581 (8.2)
Switzerland		2 (0.5)	~ ~	16 (1.4)	480 (15.3)	57 (2.1)	504 (7.0)	26 (2.4)	506 (7.2)
United States		1 (0.2)	~ ~	13 (1.2)	428 (7.1)	50 (1.8)	424 (4.6)	36 (1.8)	420 (4.1)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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 solution; write equations to represent relationships; and put events or objects in order and give a reason for their organization. Percentages based only on those students reporting that they are currently taking physics.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A tilde (~) indicates insufficient data to report achievement.

Table 10.4

Physics Students' Reports on How Often They Are Asked to Apply Science to Everyday Problems in Their Physics Lessons† – Physics
Final Year of Secondary School*

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	7 (1.4)	493 (16.6)	40 (3.2)	514 (9.0)	38 (3.4)	536 (8.8)	14 (1.8)	521 (12.4)
Austria	25 (2.8)	436 (14.6)	40 (3.8)	461 (7.8)	26 (2.9)	459 (13.6)	9 (2.6)	422 (18.6)
Canada	8 (0.8)	451 (17.1)	35 (1.8)	504 (7.8)	39 (2.4)	498 (4.7)	17 (2.5)	501 (10.4)
Cyprus	14 (1.6)	491 (25.1)	41 (2.3)	489 (9.7)	35 (2.5)	505 (7.9)	11 (1.5)	480 (21.1)
Czech Republic	r 13 (1.4)	448 (10.6)	49 (2.0)	461 (8.5)	31 (1.7)	470 (9.8)	7 (2.5)	478 (16.3)
Denmark	r 10 (1.5)	497 (12.3)	40 (2.7)	531 (7.5)	45 (2.7)	544 (7.1)	6 (1.3)	540 (22.4)
France	16 (1.2)	449 (7.6)	44 (1.1)	473 (4.6)	30 (1.3)	469 (5.7)	10 (1.1)	463 (8.0)
Germany	16 (2.0)	519 (11.1)	57 (2.4)	529 (10.7)	22 (1.8)	551 (15.4)	5 (0.9)	523 (21.2)
Greece	22 (2.4)	485 (11.5)	51 (2.9)	488 (8.4)	20 (2.2)	505 (9.0)	7 (1.4)	514 (13.8)
Latvia (LSS)	29 (3.6)	485 (21.0)	55 (4.1)	484 (21.0)	12 (1.3)	480 (19.2)	3 (0.8)	472 (19.2)
Norway	26 (1.6)	565 (7.6)	57 (1.6)	588 (7.2)	16 (1.0)	597 (8.8)	1 (0.4)	~ ~
Russian Federation	22 (2.0)	522 (14.8)	50 (1.5)	546 (13.6)	25 (2.0)	562 (10.3)	3 (0.6)	555 (24.3)
Slovenia	15 (2.4)	513 (18.3)	52 (2.8)	554 (15.5)	28 (2.4)	565 (20.9)	5 (1.2)	560 (19.8)
Sweden	30 (1.9)	564 (8.6)	54 (1.7)	577 (4.4)	14 (1.3)	577 (10.1)	2 (0.6)	~ ~
Switzerland	16 (1.3)	464 (11.2)	49 (1.5)	504 (7.1)	31 (1.8)	508 (6.4)	4 (0.8)	522 (21.7)
United States	6 (0.9)	412 (7.0)	31 (1.4)	422 (4.7)	40 (1.7)	421 (4.2)	23 (2.1)	430 (6.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Percentages based only on those students reporting that they are currently taking physics.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A tilde (~) indicates insufficient data to report achievement.

Table 10.5

Physics Students' Reports on How Often They Are Asked to Conduct Laboratory Experiments in Their Physics Lessons† – Physics

Final Year of Secondary School*

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	12 (1.7)	508 (16.0)	80 (2.2)	523 (6.0)	8 (1.9)	524 (28.3)	0 (0.3)	~ ~
Austria	52 (4.8)	434 (10.6)	33 (4.3)	465 (10.8)	10 (1.9)	476 (25.2)	6 (4.0)	469 (21.1)
Canada	8 (1.1)	496 (11.9)	65 (2.5)	493 (7.5)	24 (2.8)	506 (15.4)	3 (0.4)	504 (12.5)
Cyprus	7 (1.1)	541 (36.1)	68 (2.2)	489 (7.5)	19 (1.9)	487 (12.1)	6 (1.1)	513 (32.4)
Czech Republic	r 33 (2.9)	449 (9.0)	58 (3.1)	470 (9.1)	8 (1.4)	480 (14.5)	1 (0.8)	~ ~
Denmark	r 4 (1.2)	505 (20.3)	48 (3.0)	537 (6.8)	48 (3.2)	535 (7.6)	0 (0.0)	~ ~
France	5 (1.0)	449 (14.9)	62 (2.1)	471 (3.9)	30 (2.3)	464 (5.6)	3 (0.5)	446 (8.8)
Germany	62 (3.2)	515 (9.6)	33 (3.2)	556 (16.8)	4 (1.2)	551 (21.6)	1 (0.4)	~ ~
Greece	78 (2.7)	500 (5.7)	17 (2.3)	468 (13.0)	4 (1.2)	453 (29.6)	2 (0.6)	~ ~
Latvia (LSS)	17 (3.6)	450 (27.4)	77 (3.2)	489 (16.6)	6 (1.4)	512 (28.5)	0 (0.2)	~ ~
Norway	3 (0.9)	583 (23.2)	93 (1.6)	584 (6.3)	4 (0.9)	575 (19.9)	0 (0.3)	~ ~
Russian Federation	9 (1.6)	539 (13.3)	72 (1.9)	545 (13.9)	18 (1.7)	544 (13.4)	2 (0.3)	~ ~
Slovenia	14 (2.9)	532 (23.3)	68 (3.9)	560 (18.6)	16 (3.4)	531 (14.9)	2 (0.9)	~ ~
Sweden	4 (1.0)	581 (20.6)	79 (1.8)	576 (4.4)	16 (1.4)	562 (6.5)	1 (0.7)	~ ~
Switzerland	31 (4.4)	477 (10.8)	36 (2.1)	512 (6.9)	28 (2.9)	507 (8.6)	5 (1.7)	503 (15.4)
United States	4 (0.6)	410 (11.2)	49 (2.6)	425 (4.1)	37 (2.2)	423 (5.3)	10 (1.1)	414 (6.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Percentages based only on those students reporting that they are currently taking physics.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A tilde (~) indicates insufficient data to report achievement.

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As discussed in Chapter 7, calculators are used very frequently by final-year advanced mathematics students. A similar situation is shown in Table 10.7 for physics students. In Australia, Canada, Cyprus, Denmark, France, Norway, Slovenia, and Sweden, 80% or more of the students reported using a calculator at least daily, and in several other countries more than half of the students reported this level of use. The lowest levels of calculator use among physics students were reported in the Czech Republic and Greece, where about one-fourth of the students reported using a calculator once a month or less. Like final-year students in general and students of advanced mathematics, the students with the highest average physics achievement were those who reported the highest level of calculator use in most countries. Although the relationship was less pronounced than for students having taken advanced mathematics, in most countries students who reported daily calculator use performed better on the TIMSS physics test than those who reported less frequent use.

Like the advanced mathematics students, and final-year students in general, physics students also were given the option of using a calculator when completing the TIMSS tests. As shown in Table 10.8, during the testing session physics students reported using a calculator slightly less than did advanced mathematics students. However, most physics students in every country made moderate use (for up to ten questions) of a calculator on the TIMSS test. In Austria, Greece, Latvia (LSS), and the Russian Federation, more than one-third of the students reported not using a calculator at all. The extent of calculator use was not consistently related to achievement in every country, but physics students who reported that they did not use a calculator on the test did less well than those who reported using one.

Table 10.6

Physics Students' Reports on How Often in Physics Lessons They Are Asked to Use Computers to Solve Exercises or Problems† – Physics

Final Year of Secondary School*

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		80 (3.5)	518 (6.0)	16 (3.5)	528 (16.3)	3 (1.1)	573 (30.1)	1 (0.5)	~ ~
Austria		87 (3.0)	441 (9.0)	8 (2.2)	511 (17.7)	3 (1.1)	542 (20.2)	2 (0.6)	~ ~
Canada		72 (3.0)	501 (6.4)	20 (2.8)	488 (9.0)	6 (1.9)	485 (43.6)	1 (0.4)	~ ~
Cyprus		54 (2.8)	509 (6.5)	9 (2.1)	455 (25.5)	15 (1.8)	479 (15.2)	22 (2.3)	481 (14.2)
Czech Republic	r	91 (1.7)	462 (8.3)	7 (1.5)	481 (19.1)	1 (0.4)	~ ~	1 (0.8)	~ ~
Denmark	r	46 (3.3)	534 (7.3)	42 (2.2)	540 (7.3)	12 (2.0)	528 (12.6)	0 (0.2)	~ ~
France		69 (2.7)	468 (4.5)	25 (2.3)	465 (5.3)	4 (1.0)	466 (9.9)	1 (0.4)	~ ~
Germany		77 (3.1)	519 (9.0)	20 (3.0)	575 (14.9)	3 (0.9)	553 (22.1)	1 (0.6)	~ ~
Greece	r	63 (3.0)	499 (6.3)	22 (2.3)	482 (9.8)	11 (1.5)	468 (16.7)	4 (1.3)	507 (23.0)
Latvia (LSS)		88 (1.6)	480 (17.4)	9 (1.5)	522 (32.0)	3 (0.6)	464 (26.8)	0 (0.3)	~ ~
Norway		88 (2.5)	583 (6.5)	11 (2.4)	603 (19.6)	1 (0.4)	~ ~	1 (0.6)	~ ~
Russian Federation		83 (2.1)	542 (10.2)	12 (1.5)	577 (29.9)	3 (1.0)	533 (30.3)	1 (0.4)	~ ~
Slovenia		13 (1.9)	567 (12.4)	21 (2.4)	559 (17.7)	44 (3.0)	551 (22.7)	22 (2.2)	535 (15.4)
Sweden		83 (2.6)	571 (4.3)	17 (2.5)	585 (7.4)	0 (0.2)	~ ~	0 (0.2)	~ ~
Switzerland		80 (3.0)	489 (6.2)	17 (2.5)	545 (12.0)	2 (0.7)	~ ~	0 (0.2)	~ ~
United States		58 (4.5)	418 (4.2)	30 (3.6)	431 (5.6)	8 (1.7)	425 (8.7)	4 (1.5)	435 (22.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Percentages based only on those students reporting that they are currently taking physics.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A tilde (~) indicates insufficient data to report achievement.

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Table 10.7

Physics Students' Reports on How Often They Use a Calculator at School, Home, or Anywhere Else – Physics
Final Year of Secondary School*

Country	Rarely or Never		Monthly		Weekly		Daily	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	1 (0.4)	~ ~	0 (0.2)	~ ~	5 (1.3)	496 (22.5)	94 (1.4)	520 (5.9)
Austria	4 (1.1)	394 (14.8)	4 (0.8)	407 (17.5)	34 (2.2)	442 (7.7)	58 (2.7)	435 (7.6)
Canada	1 (0.9)	~ ~	1 (0.4)	~ ~	10 (1.3)	483 (13.5)	88 (1.1)	488 (3.7)
Cyprus	1 (0.5)	~ ~	1 (0.5)	~ ~	7 (1.3)	528 (22.9)	91 (1.7)	493 (5.6)
Czech Republic	11 (1.5)	417 (8.3)	14 (2.2)	429 (9.4)	44 (1.9)	442 (5.2)	31 (3.1)	487 (9.4)
Denmark	r 0 (0.0)	~ ~	0 (0.1)	~ ~	9 (1.5)	488 (13.0)	91 (1.5)	539 (5.4)
France	2 (0.4)	~ ~	2 (0.6)	~ ~	16 (1.4)	462 (5.7)	80 (1.7)	469 (3.8)
Germany	2 (0.6)	~ ~	0 (0.3)	~ ~	20 (1.7)	495 (14.5)	78 (1.8)	531 (13.1)
Greece	18 (1.8)	457 (9.9)	7 (1.1)	452 (19.8)	26 (2.1)	482 (10.7)	49 (2.5)	507 (5.8)
Latvia (LSS)	13 (1.8)	456 (19.2)	6 (1.1)	468 (26.5)	44 (2.0)	487 (19.9)	38 (2.4)	500 (22.7)
Norway	0 (0.1)	~ ~	1 (0.4)	~ ~	7 (0.9)	559 (8.8)	91 (1.0)	586 (6.4)
Russian Federation	10 (2.0)	494 (22.3)	4 (0.7)	532 (22.8)	30 (1.4)	537 (14.5)	57 (2.6)	559 (11.3)
Slovenia	1 (0.4)	~ ~	1 (0.6)	~ ~	18 (2.1)	513 (18.5)	80 (2.3)	523 (16.8)
Sweden	0 (0.1)	~ ~	1 (0.4)	~ ~	11 (1.5)	558 (12.7)	88 (1.5)	576 (3.7)
Switzerland	1 (0.3)	~ ~	1 (0.2)	~ ~	25 (2.1)	458 (5.4)	74 (2.0)	499 (4.0)
United States	4 (0.7)	385 (5.7)	3 (0.5)	402 (9.0)	14 (1.6)	401 (5.4)	79 (1.6)	429 (3.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).
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. A tilde (~) indicates insufficient data to report achievement.

Table 10.8

Physics Students' Reports on the Frequency of Calculator Use During the TIMSS Test
Physics
Final Year of Secondary School*

Country	Did Not Use a Calculator		Used a Calculator Very Little (<5 Questions)		Used a Calculator Somewhat (5-10 Questions)		Used a Calculator Quite a Lot (>10 Questions)	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	9 (1.7)	448 (12.3)	66 (2.3)	528 (6.2)	23 (1.9)	514 (10.0)	2 (0.8)	~ ~
Austria	34 (2.7)	421 (8.3)	49 (2.3)	440 (6.8)	15 (1.6)	456 (15.0)	1 (0.4)	~ ~
Canada	10 (1.6)	451 (10.3)	61 (1.8)	479 (3.8)	27 (1.6)	507 (7.4)	3 (0.4)	548 (19.9)
Cyprus	23 (2.5)	476 (10.9)	60 (2.6)	500 (6.4)	15 (1.9)	510 (17.5)	2 (0.8)	~ ~
Czech Republic	18 (1.8)	425 (11.8)	62 (3.1)	449 (5.3)	19 (2.1)	485 (11.0)	1 (0.4)	~ ~
Denmark	11 (1.4)	512 (9.8)	66 (1.8)	537 (5.0)	21 (1.8)	541 (9.4)	2 (0.6)	~ ~
France	17 (1.4)	447 (4.6)	63 (1.5)	471 (4.5)	18 (1.7)	471 (7.4)	1 (0.4)	~ ~
Germany	17 (2.1)	475 (19.2)	64 (2.5)	528 (12.1)	18 (2.2)	546 (12.7)	1 (0.5)	~ ~
Greece	75 (2.8)	475 (6.0)	22 (2.7)	530 (9.6)	3 (0.9)	494 (32.1)	1 (0.6)	~ ~
Latvia (LSS)	38 (4.5)	471 (24.2)	49 (3.3)	490 (23.0)	11 (2.1)	514 (15.6)	1 (0.3)	~ ~
Norway	4 (0.8)	558 (17.0)	56 (1.8)	572 (7.7)	37 (1.8)	597 (6.8)	3 (0.6)	616 (18.1)
Russian Federation	36 (2.8)	543 (12.1)	49 (2.2)	551 (11.9)	14 (1.3)	570 (15.5)	1 (0.4)	~ ~
Slovenia	17 (2.2)	476 (15.2)	65 (2.4)	532 (16.6)	16 (1.5)	562 (17.5)	2 (1.0)	~ ~
Sweden	3 (0.6)	526 (26.5)	53 (2.6)	562 (5.1)	38 (2.5)	588 (5.8)	5 (0.7)	611 (16.6)
Switzerland	13 (1.5)	461 (8.8)	62 (1.6)	493 (3.9)	23 (1.3)	496 (7.6)	2 (0.4)	~ ~
United States	19 (1.3)	391 (4.0)	64 (1.4)	427 (3.5)	16 (1.1)	443 (4.8)	1 (0.3)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

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What Are Secondary School Students' Educational Resources and Plans?

The relationship between parental education and achievement among final-year students was described in Chapter 4 for final-year students in general, and in Chapter 7 for those students having taken advanced mathematics. The results for final-year students having taken physics are again given for the same three educational levels: finished university, finished upper secondary school but not university, and finished primary school but not upper secondary school (see Table 10.9). The modifications that some countries made in the categories are those that are described in Figure 4.6. The clear positive relationship between parents' education and achievement that was described in the earlier chapters is also apparent in Table 10.9 for students having taken physics. Physics students' reports of level of parental education were very similar to the reports of advanced mathematics students, with more than 30% of them reporting that at least one parent had finished university in every country except Austria. More than half the physics students in Canada, Germany, Latvia (LSS), the Russian Federation, and the United States reported that at least one parent had completed university.

Like the plans for further education of final-year students having taken advanced mathematics, those of final-year physics students center mainly on university. The students planning to attend university, as reported in Table 10.10, are in the majority in every country; and in 11 countries, Australia, Canada, Cyprus, the Czech Republic, Greece, Latvia (LSS), the Russian Federation, Slovenia, Sweden, Switzerland, and the United States, the percentage planning a university career exceeded 80%. The percentage of physics and mathematics students planning to attend university was very similar in every country except Denmark and Slovenia, where greater percentages of physics students reported plans to attend university. The percentage planning to choose a vocationally oriented program, low among advanced mathematics students, was even lower among physics students. Only in Norway and Germany did more than 15% of physics students report such intentions. Very few of the physics students reported that they did not plan to continue their education. Only in Austria and Denmark did at least 10% of students indicate that this was their plan. In nearly every country, the students planning to attend university had higher average physics achievement than any other group.

Table 10.9

Physics Students' Reports on the Highest Level of Education of Either Parent†
Physics
Final Year of Secondary School*

Country	Finished University[1]		Finished Upper Secondary but Not University[2]		Finished Primary but Not Upper Secondary[3]		Do Not Know	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	42 (3.3)	539 (8.3)	34 (3.0)	511 (8.1)	19 (2.1)	481 (9.7)	5 (1.5)	533 (24.8)
Austria	19 (2.0)	447 (10.0)	71 (2.0)	434 (7.5)	8 (1.5)	409 (11.7)	2 (0.6)	~ ~
Canada	51 (1.6)	502 (4.5)	37 (1.3)	472 (4.7)	7 (0.8)	481 (11.0)	6 (1.1)	444 (21.8)
Cyprus	44 (1.8)	507 (7.5)	36 (2.6)	488 (9.5)	17 (1.9)	481 (12.0)	3 (0.9)	477 (23.7)
Czech Republic	48 (1.9)	469 (9.1)	41 (1.8)	440 (5.7)	11 (1.1)	425 (6.1)	0 (0.0)	~ ~
Denmark	r 36 (2.1)	554 (9.8)	54 (2.3)	525 (4.8)	6 (1.2)	527 (20.7)	5 (1.1)	506 (30.2)
France	30 (2.1)	488 (4.9)	43 (2.1)	464 (4.0)	22 (2.3)	444 (8.4)	5 (0.7)	466 (12.5)
Germany	52 (3.2)	537 (13.4)	46 (3.1)	507 (13.3)	2 (0.6)	~ ~	- -	- -
Greece	34 (2.4)	510 (8.4)	42 (2.3)	479 (7.2)	21 (2.7)	472 (10.6)	3 (1.2)	449 (39.0)
Latvia (LSS)	52 (5.1)	508 (25.0)	44 (5.1)	467 (14.0)	2 (0.8)	~ ~	2 (0.5)	~ ~
Norway	43 (2.5)	599 (7.4)	45 (2.2)	575 (7.9)	7 (1.1)	559 (11.8)	5 (0.8)	555 (14.4)
Russian Federation	65 (2.2)	559 (10.4)	35 (2.2)	518 (15.7)	0 (0.1)	~ ~	0 (0.2)	~ ~
Slovenia	39 (3.0)	548 (23.5)	53 (2.1)	507 (12.9)	8 (1.3)	481 (15.3)	0 (0.2)	~ ~
Sweden	41 (2.0)	587 (6.2)	41 (2.0)	565 (7.4)	8 (1.6)	571 (11.1)	9 (1.3)	551 (9.4)
Switzerland	34 (1.4)	490 (4.9)	59 (1.8)	489 (4.7)	5 (1.0)	473 (10.5)	1 (0.4)	~ ~
United States	55 (2.5)	440 (3.9)	41 (2.4)	407 (4.1)	3 (0.5)	387 (6.8)	2 (0.3)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† 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 4.5 for country modifications to the definitions of educational levels.

* See Appendix A for characteristics of the students sampled.

[1] In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

[2] 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.

[3] Finished primary or some secondary school not equivalent to completion of upper secondary.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

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Table 10.10

Physics Students' Reports on Their Plans for Future Education† – Physics Final Year of Secondary School*

Country	University[1]		Vocationally Oriented Programs[2]		Other Postsecondary Education[3]		Does Not Intend to Continue Education	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
Australia	89 (1.6)	524 (7.0)	4 (1.0)	460 (13.4)	2 (0.8)	~ ~	4 (1.3)	455 (9.4)
Austria	68 (2.0)	444 (7.1)	12 (1.5)	413 (12.8)	6 (1.0)	417 (12.6)	14 (1.6)	421 (13.1)
Canada	82 (1.6)	488 (4.7)	5 (1.2)	462 (10.3)	12 (1.8)	485 (12.6)	1 (0.9)	~ ~
Cyprus	91 (1.5)	500 (5.1)	6 (1.3)	454 (26.3)	2 (0.7)	~ ~	1 (0.7)	~ ~
Czech Republic	93 (1.0)	456 (6.5)	5 (0.7)	396 (8.9)	1 (0.3)	~ ~	2 (0.5)	~ ~
Denmark	r 74 (2.0)	555 (6.6)	5 (1.1)	453 (15.8)	10 (1.4)	490 (13.4)	10 (1.5)	518 (15.5)
France	75 (1.7)	471 (4.4)	12 (1.2)	453 (5.6)	12 (1.0)	457 (6.9)	1 (0.4)	~ ~
Germany	76 (5.5)	540 (9.6)	17 (4.6)	456 (17.9)	3 (0.9)	493 (22.1)	3 (0.8)	501 (15.1)
Greece	86 (1.9)	499 (5.2)	5 (1.3)	430 (19.7)	8 (1.2)	432 (15.4)	2 (0.7)	~ ~
Latvia (LSS)	85 (1.4)	491 (21.1)	7 (0.8)	478 (17.7)	8 (1.0)	447 (30.9)	1 (0.4)	~ ~
Norway	75 (2.2)	595 (6.4)	19 (1.9)	554 (10.8)	5 (0.9)	535 (11.5)	1 (0.3)	~ ~
Russian Federation	89 (2.2)	554 (10.7)	9 (1.9)	473 (24.2)	2 (0.5)	~ ~	0 (0.1)	~ ~
Slovenia	92 (1.6)	526 (16.5)	5 (1.3)	485 (20.4)	1 (0.5)	~ ~	1 (0.6)	~ ~
Sweden	92 (0.8)	580 (3.7)	3 (0.7)	503 (24.8)	4 (0.6)	508 (15.2)	2 (0.5)	~ ~
Switzerland	90 (1.1)	492 (3.7)	2 (0.5)	~ ~	4 (0.5)	454 (11.5)	4 (1.0)	465 (17.5)
United States	92 (0.7)	425 (3.4)	3 (0.4)	383 (6.7)	5 (0.7)	391 (6.4)	0 (0.0)	~ ~

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Educational options were defined by each country to conform to their national systems and may not be comparable across countries. See Figure 4.2 for definitions and any national adaptations of the international options in each category.

* See Appendix A for characteristics of the students sampled.

1 In most countries, defined as at least a 3-year degree program at a university or an equivalent institute of higher education.

2 Defined in most countries as vocational or technical courses at a tertiary institution not equivalent to a university degree program (e.g., trade or business school, junior or community college, and other shorter vocational programs), but may also include higher-level upper secondary vocational programs in some countries

3 Includes other postsecondary education defined in each country. Includes categories such as academic courses at junior or community college, short university or polytechnic courses, and college-preparatory courses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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. A tilde (~) indicates insufficient data to report achievement.

Students who have studied physics in upper secondary school are well positioned to continue their education in the sciences or in areas of scientific application. Table 10.11 presents students' reports of their choices for study after secondary school from a range of areas where students with advanced preparation in physics might seek further education. The areas include physics or chemistry, biological or earth science, health sciences or related occupations, mathematics or computer/information sciences, engineering, and business. An "other" category was provided for students whose preferred area of study was not included. Although choice of study area varied considerably across countries, the most popular were engineering, mathematics or computer/information sciences, health sciences or related occupations, and business. Engineering was the most popular area overall, and was the area chosen by the most physics students in Australia, Denmark, Norway, and Sweden. Health sciences or related occupations were most popular in Austria, Canada, Cyprus, France, Switzerland, and the United States. Business was the area of choice for the most students in the Czech Republic, Germany, Latvia (LSS), and the Russian Federation. Mathematics or computer/information sciences are the most popular choice for physics students only in Greece and Slovenia. Neither of the science options (physics or chemistry, or biological or earth science) was the preferred choice in any country, although biological or earth science was among the more popular choices in France. Relatively few physics students chose physics or chemistry as their preferred area of future study; only in Denmark, France, Greece, and Norway did as many as 10% of students indicate this as their choice. In Austria, the Czech Republic, and Switzerland, students most often reported that they planned to study some area other than the choices provided.

Table 10.11

Physics Students' Reports on the Area They Intend to Study After Secondary School†
Physics
Final Year of Secondary School*

Country		Percent of Students						
		Physics or Chemistry	Biological or Earth Sciences	Health Sciences or Related Occupations	Mathematics or Computer /Information Sciences	Engineering	Business	Other
Australia		8 (1.4)	8 (1.2)	21 (2.2)	15 (2.8)	27 (3.0)	8 (1.2)	12 (2.1)
Austria	s	4 (1.0)	5 (1.3)	20 (1.9)	5 (1.2)	8 (1.6)	15 (1.8)	43 (2.7)
Canada		8 (1.0)	9 (1.3)	27 (1.5)	10 (0.7)	22 (1.9)	10 (1.3)	15 (1.0)
Cyprus		7 (1.5)	5 (1.3)	25 (2.4)	19 (1.8)	22 (1.7)	4 (1.1)	19 (1.6)
Czech Republic		2 (0.5)	14 (1.5)	13 (1.1)	12 (1.3)	3 (0.6)	20 (1.8)	37 (3.3)
Denmark	r	10 (1.5)	5 (1.3)	12 (1.6)	12 (1.5)	29 (2.7)	11 (1.5)	22 (2.7)
France		10 (1.3)	18 (1.8)	19 (1.3)	18 (1.2)	15 (1.6)	7 (1.1)	14 (1.3)
Germany		8 (1.7)	4 (0.8)	7 (1.8)	13 (2.2)	18 (1.5)	26 (3.9)	24 (2.6)
Greece		13 (1.9)	2 (0.9)	0 (0.3)	36 (2.1)	28 (2.1)	2 (0.9)	18 (1.8)
Latvia (LSS)		3 (0.6)	5 (0.8)	8 (1.2)	12 (1.6)	6 (0.9)	35 (2.3)	32 (2.6)
Norway		12 (1.0)	4 (0.9)	20 (1.3)	13 (1.5)	30 (1.7)	7 (1.1)	15 (0.9)
Russian Federation		6 (1.0)	3 (0.8)	6 (1.3)	29 (2.3)	9 (1.0)	30 (1.9)	17 (1.5)
Slovenia		7 (1.6)	5 (0.9)	12 (2.2)	21 (3.3)	18 (3.6)	18 (2.0)	19 (2.9)
Sweden		8 (1.2)	7 (1.1)	11 (1.9)	12 (2.2)	42 (3.6)	4 (0.7)	17 (2.1)
Switzerland		5 (0.7)	7 (1.0)	18 (1.4)	4 (0.7)	8 (1.1)	14 (1.6)	46 (1.7)
United States		3 (0.6)	7 (0.7)	23 (1.5)	7 (0.7)	15 (1.3)	16 (1.2)	29 (1.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

† Percentages based only on those students reporting that they intend to continue their education after secondary school.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

As was also reported in Chapter 7 for advanced mathematics students, there were considerable differences between male and female physics students in their choice of area for further study (see Table 10.12). Among students choosing health sciences or related occupations, and to a lesser extent biological or earth sciences, there were proportionately more females than males in many countries. However, in engineering, and in mathematics or computer/information sciences, males often outnumbered females by a substantial margin. As was found in the case of advanced mathematics students, a substantially higher percentage of females than males in most countries plan to pursue future studies in other areas not listed in Table 10.12.

Table 10.12

Physics Students' Reports on the Area They Intend to Study After Secondary School by Gender – Physics
Final Year of Secondary School*

Country		Percent of Students							
		Physics or Chemistry		Biological or Earth Sciences		Health Sciences or Related Occupations		Mathematics or Computer/ Information Sciences	
		Males	Females	Males	Females	Males	Females	Males	Females
Australia		7 (1.8)	9 (2.5)	6 (1.5)	10 (2.5)	14 (2.6)	34 (4.1)	19 (4.0)	8 (2.3)
Austria	s	5 (1.7)	3 (1.1)	4 (2.1)	5 (1.5)	17 (2.4)	23 (2.8)	9 (2.5)	1 (0.7)
Canada		7 (1.3)	8 (1.5)	7 (1.2)	11 (2.0)	16 (2.3)	39 (2.9)	14 (0.9)	6 (1.0)
Cyprus		7 (2.0)	6 (1.5)	5 (1.6)	5 (2.1)	21 (3.4)	30 (3.8)	20 (2.1)	18 (3.4)
Czech Republic		4 (0.9)	1 (0.6)	11 (1.9)	16 (1.8)	11 (1.9)	14 (1.6)	23 (2.2)	4 (1.0)
Denmark	r	11 (1.8)	9 (3.7)	5 (1.5)	5 (2.3)	8 (1.9)	25 (4.0)	14 (2.0)	4 (1.5)
France		10 (1.4)	9 (1.9)	16 (2.1)	21 (2.5)	11 (1.6)	31 (2.6)	22 (1.7)	11 (1.7)
Germany		8 (2.0)	7 (3.2)	4 (1.1)	4 (1.3)	5 (2.6)	10 (2.6)	18 (3.0)	4 (1.6)
Greece		11 (2.2)	16 (3.3)	2 (0.8)	3 (1.4)	0 (0.3)	1 (0.5)	36 (2.6)	37 (5.2)
Latvia (LSS)		3 (0.9)	2 (1.3)	4 (1.4)	6 (1.4)	5 (1.6)	11 (1.6)	18 (2.3)	7 (1.1)
Norway		13 (1.2)	9 (1.5)	4 (1.1)	4 (1.1)	12 (1.4)	41 (2.6)	14 (1.7)	7 (2.2)
Russian Federation		9 (1.8)	3 (1.3)	3 (1.3)	3 (1.0)	3 (0.8)	11 (2.5)	36 (2.8)	20 (2.8)
Slovenia		7 (1.5)	8 (5.0)	5 (1.2)	5 (2.3)	7 (2.3)	24 (5.3)	26 (4.4)	10 (2.6)
Sweden		6 (1.4)	11 (1.9)	5 (1.1)	13 (2.4)	4 (0.9)	25 (4.0)	17 (2.9)	3 (0.9)
Switzerland		7 (1.2)	2 (0.7)	7 (1.3)	7 (1.2)	10 (1.4)	25 (2.4)	5 (1.1)	2 (0.8)
United States		5 (0.8)	2 (0.5)	7 (0.9)	8 (0.9)	16 (2.4)	31 (2.5)	10 (1.1)	4 (0.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

Table 10.12 (Continued)

Physics Students' Reports on the Area They Intend to Study After Secondary School by Gender – Physics

Final Year of Secondary School*

Country	Percent of Students					
	Engineering		Business		Other	
	Males	Females	Males	Females	Males	Females
Australia	37 (4.5)	10 (3.5)	6 (1.5)	13 (2.0)	10 (2.2)	16 (3.7)
Austria	13 (3.0)	3 (1.3)	20 (3.1)	11 (2.3)	30 (4.4)	53 (3.3)
Canada	33 (2.9)	9 (1.8)	10 (1.5)	10 (1.6)	13 (1.1)	17 (1.6)
Cyprus	26 (2.7)	16 (3.4)	4 (1.6)	3 (1.5)	18 (2.4)	22 (3.0)
Czech Republic	5 (1.2)	2 (0.5)	20 (2.6)	20 (2.0)	27 (2.6)	43 (3.9)
Denmark	34 (3.0)	11 (3.2)	12 (2.0)	6 (2.8)	16 (2.8)	41 (6.3)
France	22 (2.8),	5 (1.7)	5 (1.1)	9 (1.8)	14 (1.9)	14 (1.9)
Germany	23 (2.3)	7 (1.5)	24 (3.4)	29 (6.3)	17 (2.6)	39 (5.7)
Greece	29 (3.0)	25 (3.9)	2 (1.2)	2 (1.1)	18 (2.4)	18 (3.0)
Latvia (LSS)	11 (1.8)	1 (0.4)	35 (2.6)	34 (2.7)	25 (2.1)	39 (3.9)
Norway	33 (1.7)	21 (2.6)	8 (1.5)	2 (1.4)	15 (1.0)	16 (2.5)
Russian Federation	15 (1.7)	2 (0.6)	25 (2.8)	37 (2.4)	11 (1.5)	24 (2.8)
Slovenia	23 (4.4)	3 (1.4)	17 (2.3)	19 (3.5)	14 (2.7)	31 (5.7)
Sweden	51 (3.4)	22 (3.0)	4 (0.9)	4 (1.2)	14 (2.3)	23 (2.3)
Switzerland	12 (1.5)	4 (1.2)	24 (2.7)	4 (0.8)	36 (2.6)	56 (2.5)
United States	24 (1.9)	5 (0.7)	15 (1.8)	16 (1.3)	24 (1.9)	34 (2.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Figure B.6).

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.

Appendices

Appendices

Appendix A

Structure of Upper Secondary Education Systems and Characteristics of Students Tested

The countries participating in TIMSS vary greatly with respect to the nature of their upper secondary education systems. Some countries provide comprehensive education to students in their final years of schools, while other countries are highly tracked and students attend either academic, vocational, or technical schools. Some countries fall in the middle of these extremes where students are enrolled in academic, vocational, or technical programs of study within schools. Across countries there are also varying definitions of academic, vocational, and technical programs and the kind of education and training students in these programs receive.

There also are variations across and within countries with respect to the grades representing the final year of schooling for students. In some countries, all students in their final year of schooling are in the same grade (e.g., secondary schooling ends for all students in Grade 12). In other countries, determining the final year of schooling is much more complicated because there are one or more academic tracks, one or more vocational tracks, and apprenticeship programs. In these countries, the final year of schooling may vary by track, with some students completing secondary school after a two-, three-, or four-year upper secondary program, depending on the type of school or program of study. Furthermore, for vocational programs it is not always straightforward as to when schooling is completed.

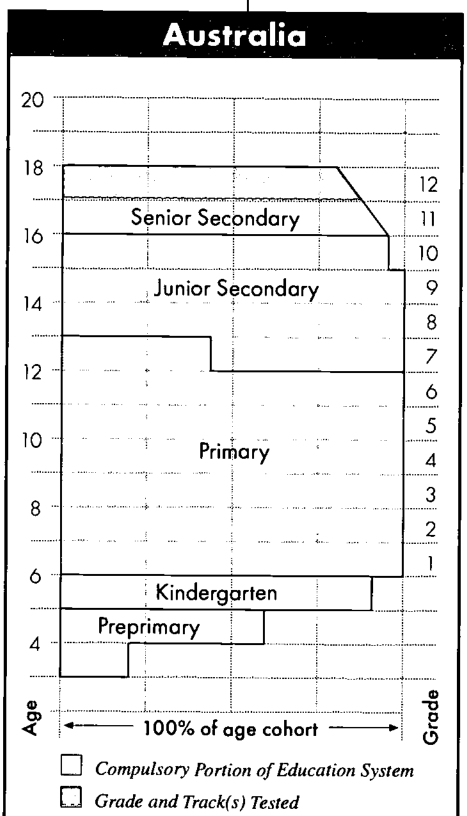
In order to make valid comparisons of the performance of students across countries in mathematics and science literacy, advanced mathematics, and physics, it is critical that there be an understanding of which students were tested in each country, that is, how each country defined the target population. It also is important to understand how each upper-secondary education system is structured and how the tested students fit into the system as a whole. In order to provide a context with which to interpret the achievement results presented in this report, this appendix contains a summary, provided by the National Research Coordinator of each country, describing the structure of the upper secondary system and specifying the grades and tracks (programs of study) in which students were tested for TIMSS. Additional information about the education systems can be found in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.*[1]

[1] Robitaille D.F. (Ed.) (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

AUSTRALIA

Structure of Upper Secondary System

School education is the responsibility of the individual states and territories in Australia. Secondary education is provided for either five or six years depending on the length of primary education in the state. Australia's secondary schools provide a comprehensive education, although students can focus on academic/pre-university studies, including humanities and art, mathematics and science, commerce, and other disciplines, or they can focus on vocationally oriented studies.



Students Tested in Mathematics and Science Literacy

Australia tested students in the final year of secondary school, Grade 12, in government, Catholic, and independent schools.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in the final year of secondary school, Grade 12, enrolled in mathematics courses (varies across states) preparing them for postsecondary study, and students in Grade 12 who took such mathematics courses during Grade 11.

Physics: students in the final year of secondary school, Grade 12, enrolled in Year 12 physics.

AUSTRIA

Structure of Upper Secondary System

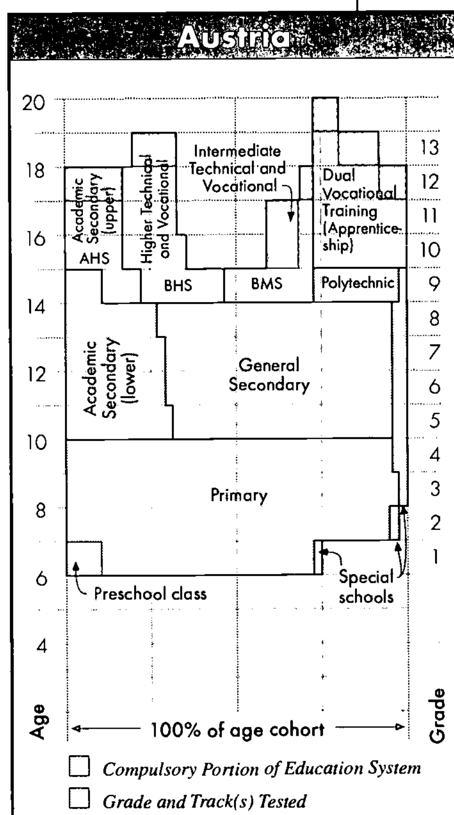
Academic and vocational schools form the upper secondary schooling in Austria. Academic secondary school (AHS) is a four-year cycle of pre-academic general education. Students may specialize in certain areas, but generally study a whole range of subjects. At the end of the cycle, students take a matriculation examination (*Matura*) which, upon passing, enables them to enter university.

There are three variations of vocational schools in Austria. Higher-technical and vocational (BHS) is a five-year cycle in which students study a similar academic curriculum to that in the AHS, but also study theoretical subjects relevant to future professions. Students train for careers in industry, trade, business, agriculture, or

Austria (cont.)

human service occupations. The final examination is similar to the AHS *Matura* and enables students to continue to university or obtain certain levels of vocational qualification. The final year of this cycle is Grade 13.

Intermediate-technical and vocational schools (BMS) are basically full-time schools equivalent to the dual system of school and apprenticeship (see below). These schools provide training in apprenticed trades and general education. The cycle is one to four years, but typically lasts three to four years. Successful completion results in vocational licenses which are sometimes more extensive than the ones given by the dual system. There are also higher teacher training colleges that represent an alternative route from the ninth year (grade) onwards.



In the system of dual vocational education – Apprenticeship/*Berufsschulen* (BS) – apprentices in business and industry receive practical vocational training at their place of work and also attend part-time vocational schools, *Berufsschulen*. Students typically attend the *Berufsschule* one day a week where some element of general education is included. The length of the course is from two to four years, but is three years for most students. The vocational qualification licenses the recipient to work in a legally defined trade.

Students Tested in Mathematics and Science Literacy

Austria tested students in their final year of academic schools (AHS), Grade 12, their final year of higher technical and vocational (BHS), Grade 13, and their final year of medium technical and vocational (BMS), Grades 10, 11, or 12, depending on the vocational program of the student, and students in their final year of the apprenticeship (BS).

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year of the academic or higher technical track, taking courses in advanced mathematics.

Physics: students in their final year of the academic or higher technical track, taking courses in physics.

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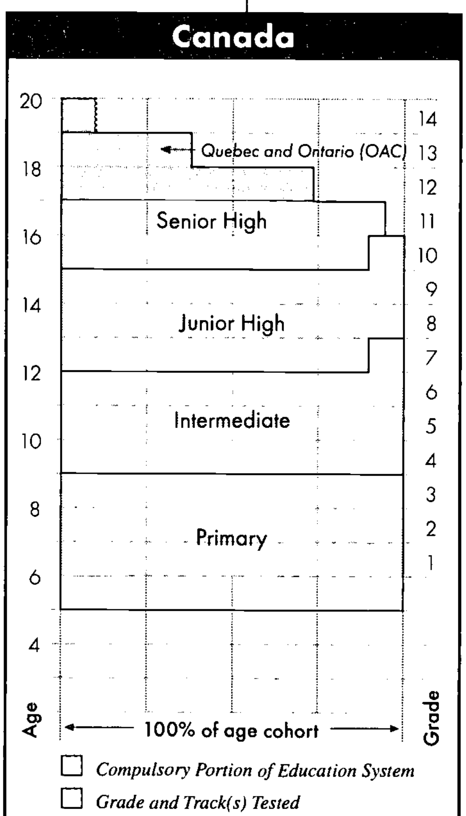
CANADA

Structure of Upper Secondary System

Secondary education in Canada is comprehensive, although students can focus on academic/pre-university studies or vocationally oriented studies. The first years of secondary school are devoted to compulsory subjects, with some optional subjects included. In the latter years, the number of compulsory subjects is reduced, permitting students to spend more time on specialized programs that prepare them for the job market, or to take specific courses they need to meet the entrance requirements of the college or university of their choice. Senior high school ends in Grade 12 in all provinces except Quebec, where it ends in Grade 11. In Ontario, some students complete secondary schooling at the end of Grade 12, whereas others continue for an extra year to complete the Ontario Academic Credits (OAC) necessary for admission to university. Students in Quebec continue from Grade 11 to either a two- or three-year training program prior to entry into tertiary education or the workplace.



Students Tested in Mathematics and Science Literacy

Canada tested students in Grade 12 in all provinces except Quebec where students in Grades 13 and 14 (depending on program) were tested. In Ontario, students completing the OAC in Grade 13 also were tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year in mathematics courses preparing them for postsecondary study (varies by province), except in Quebec where students in the two-year science program were tested.

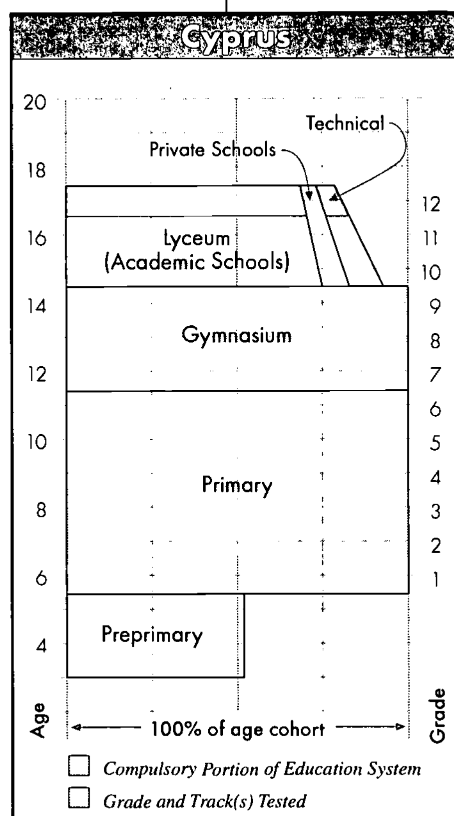
Physics: students in their final year in physics courses preparing them for postsecondary study (varies by province), except in Quebec where students in the two-year science program were tested.

Cyprus

Structure of Upper Secondary System

Academic schools (lycea) and technical schools form the upper secondary schooling in Cyprus. At the lyceum, which comprises Grades 10, 11, and 12, students can choose one of five groups of subjects – classical (arts), mathematics and science, economics, commercial/secretarial, and foreign languages.

In technical schools, also three years in duration, students can take technical courses with particular emphasis on mathematics and science. Graduates of these programs typically follow further studies in colleges or universities. Technical schools also offer vocational programs in which students in the final year follow a training program in industry for two days a week and attend school for three days a week. In the vocational section, more emphasis is given to practical skills. The aim of public technical schools is to provide industry with technicians and craftsmen in various specializations such as mechanical and automobile engineering, computers, electronics, building, graphic arts, dress-making, gold smithery, shoe manufacturing, and many others. Cyprus' private secondary schools are oriented towards commercial and vocational education and last for six years.



Students Tested in Mathematics and Science Literacy

Cyprus tested students in Grade 12 of lycea and the technical schools. Vocational students in technical schools were not tested. Students in the private vocational schools were not included.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year in the mathematics/science program of study at the lyceum.

Physics: students in their final year in the mathematics/science program of study at the lyceum.

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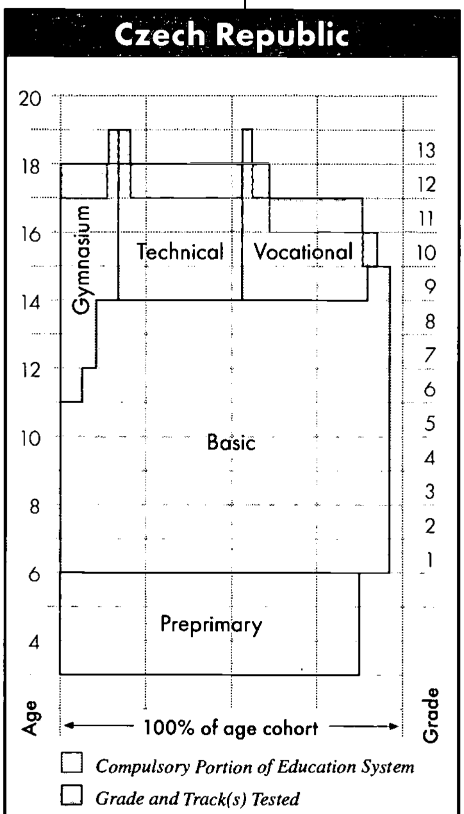
Czech Republic

Structure of Upper Secondary System

There are three types of secondary schools in the Czech Republic: gymnasium, technical, and vocational. The gymnasium is a four-, six-, or eight-year general secondary school providing demanding academic training for higher education. Students are in one of three streams in the gymnasium: humanities, science, or general education. Secondary technical schools, four or five years in duration, provide a broad general education as well as specialized study in a particular field (e.g., nursing, certain technical areas, tourism, library science, accounting, etc.). Students successfully completing the gymnasium or secondary technical school, and passing the final examination (maturita), are eligible to apply to institutions of higher education. Secondary vocational schools, two, three, four, or five years in duration, provide practical vocational training as well as general education, with the aim to prepare students for occupations. These professional schools specialize mostly in engineering and technical areas.



Secondary schooling ends in different years depending on the type of school and the course of study within school. In almost all secondary technical school and gymnasia, students complete their education at the end of Grade 12, although a few complete their studies in Grade 13. In vocational schools, students may end in Grades 10, 11, 12, or 13, depending on their type of vocation.

Since the time of the TIMSS testing (1995), the Czech system has been modified to reflect an extension of basic school. Beginning in 1996, Grade 9 became compulsory (until this decision was made, Grade 9 was an optional grade, attended by 14% of the age cohort in 1993/94). It means that currently all secondary technical and gymnasia students complete their education in Grade 13 and most vocational students complete their studies in Grade 12.

Students Tested in Mathematics and Science Literacy

The Czech Republic tested students in their final year of each type of school. In technical schools and gymnasia, students in Grades 12 and 13 were tested. In vocational schools, students in Grades 10, 11, 12, and 13 were tested, depending on their vocation.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: gymnasium students in their final year of study, Grade 12 or 13.

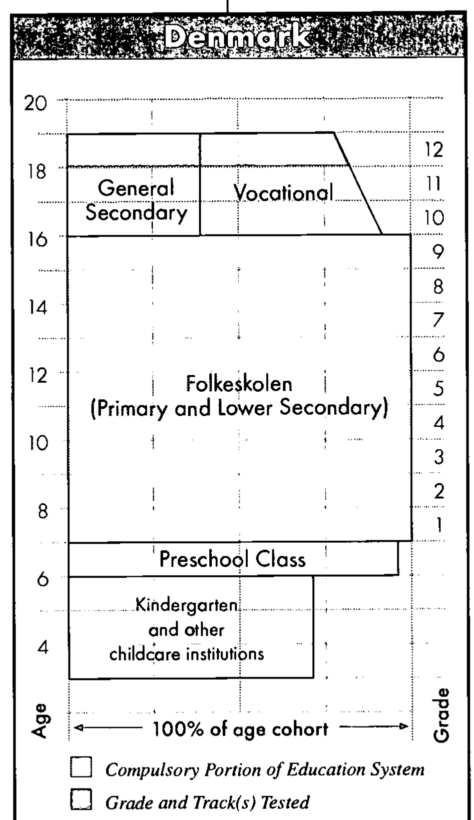
Physics: gymnasium students in their final year of study, Grade 12 or 13.

Denmark

Structure of Upper Secondary System

The general upper secondary programs are comprised of the general upper secondary certificates (*Studentereksamen*), the higher preparatory exam (HF) for mature students, the higher commercial exam (HHX), and the higher technical exam (HTX). The first two programs are taught at the Gymnasium and the last two at commercial and technical schools, respectively. All programs have a duration of three years except for the HF which is two years. The aim of the first two programs is primarily to prepare students for further studies at the tertiary level. The HHX and HTX prepare pupils for higher education but qualify also as final vocational education.

Vocational upper secondary programs encompass approximately 100 different specializations including vocational education and training, training for social affairs and health officers, agricultural education, and maritime education. Vocational training in Denmark is rooted in the apprenticeship tradition, but a wide-ranging modernization has been carried out over the past 30 years. This modernization has taken into account the lack of capacity among small and medium-sized enterprises to organize and carry out such training and reflects the need for a continuous updating of such programs.



Students Tested in Mathematics and Science Literacy

Denmark tested students in Grade 12 of the general secondary and vocational schools. Students finishing their formal schooling after Folkeskole (Grade 9) were not tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: mathematics and physics students in the gymnasium and mathematics students in their final year, Grade 12, of the technical or higher preparation tracks.

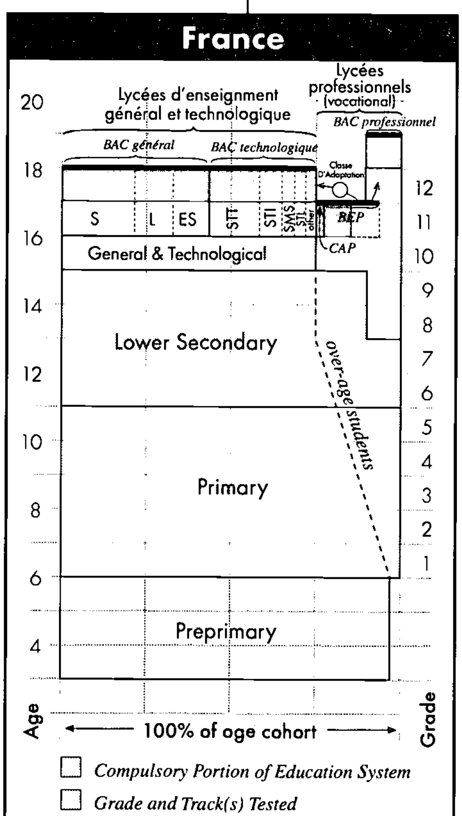
Physics: mathematics and physics students in the gymnasium and physics students in their final year, Grade 12, of the technical track.

FRANCE

Structure of Upper Secondary System

There are two types of upper secondary schools in France: *lycées d'enseignement général et technologique*, or upper secondary school for Grades 10 to 12, and *lycées professionnels* or vocational upper secondary school, which may end at Grade 11 or Grade 13.

In the *lycée d'enseignement général et technologique*, students in Grades 10, 11, and 12 are in either the general track or the technological track. In Grade 10, there are both common areas of study and optional courses in the general and technological tracks. All students at this level take mathematics and science courses. In Grade 11, the different tracks are strongly differentiated, leading to corresponding types of *baccalauréats*. The *baccalauréat général* has three main tracks: scientific (S), literary (L), and economic and social (ES). The *baccalauréat technologique* has four major tracks within it: tertiary sciences and technologies (STT), industrial sciences and technologies (STI), medical-social sciences (SMS), and laboratory sciences and technologies (STL). The type and amount of mathematics and science taken by *lycée* students is different for each of the tracks within the general and technological tracks. The final year of the general and technological tracks is Grade 12.



Vocational Grade 10 is the first year of a program leading to the *Brevet d'études professionnelles* (BEP) or to the *Certificat d'aptitude professionnelle* (CAP). Most pupils achieve a *Brevet d'études professionnelles*, which is granted after Grade 11. About 50 percent of students achieving this diploma decide to continue their studies, either by joining the technological track through a *classe d'adaptation* or by continuing in vocational secondary for an additional two years to achieve the *baccalauréat professionnel*. Their choice depends mainly on their results, but also on the area of their studies and employment prospects with a *Brevet d'études professionnelles*. The *baccalauréat* leads directly to university studies. The final year for a student in the *lycée professionnel* is either Grade 11 or Grade 13, depending on whether or not they plan to continue their studies.

Note: Compulsory schooling goes from the age of 6 until the age of 16. With some students repeating some classes, the correspondence between age and grade becomes theoretical.

France (cont.)

Students Tested in Mathematics and Science Literacy

France tested students in the final year of preparation for the *baccalauréat* (nonrepeaters of this final year). This included students in Grade 12 preparing for the *baccalauréat général ou technologique*, and in Grade 13 for the *baccalauréat professionnel* (vocational). Also tested were students in the final year (nonrepeaters of this year) of preparation for the *Brevet d'études professionnelles* (BEP) or the *Certificat d'aptitude professionnelle* (CAP) who will not continue towards a *baccalauréat.*

Students Tested in Advanced Mathematics and Physics

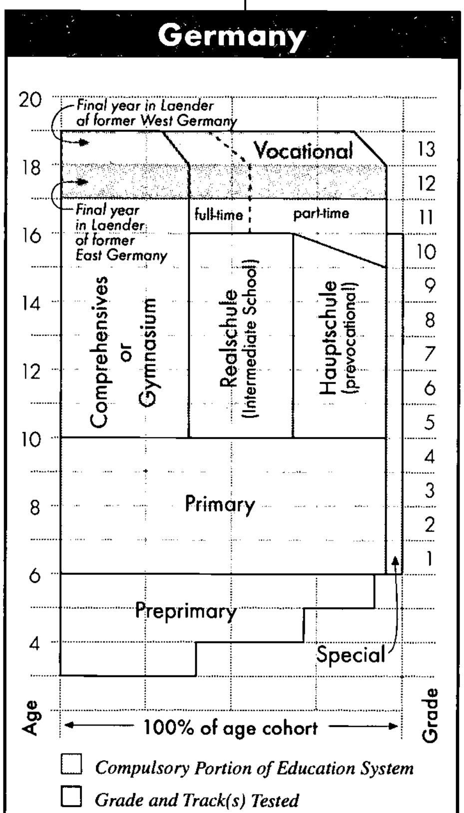
Advanced Mathematics: students in their final year of the scientific track, Grade 12, preparing for the *baccalauréat général.*

Physics: students in their final year of the scientific track, Grade 12, preparing for the *baccalauréat général.*

GERMANY

Structure of Upper Secondary System

The upper secondary education system, Grades 11 to 13, in Germany is comprised of two types of schools – gymnasia or comprehensive schools and vocational schools. Education is compulsory up to age 18. In the upper grades of gymnasium, beginning in Grade 11, students can choose specializations within a rather complicated framework that allocates approximately one-third of instruction time to languages and arts, one-fourth to social studies (civic education, history, religion or philosophy), one-third to mathematics and science, and one-twelfth to sports. Upon successful completion of the final examination at the end of Grade 12 or 13 (final year depends on the Laender) a student may attend university.



Those students interested in vocational training have a variety of options. A dual system combines general education and theoretical instruction in the specific area of occupational training in part-time schools (*Berufsschule*), and practical training in one of over 500,000 authorized companies or businesses (*Betriebe*). Usually students in the dual system attend school two days a week and work the other three days at a company in a training program. At the company, students are supervised and taught by accredited trainers according to the training regulations in effect pertaining to the occupation. In larger companies, students often receive additional instruction in company schools. There is also a broad range of full-time vocational schools, such as *Fachgymnasien*, where students are instructed in economic and technical fields and admission requirements for university-level studies are fulfilled. Other types of schools are *Fachoberschulen* that certify for further specialized scientific training at institutions of higher education as well as *Berufsfachschulen* that provide occupational training for careers in social and health services and business.

Students Tested in Mathematics and Science Literacy

Germany tested students in their final year in the academic track of upper secondary education and the vocational education programs. This corresponded to Grade 13 in the Laender of the former West Germany and to Grade 12 in the Laender of the former East Germany.

Students Tested in Advanced Mathematics and Physics

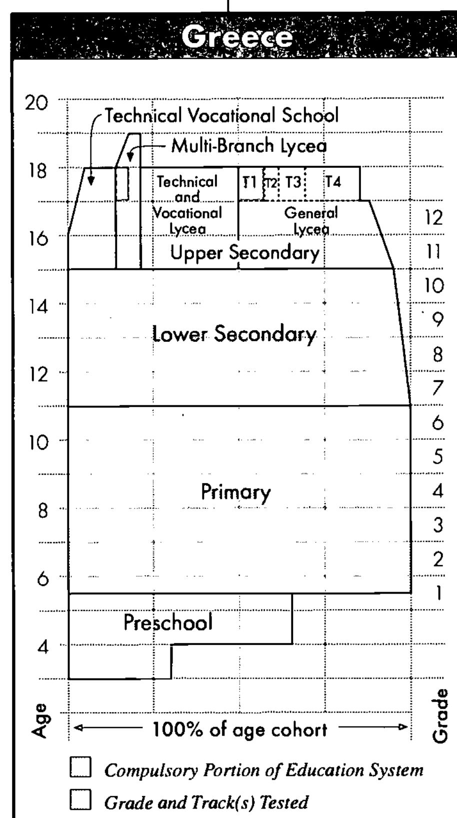
Advanced Mathematics: students in their final year, Grade 12 or 13 depending on the Laender, in advanced mathematics courses (3 to 5 periods per week).

Physics: students in their final year, Grade 12 or 13, in physics courses (3 to 5 periods per week).

GREECE

Structure of Upper Secondary System

The upper secondary system in Greece is a three-year program, Grades 10 to 12, taken in the general (academic) *Lyceum,* in the multibranch, semi-comprehensive *Lyceum* or in the technical-vocational *Lyceum.* Some students attend vocational and technical schools that provide two years of education, ending at Grade 11. In the general *Lyceum*, students in Grades 10 and 11 take the same courses. Students in the final grade may follow one out of four option streams in order to prepare them for tertiary education entry examinations. The four possible streams are science and engineering (T1), medical (T2), humanities (T3), and social science (T4). They may follow an alternative cycle if they do not choose to continue their education at the tertiary level. In the technical-vocational and multibranch schools, a wide range of option cycles of vocational and/or general education is provided.



Students Tested in Mathematics and Science Literacy

Greece participated only in the advanced testing and therefore tested a limited portion of their final-year students in the *Lyceum.* It tested students in Grade 12 of the general (academic) *Lyceum* as well as students in Grade 12 of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring mathematics and/or science.

Students Tested in Advanced Mathematics and Physics

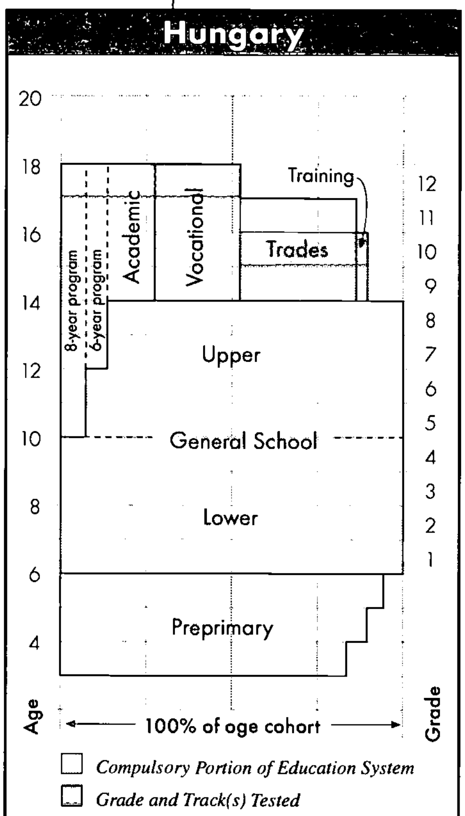
Advanced Mathematics: students in their final year, Grade 12, of the general (academic) *Lyceum* and of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring mathematics.

Physics: students in their final year, Grade 12, of the general (academic) *Lyceum* and of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring physics.

Hungary

Structure of Upper Secondary System

The upper secondary system in Hungary consists of five types of schools: a four-year academic secondary school (Grades 9 to 12), a four-year vocational secondary school (Grades 9 to 12), a three-year trade school (Grades 9 to 11), and a six-year or an eight-year academic program (Grades 7 to 12 or 5 to 12). Academic secondary schools offer general education and, for many students, lead to university. Vocational secondary schools prepare students for the work force (often technical vocations) or, alternatively, graduates may enter universities that match their vocational orientation. Trade schools and training schools emphasize practical knowledge and skills to train skilled workers. Students in the trade schools leave school after Grade 10 and spend their final year in out-of-school practice.



Students Tested in Mathematics and Science Literacy

Hungary tested students in their final year of academic secondary and vocational schools (Grade 12) and students in the final in-school year of trade school (Grade 10).

Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics in Hungary.

Iceland

Structure of Upper Secondary System

After completing primary and lower secondary education in Iceland, students are entitled to commence study at the upper secondary level regardless of their performance in final exams at the lower secondary level. If a student's academic standing is lower than a prescribed minimum, he/she must begin by attending special preparatory courses in basic subjects and improve his/her standing before commencing regular studies at the upper secondary level.

There are four main types of upper secondary schools in Iceland:

1. Grammar schools offer a four-year academic program of study leading to matriculation (*stúdentspróf*), i.e., higher education entrance examination. Students who complete the course satisfactorily are entitled to apply for admission to university.

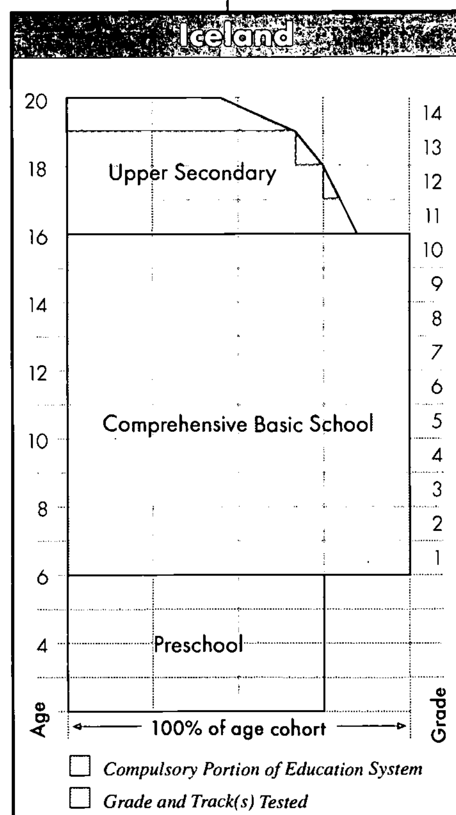
2. Industrial-vocational schools primarily offer vocational courses that prepare students for skilled trades. They also offer studies leading to a technical matriculation examination.

ICELAND (CONT.)

3. Comprehensive schools provide academic courses comparable to those of the grammar schools and vocational training comparable to that offered by industrial-vocational schools, as well as other specialized vocational training courses.

4. Specialized vocational schools offer training for specific vocations (Seamen's and navigational colleges, The Fish Processing School, marine engineering colleges, The Technical College of Iceland, fine arts colleges, agricultural colleges, The Icelandic College for Pre-school Teachers, The Icelandic College of Social Pedagogy).

At the upper secondary level, general academic education is primarily organized as a four-year course leading to matriculation, but two-year courses are also offered. The main areas of study of these two-year courses are in education, physical education, and commerce. They are organized as part of the course leading to matriculation (70 units of the 140 required) and students in these shorter courses can therefore continue on to matriculation. Such courses are usually intended as preparatory studies for other courses within the school or at specialized vocational schools.



Traditional grammar schools and upper secondary comprehensive schools are virtually the only schools offering education leading to matriculation. There are basically six courses of academic study leading to matriculation. These are studies in languages, sociology, economics, physical education, natural sciences, and physics. Additional fine arts studies, in music, for example, may lead to matriculation, as does a technical program offered as a follow-up to vocational training.

Vocational training takes place in comprehensive schools, industrial-vocational schools, and specialized vocational schools. Subjects included in vocational programs of study can be grouped as general academic subjects, theoretical vocational subjects, and practical vocational subects. The length of the courses offered varies from one to ten semesters. Many forms of vocational training award students certification for certain types of employment. This applies especially to study in certified trades, but also to some other studies, such as the training of nurses aides and qualified skippers.

Students Tested in Mathematics and Science Literacy

Iceland tested students who were to graduate that year from an upper secondary school, that is, students in Grades 12, 13, and 14.

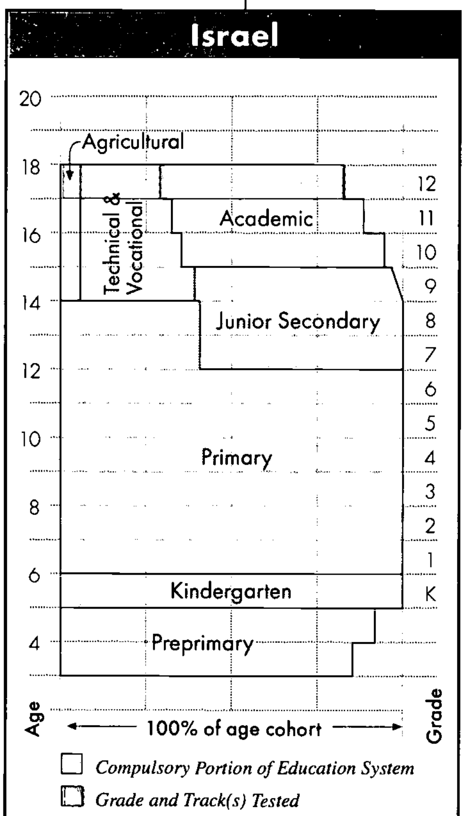
Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics.

ISRAEL

Structure of Upper Secondary System

Secondary schools provide three different tracks: academic, technical and vocational, and agricultural. There are four school types: comprehensive (which cater to all three tracks); technical/vocational (vocational track); general schools (academic track); and agricultural schools (agricultural track). Programs are from 2 to 4 years and end in Grade 12. Technical education offers a range of courses, including design, computer studies, industrial automation studies, electronics, and telecommunications. Graduates of the technical track are encouraged to serve in technical units of the Israeli defense forces to continue their studies in institutes of higher education.



Students Tested in Mathematics and Science Literacy

Israel tested students in the Hebrew education system only. Students in their final year of secondary school, Grade 12, were tested, in all three tracks.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in advanced mathematics courses in Comprehensive and General schools.

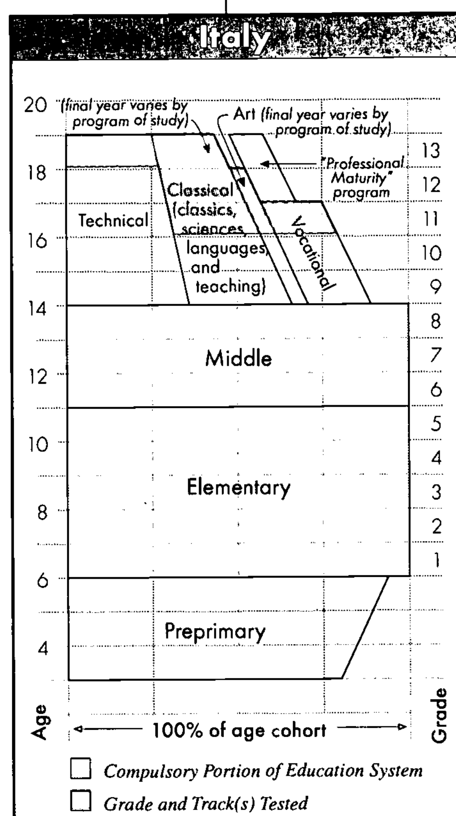
Physics: students in physics courses in Comprehensive and General schools.

ITALY

Structure of Upper Secondary System

After finishing compulsory education and passing the junior secondary school leaving examination, students in Italy may attend senior secondary school for an additional three, four, or five years. Students must pay a fee to the state and to the school they attend. There are four school types: classical schools, art schools, technical schools, and vocational schools. Classical schools include the *Liceo Classico*, which prepares humanities students for university; the *Liceo Scientifico*, which prepares mathematics and science students for university; the *Instituto Magistrale* for primary teacher education; the *Scuola Magistrale* for preprimary teacher education; and the *Liceo Linguistico* which prepares language students for university. Art schools, including the *Liceo Artistico* and the *Instituti d'Arte*, train students in the visual arts and lead to university or fine arts academies.

Technical schools, *Instituti Technici,* provide a five-year program to prepare students for professional, technical, or administrative occupations in the agricultural, industrial, or commercial sector. These schools give students access to university. Vocational schools provide a three-year program to train students to become qualified first-level technicians. Students may study an additional two years at *Instituti Professionali* and obtain a "professional maturity" designation, giving access to university.



Students Tested in Mathematics and Science Literacy

Italy tested students in all types of schools in their final year of secondary school. The final grade of school depended on the focus of study within school type. Classical studies: *Liceo Classico* (Grade 13); *Liceo Scientifico* (Grade 13); *Instituto Magistrale* (Grade 12); and *Scuola Magistrale* (Grade 11). Artistic studies: *Liceo Artistico* (Grade 12); *Instituto d'art* (Grade 12); and *Scuola d'art* (Grade 11). Vocational studies: *Instituto Professionale* (Grade 11). Technical studies: *Instituti Technici* (Grade 13). Italy did not test students in private schools.

Students Tested in Advanced Mathematics and Physics

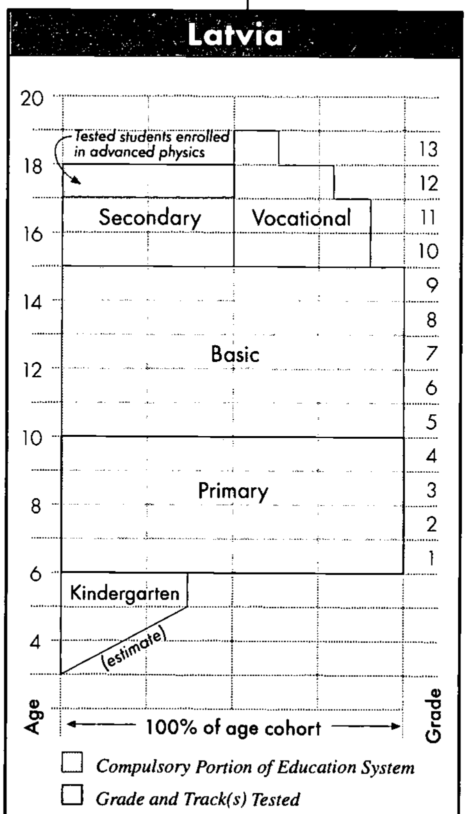
Advanced Mathematics: students in their final year of *Liceo Scientifico* (classical schools), Grade 11, 12, or 13, depending on the student's program of study, and *Instituti Technici* (technical schools), Grade 13.

Physics: students in their final year of *Liceo Scientifico* (classical schools), Grade 11, 12, or 13, depending on the student's program of study, and *Instituti Technici* (technical schools), Grade 13.

Latvia

Structure of Upper Secondary System

After basic education, Latvian students may attend secondary school (Grades 10 to 12), where they enter a three-year academic program to prepare for further studies in higher education or enter a vocational school for two to four years. In the academic secondary program, compulsory subjects include Latvian language and literature, mathematics, a foreign language, world history, Latvian history, and physical education. Optional subjects include the study of a second foreign language, economics, geography, computer science, physics, chemistry, biology, music, nature and society, and others. Vocational schools prepare students for independent technical work in various fields and include technical schools, medical schools, agricultural schools, teacher-training schools, and art schools. Vocational schools include instruction in theory and practice in the vocation of choice and some general education instruction.



Students Tested in Mathematics and Science Literacy

Latvia did not test students in mathematics and science literacy.

Students Tested in Advanced Mathematics and Physics

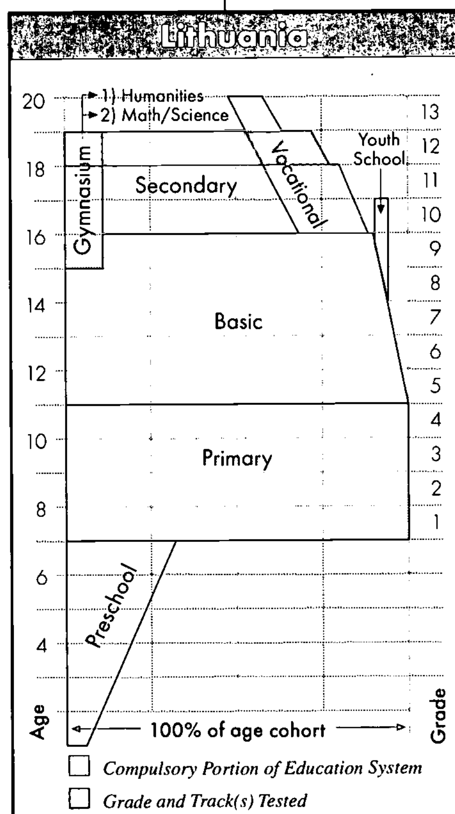
Advanced Mathematics: Latvia did not test students in advanced mathematics.

Physics: students in Grade 12, enrolled in advanced physics courses, in Latvian-speaking academic secondary schools.

LITHUANIA

Structure of Upper Secondary System

Upper secondary education in Lithuania includes four-year gymnasia, three-year secondary schools, and two-, three-, or four-year programs in vocational schools. The gymnasium is a four-year educational institution which offers general education at a more advanced level than that in the secondary schools. Traditionally, gymnasia are split into two programs: (1) humanities and (2) mathematics and science. Vocational schools provide general secondary education and training in a profession. There are also "youth schools" for students in basic or secondary school who are, for social reasons, unable to attend general schools. The youth schools provide a one- or two-year program after which students may reenter either the general or vocational schools.



Students Tested in Mathematics and Science Literacy

Lithuania tested students in Grade 12 in vocational, gymnasia, and secondary schools where Lithuanian is the language of instruction. Schools not under the authority of the Ministry of Education or the Ministry of Science were excluded.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year, Grade 12, of the mathematics and science gymnasia and students in secondary schools offering enhanced curriculum in mathematics.

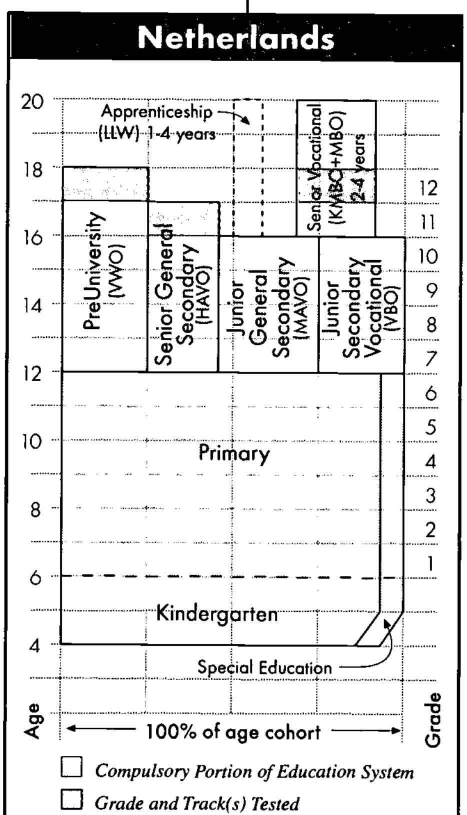
Physics: Lithuania did not test students in physics.

NETHERLANDS

Structure of Upper Secondary System

Secondary education in the Netherlands is four to six years in duration. Students may follow one of four main tracks: pre-university education (VWO); senior general secondary education (HAVO); junior general secondary education (MAVO); or junior secondary vocational education (VBO).

VWO is a six-year program that leads to university or colleges of higher professional education. HAVO is a five-year program designed to prepare students for higher professional education. MAVO is a four-year program after which students may go on to the fourth year of HAVO, take a short or long senior secondary vocational education course (KMBO or MBO), join an apprenticeship course (LLW), or enter the labor market. VBO is a four-year course of prevocational education specializing in technical, home economics, commercial, trade, and agricultural studies. This can lead to a KMBO or MBO course, an apprenticeship course (LLW), or the labor market. As of 1993, a common core curriculum is taught in the first three grades of VBO, MAVO, HAVO, and VWO. The core curriculum includes 15 subjects, among which are mathematics, combined physics and chemistry, biology, and geography (including earth science). This was the structure of the Netherlands' education system at the time of testing (1995). As of August 1997, the MBO, KMBO, and LLW programs are designated as Senior Vocational Education, offering short and long courses on a full-time or part-time basis.



Students Tested in Mathematics and Science Literacy

The Netherlands tested students in the final year, Grade 12, of the six-year VWO (pre-university) program, students in the final year, Grade 11, of the five-year HAVO (senior general secondary) program, and students in the second year, Grade 12, of a two- to four-year MBO or KMBO (senior secondary vocational) program. These latter students would have completed a four-year MAVO program or a four-year VBO program after primary school before beginning the KMBO or MBO program. Students in the LLW (apprenticeship) programs were excluded.

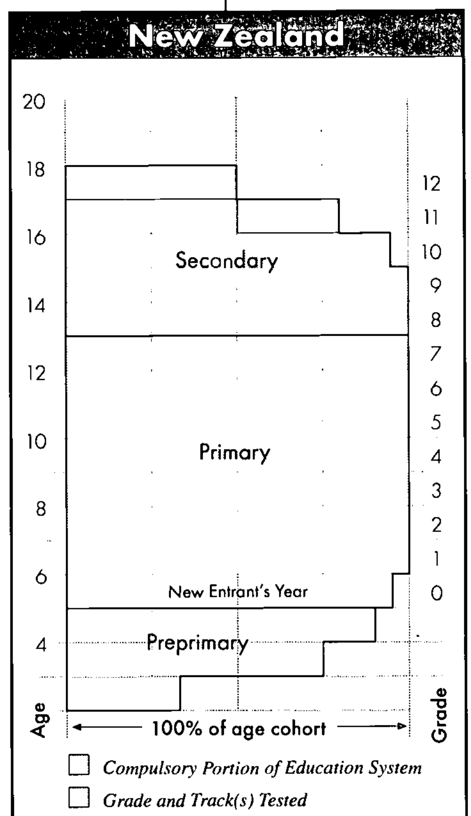
Students Tested in Advanced Mathematics and Physics

The Netherlands did not test students in advanced mathematics or physics.

New Zealand

Structure of Upper Secondary System

Education is compulsory from the ages of 6 to 16, but most children start primary school on their fifth birthday. Students in New Zealand generally have between 12-and-a-half and 13-and-a-half years of schooling, depending on the month of the year in which they were born. Secondary education in New Zealand is offered in comprehensive schools from Grades 8 to 12 (Years 9 to 13). At the lower secondary level, students are required to take a number of compulsory subjects in combination with some optional subjects. The diversity of subjects from which students may choose increases in Grades 11 and 12 (Years 12 and 13).[2] Senior students may also be studying subjects at both senior class levels. For example, a student in Grade 12 may take all Grade 12 subjects, or a combination of Grade 11 and Grade 12 subjects.



There are three national awards which students may choose to study for at secondary school, although not all students choose to participate in national examinations.[3] The first, School Certificate, is the national award undertaken by students at the end of their third year of secondary schooling (Grade 10). The second award, Sixth Form Certificate, is undertaken by most students in their fourth year of secondary schooling (Grade 11). Both certificates can be awarded in single subjects, and a candidate may enter in up to six subjects in one year for each award. The third award, University Bursaries/ Entrance Scholarship, is undertaken by the majority of students at the end of Grade 12 (Year 13). Students may elect to sit for examinations in up to five subjects. In addition, students who have completed a five-year course of study are awarded a Higher School Certificate. A student's performance in, for example, School Certificate mathematics and/or science, often determines his/her participation in these national examinations. While participation in national examinations provides an indication of subject choice, it does not, however, include the range of non-assessed courses or school-developed courses undertaken by many students in the senior school.

Students Tested in Mathematics and Science Literacy

New Zealand tested students in Grade 12 and students in Grade 11 who were not returning to school for Grade 12.

Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics.

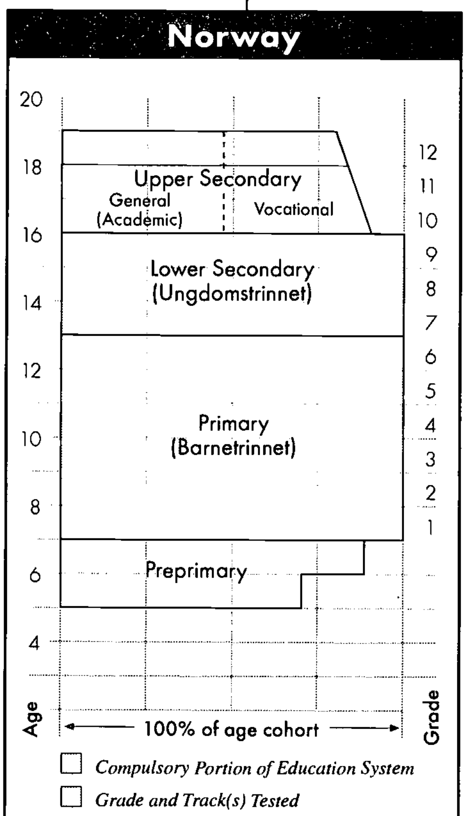
[2] Nomenclature prior to 1996: Primary school education - New Entrants to Form 2; Secondary school education - Form 3 to Form 7. The new nomenclature for class levels was introduced at the beginning of 1996, and is based on years of attendance at a school rather than on curriculum level.

[3] The three national awards are administered by the New Zealand Qualifications Authority (NZQA).

Norway

Structure of Upper Secondary System

Upper secondary education normally covers the 16-19 year age group or the period from the tenth to the twelfth year of education and training, including general and vocational education as well as apprenticeship training.



Under the system for students tested for TIMSS in 1995, general and vocational studies existed side by side in the same school. There were ten areas of study, namely: General (Academic) Studies; Commercial and Clerical Subjects; Physical Education; Craft and Aesthetic Subjects; Home Economics; Technical and Industrial Subjects; Fishing Trade Subjects; Agricultural and Rural Subjects; Maritime Subjects; and Social Studies and Health. The first three areas of study, as well as the music branch within the area of study of Aesthetic Subjects, met the requirements for admission to universities and other higher educational institutions.

This structure was rather complicated, with a varied set of offerings ranging from general schooling to vocational areas of study with special one-, two-, and three-year programs for more than 200 vocational areas.

Beginning in 1994, a simple, comprehensive system for upper secondary school was introduced. All young people between the ages of 16 and 19 have a legal right to three years of upper secondary education, qualifying them for an occupation and/or higher education.

The following three-year programs of study are offered: General and Business Studies; Music, Drama, and Dance Studies; Sports and Physical Education (all three studies qualifying for higher education); Health and Social Studies; Arts, Crafts, and Design Studies; Agriculture, Fishing, and Forestry Studies; Hotel, Cooking, Waiting, and Food Processing Trades; Building and Construction Trades; Service and Technical Building Trades; Electrical Trades; Engineering and Mechanical Trades; Chemical and Processing Trades; Carpentry. (The last ten programs normally qualify students for an occupation.) It has now become much easier for those with a vocational occupation to meet the requirements for entry to higher education. The number of courses in the second and third years are significantly reduced in the new reform.

Students Tested in Mathematics and Science Literacy

Norway tested students in Grade 12 within all areas of study.

Norway (cont.)

Students Tested in Advanced Mathematics and Physics

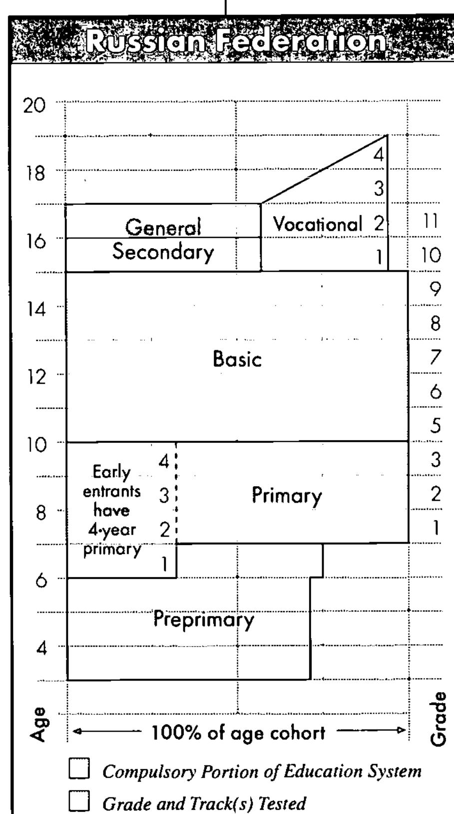
Advanced Mathematics: Norway did not test students in advanced mathematics.

Physics: students in their final year, Grade 12, of the three-year physics course in the General (Academic) Studies area. The three-year course in physics includes a foundation course in general science and two physics courses, normally taken in the second and third year.

Russian Federation

Structure of Upper Secondary System

The upper secondary education system in the Russian Federation is a two- to four-year program following compulsory education. Students in upper secondary school join either the general secondary program (usually 2 years) or vocational program (two to four years). General secondary includes general schools, schools specializing in specific disciplines, gymnasia, lycea, boarding schools, and schools for children with special needs. There are two possibilities for vocational education: initial vocational education provided in so-called professional-technical schools and secondary vocational education provided in the secondary specialized educational establishments (SSZY, technicums, colleges, etc.). All students in upper secondary education have mathematics and science as compulsory subjects. Graduates from both general secondary and vocational secondary programs may continue their education in universities or other higher educational institutions after passing the entrance examinations.



Students Tested in Mathematics and Science Literacy

The Russian Federation tested students in the final year, Grade 11, of general secondary schools. Students in the vocational program were excluded.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year, Grade 11, in general secondary schools in advanced mathematics courses or advanced mathematics and physics courses.

Physics: students in their final year, Grade 11, in general secondary schools in advanced physics courses or advanced mathematics and physics courses.

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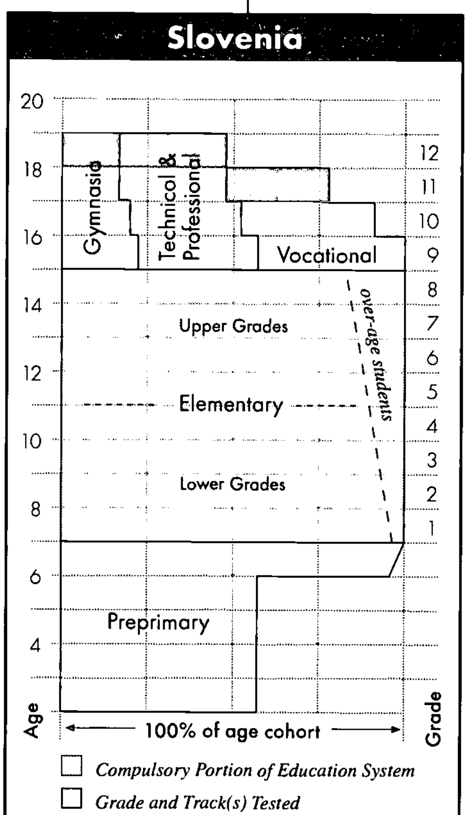
Slovenia

Structure of Upper Secondary System

There are three types of secondary schools in Slovenia: the four-year gymnasium, the four-year technical and professional school, and the two- or three-year vocational school. Students may write an entrance examination to enter tertiary education after completing any four-year upper secondary school. Gymnasia are in principle comprehensive, but some offer a science-heavy curriculum while others emphasize humanities and languages. All students must study mathematics, physics, chemistry, biology, two foreign languages, and a social sciences program of psychology, sociology, and philosophy. As of 1995, students sit for a five-subject externally assessed baccalaureate examination to enter university. The examination includes Slovenian, mathematics, a foreign language, and two subjects chosen by the student. The technical and professional baccalaureate features the same required subjects as the gymnasia, but students choose from economics, electronics, engineering, or similar subjects for the final two sessions. Vocational schools offer programs from two to four years in duration, and usually involve practical work experience as well as classroom time. All vocational schools end with a final examination that may differ from school to school.



Students Tested in Mathematics and Science Literacy

Students in Grade 12 in gymnasia and in technical secondary schools, as well as students in Grade 11 in vocational schools were tested. Students finishing vocational school in Grades 9 and 10 were not tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year of gymnasia and technical and professional schools, Grade 12, were tested (all take advanced mathematics).

Physics: students in their final year of gymnasia, Grade 12, taking the physics matura exam, were tested.

Note: Slovenia has a substantial proportion of students in each grade that are older than the corresponding age shown on the diagram.

South Africa

Structure of Upper Secondary System

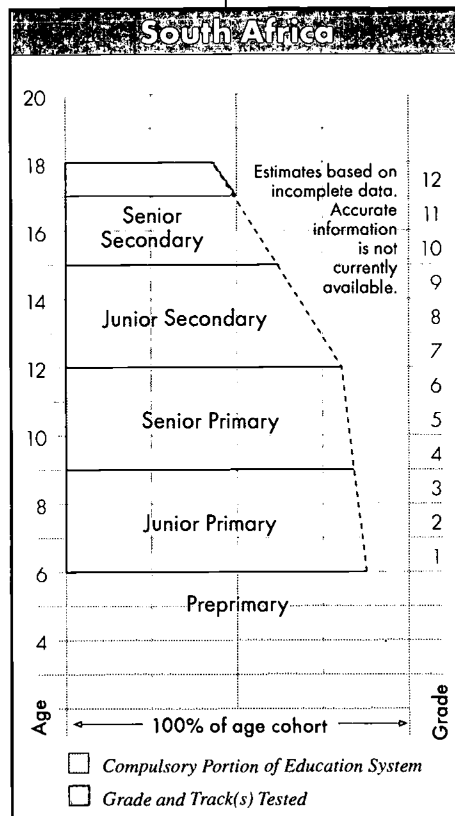
Senior secondary school in South Africa covers Grades 10 to 12. The majority of South African secondary schools are comprehensive. During the first year of senior secondary school (Grade 10), students select six subjects, including the required English and Afrikaans, defining the focus of their studies. Mathematics and science are optional subjects. There are a limited number of schools that provide commercial or technical subjects and a few that provide specialization in the arts. Because of the previous absence of compulsory schooling in South Africa, there is a wide range of entry ages in South African schools, a problem compounded by large numbers of students repeating classes and high drop-out rates.

Students Tested in Mathematics and Science Literacy

Students in Grade 12 were tested in South Africa.

Students Tested in Advanced Mathematics and Physics

South Africa did not test students in advanced mathematics or physics.



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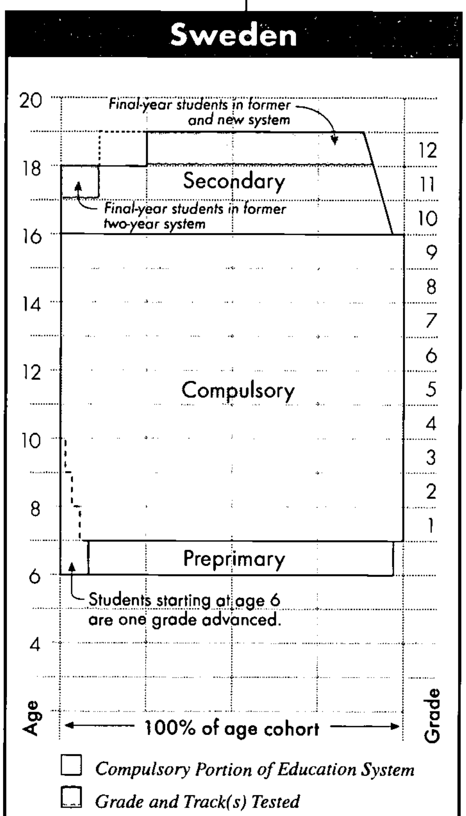
SWEDEN

Structure of Upper Secondary System

Since 1970, upper secondary school was divided into 47 different lines (*linjer*) and some 400 specialized courses (*specialkurser*). The duration of the lines was two or three years (*2-åriga linjer* and *3-åriga linjer*, respectively). Thirty-six of the lines were practical/vocational, and 30 of these were of two years duration. Out of the 11 lines for students preparing for university, 5 were of two years duration. The lines were further divided into branches or variants. A new system of upper secondary education was implemented in the early 1990s and was fully up and running by 1996. The new upper secondary system in Sweden is organized into 16 national study programs of three years duration. Students may also follow a specially designed program or an individual program. All 16 national tracks enable students to attend university, although two tracks, Natural Science and Social Science, are specially-geared towards preparing students for university. All programs include eight core subjects: Swedish, English, civics, religious education, mathematics, general science, physical and health education, and arts activities. At the time of TIMSS testing, some schools were still on the former system where students were in upper secondary for two years, while other schools had switched to the new system of a three-year course.



Students Tested in Mathematics and Science Literacy

In schools where the new three-year upper secondary system was implemented, students in Grade 12 were tested. In schools with the former two- or three-year system, students in the final year, Grade 11 or 12, respectively, were tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in the final year, Grade 12, of the Natural Science or Technology lines.

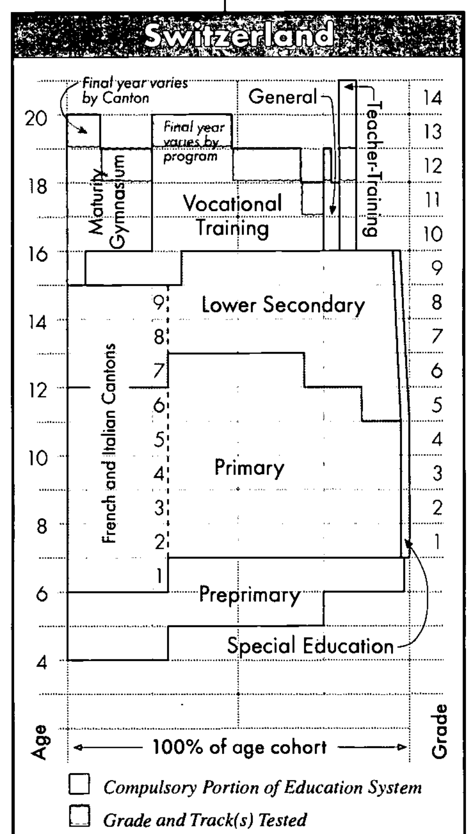
Physics: students in the final year, Grade 12, of the Natural Science or Technology lines.

Note: The diagram represents the Swedish school system during the 1994-95 school year when the system was undergoing changes.

Switzerland

Structure of Upper Secondary System

Upper secondary education in Switzerland is divided into four major types that last between 2 to 5 years, depending on the type and canton. The four types are: *Maturitätsschule* (gymnasium); general education; vocational training; and teacher training. Each major track is differentiated into a number of tracks with narrower definitions. The *Maturitätsschule* is designed to prepare students for university entrance. Typically, students enter at age 15/16, for a total of four years. The school leaving certificate gives them access to higher education. There are five types of *Maturitätsschule*: Type A (emphasis on Greek and Latin); Type B (Latin and modern languages); Type C (mathematics and science); Type D (modern languages); and Type E (economics). *Maturitätsschulen* are governed by federal regulation. The final grade in this type of school could be Grade 12, 12.5, or 13, depending on the canton.



General education schools provide general education to prepare students for certain non-university professions (such as paramedical and social fields). These programs are two or three years in duration and comprise about 3 percent of the in-school population. The upper secondary teacher training program is a five-year program that begins after compulsory education and can lead to university studies.

Vocational training is mostly in the form of apprenticeship, consisting of two basic elements: practical training on the job in an enterprise (3.5 to 4 days per week), and theoretical and general instruction in a vocational school (1 to 1.5 days per week). Vocational training is regulated by federal law and provides recognized apprenticeships of two to four years duration in approximately 280 vocations in the industrial, handicraft, and service sectors. Some students do go on to specialized tertiary institutes in the corresponding vocational field. The final year of vocational training varies by occupation.

Students Tested in Mathematics and Science Literacy

Students in their final year of gymnasium, general education, teacher training, and vocational training were tested. This corresponded to Grade 11 or 12 in gymnasium (final year depends on canton); Grade 12 in the general track; Grade 12 in the teacher-training track; and Grade 11, 12, or 13 in vocational track (final year varies by occupation).

Students Tested in Advanced Mathematics and Physics

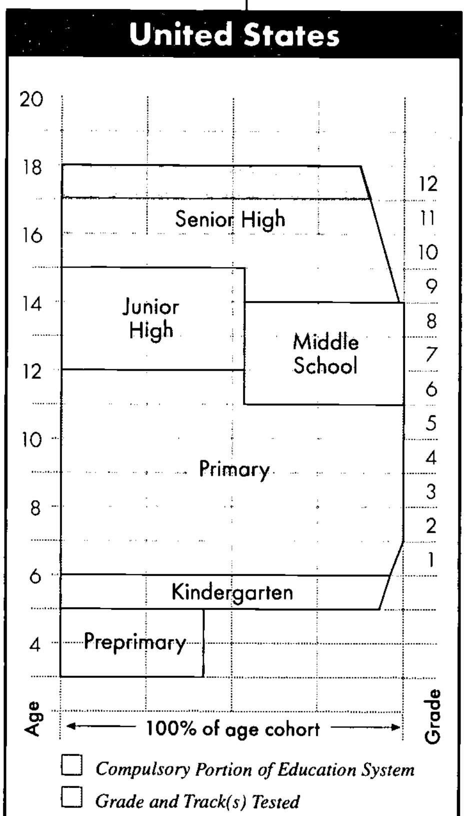
Advanced Mathematics: students in their final year, Grade 12 or 13, of *Maturitätsschule* (gymnasium), in schools and programs (A-E) with federal recognition.

Physics: students in their final year, Grade 12 or 13, of *Maturitätsschule* (gymnasium), in schools and programs (A-E) with federal recognition.

United States

Structure of Upper Secondary System

Secondary education in the United States is comprehensive and lasts from Grade 9 to 12 or 10 to 12. Students attend high schools that offer a wide variety of courses. Each student chooses or is guided in the selection of an individually unique set of courses based on their personal interests, future aspirations, or ability. Students who choose a higher proportion of courses which prepare them for university study are generally said to be in a college preparatory or "academic" school program. Those who choose a higher proportion of vocational courses are in a vocational/technical or "vocational" school program. Those whose choice of courses combines general academic and vocational coursework are in general academic or "general" school programs.



Students Tested in Mathematics and Science Literacy

Students in Grade 12 were tested in the United States.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in Grade 12 who had taken Advanced Placement Calculus, Calculus, or Pre-Calculus.

Physics: students in Grade 12 who had taken Advanced Placement Physics or Physics.

Appendix B

Overview of TIMSS Procedures

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, the number of grades tested, and testing in 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 a deeper insight into how various factors contribute to the overall outcomes of schooling. Particular emphasis has been placed on refining our understanding of students' opportunity to learn as this opportunity becomes 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, TIMSS was expanded beyond the already substantial task of measuring achievement in two subject areas to 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 defined 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 interpretation and comparison of results, TIMSS also collected extensive information about the social and cultural contexts for learning, many of which are related to variations among education systems.

[1] Because of the time elapsed since earlier IEA studies, curriculum and testing methods have undergone many changes. TIMSS has sought to reflect the most current educational and measurement practices. The resulting 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.

Nearly 50 countries participated in one or more components of the TIMSS data collection effort, including the curriculum analysis. To gather information about the intended curriculum, mathematics and science specialists in each participating country worked section by section through curriculum guides, textbooks, and other curricular material to categorize them in accordance with detailed specifications drawn 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 Intentions 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 involving the following three 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 subgroups of these students: students having taken advanced mathematics, and students having taken physics.

Countries participating in the study were required to test 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 testing at Populations 1 and 2, subsets of the upper-grade students who completed the written tests also participated in a performance assessment consisting of hands-on 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 B.1 shows the countries that participated in the various components of TIMSS achievement testing.

From a broad array of questionnaires, TIMSS also collected data about how the curriculum is implemented in classrooms, including the instructional practices used to deliver it. The questionnaires were also used to collect information about the social and cultural contexts for learning. Questionnaires were distributed at the country

[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. (1997). *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. (1997). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Figure B.1

Countries Participating in 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	●	●	●	●	●	●	●

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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level about decision-making and organizational features of the national education systems. Students answered questions pertaining to their attitudes towards mathematics and science, classroom activities, home background, and out-of-school activities. At Populations 1 and 2, the mathematics and science teachers of sampled students responded to questions about teaching emphasis on the topics in the curriculum frameworks, instructional practices, textbook use, 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 support for teachers. In addition, a volume was compiled that describes the education 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 topics 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, what affects student performance, and how mathematics and science education can be improved.

Developing the TIMSS Tests

The TIMSS curriculum frameworks underlying the mathematics and science tests at all three populations were developed by groups of mathematics educators with input from the TIMSS National Research Coordinators (NRCs). As shown in Figures B.2 and B.3, the mathematics and science curriculum frameworks each contain three dimensions or aspects. The content aspect represents the subject matter content of school mathematics or science. The performance expectations aspect describes, in a non-hierarchical way, the many kinds of performance or behavior that might be expected of students in school mathematics or science. The perspectives aspect focuses on the development of students' attitudes, interest, and motivation in mathematics or science.[5]

Three tests were developed for the TIMSS assessment of students in the final year of secondary school: the mathematics and science literacy test; the advanced mathematics test; and the physics test. The tests were developed through an international consensus involving input from experts in mathematics, science, and measurement. The TIMSS Subject Matter Advisory Committee, including distinguished scholars from 10 countries, ensured that the mathematics and science literacy tests represented current conceptions of literacy in those areas, and that the advanced mathematics

[4] Robitaille, D.F. (Ed.). (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

[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.

Figure B.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

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Figure B.3

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
- Investigating the natural world
- Communicating

Perspectives

- Attitudes
- Careers
- Participation
- Increasing interest
- Safety
- Habits of mind

and physics tests reflected current thinking and priorities in the fields of mathematics and physics. The items underwent an iterative development and review process, with multiple pilot tests. Every effort was made to ensure that the items exhibited no bias towards or against particular countries, including modifying specifications in accordance with data from the curriculum analysis component, obtaining ratings of the items from subject matter specialists in 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 advanced mathematics and physics tests to their curricula at the final year of secondary schooling, identifying 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 C). This analysis was not conducted for the mathematics and science literacy test; that test was designed as a general measure of mathematics and science literacy and was not intended to represent the curriculum for students at the end of secondary school, and the students tested were not necessarily enrolled in mathematics and science courses at the time of testing.

The mathematics and science literacy test was designed to test students' general mathematical and scientific knowledge and understanding of mathematical and scientific principles. The mathematics items cover number sense, including fractions, percentages, and proportionality. Algebraic sense, measurement, and estimation are also covered, as are data representation and analysis. Reasoning and social utility were emphasized in several items. A general criterion in selecting the items was that they should involve the types of mathematics questions that could arise in real-life situations and that they be contextualized accordingly. Similarly, the science items selected for use in the TIMSS literacy test were organized according to three areas of science, earth science, life science, and physical science, as well as including a reasoning and social utility component. The emphasis was on measuring how well students can use their knowledge in addressing real-world problems having a science component. The test was designed to enable reporting for mathematics literacy and science literacy separately as well as overall.

In order to examine how well students understand advanced mathematics concepts and can apply knowledge to solve problems, the advanced mathematics test was developed for students in their final year of secondary school having taken advanced mathematics. This test enabled reporting of achievement overall and in three content areas: numbers, equations, and functions; calculus; and geometry. In addition to items representing these three areas, the test also included items related to probability and statistics and to validation and structure, but because there were few such items, achievement in these areas was not estimated.

[6] For a full discussion of the TIMSS tests development effort, 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; D.F. Robitaille and R.A. Garden (Eds.), *TIMSS Monograph No. 2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Educational Press; and Orpwood, G. and Garden, R.A. (1998). *Assessing Mathematics and Science Literacy, TIMSS Monograph No. 4*. Vancouver, B.C.: Pacific Educational Press.

The physics test was developed for students in their final year of secondary school who had taken physics, in order to examine how well they understand and can apply physics principles and concepts. It enabled reporting of physics achievement overall and in five content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity.

Table B.1 presents the number and type of items included in the literacy test for mathematics literacy and science literacy, and the number of score points in each category. Tables B.2 and B.3 present information about the items on the advanced mathematics and physics tests.

In each of the three tests, approximately one-third of the items were in the free-response format, requiring students to generate and write their own answers. Designed to take up about one-third of students' response time, some free-response questions asked for short answers while others required extended responses in which students needed to show their work. The remaining questions were in 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 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 three points. This, added to the fact that some items had two parts, means that the total number of score points exceeds the number of test items.

The TIMSS instruments were prepared in English and translated into the other languages used for testing. In addition, it sometimes was necessary to adapt the international versions for cultural purposes, even in the countries that tested in English. This process represented an enormous effort for the national centers, with many checks along the way. The translation activity included: 1) developing guidelines for translation and cultural adaptation, 2) translation of the tests, by two or more independent translators in accordance with the guidelines, 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); and "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.

Table B.1

Distribution of Mathematics and Science Literacy Items by Reporting Category

Reporting Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points
Mathematics Literacy	58%	44	34	8	2	53
Science Literacy	42%	32	18	9	5	43
Total	100%	76	52	17	7	96

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Table B.2

Distribution of Advanced Mathematics Items by Content Category

Content Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points
Numbers & Equations	26%	17	13	2	2	22
Calculus	23%	15	12	2	1	19
Geometry	35%	23	15	4	4	29
*Probability and Statistics	11%	7	5	2	0	8
*Validation and Structure	5%	3	2	0	1	4
Total	100%	65	47	10	8	82

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[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 two or three points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test.

* Probability and Statistics and Validation and Structure were not scaled separately. However, the overall advanced mathematics scale includes those 10 items.

Table B.3

Distribution of Physics Items by Content Category

Content Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Mechanics	25%	16	11	4	1	19
Electricity and Magnetism	25%	16	10	3	3	21
Heat	14%	9	6	3	0	12
Wave Phenomena	15%	10	6	3	1	12
Modern Physics: Particle, Quantum and Astrophysics, and Relativity	22%	14	9	2	3	17
Total	100%	65	42	15	8	81

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[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 two points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test. Because the percentages are rounded to the nearest whole number, the total may appear inconsistent.

TIMSS Test Design

The assessment of the final-year students was accomplished through a complex design that included four types of test booklets (nine booklets in total) that were distributed to students based on their academic preparation. The four types of test booklets below were intended to yield proficiency estimates in mathematics and science literacy, advanced mathematics, and physics:

- Two literacy booklets (booklets 1A and 1B) containing mathematics and science literacy items
- Three physics booklets (booklets 2A, 2B, and 2C) containing physics items only
- Three mathematics booklets (booklets 3A, 3B, and 3C) containing advanced mathematics items only
- One mathematics/physics booklet (booklet 4) containing items in physics, advanced mathematics, and mathematics and science literacy.

The TIMSS test design included 12 mutually exclusive clusters of items distributed among the four types of test booklets in a systematic fashion. The 12 clusters are labeled A through L. Each cluster could appear in more than one test booklet and, in a few cases, in different positions within the booklets. The items within a cluster always appear in the same order and position.[8]

To facilitate booklet rotation and ensure proper achievement estimates, students were classified as to their preparation in mathematics and physics. Each student was characterized as having taken advanced mathematics (M) or not (O), and as having taken physics (P) or not (O). This two-way classification yielded four mutually exclusive and exhaustive categories of students:

OO	Students having studied neither advanced mathematics nor physics
OP	Students having studied physics but not advanced mathematics
MO	Students having studied advanced mathematics but not physics
MP	Students having studied both advanced mathematics and physics

The nine test booklets were rotated among students based on this classification scheme (OO, OP, MO, MP), so that each student completed one 90-minute test booklet. Students classified as OO received either booklet 1A or 1B, the two booklets containing items related to mathematics and science literacy. Students classified as OP received either booklet 1A or 1B, or one of the three booklets containing physics material (2A, 2B, or 2C). Students classified as MO received either booklet 1A or 1B, or one of the three booklets containing advanced mathematics material (3A, 3B, or 3C). Students classified as MP also received one booklet, although in this case it could have been any one of the booklets (1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, 4).

[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 Educational 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.

Population Definition and Sampling for Students in the Final Year of Secondary School

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 the available sampling information and of the sampling activities themselves. For TIMSS, NRCs worked on all phases of sampling with staff from Statistics Canada. NRCs were trained 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.

The intention of the assessment of final-year students was to measure what might be considered the "yield" of the elementary and secondary education systems of a country with regard to mathematics and science. The international desired population, then, was all students in the final year of secondary school. Students repeating the final year were not part of the desired population. For each secondary education track in a country, the final grade of the track was identified as being part of the target population, allowing substantial coverage of students in their final year of schooling. For example, grade 10 could be the final year of a vocational program, and grade 12 the final year of an academic program. Both of these grade/track combinations are considered to be part of the population (but grade 10 in the academic track is not). Appendix A provides information about the students tested in each country.

Coverage of TIMSS Population

In a few situations where TIMSS testing of the international desired population could not be implemented, countries were permitted to define a national desired population that did not include part of the international desired population. Exclusions could be based on geographic areas or language groups. Table B.4 shows differences in coverage between the international and national desired populations. Most participants achieved 100% coverage (20 out of 24). The countries with less than 100% coverage are footnoted in tables in this report. Israel and Lithuania, as a matter of practicality, needed to define their tested populations according to the structure of their school systems. Latvia, which participated only in the physics assessment, also limited its testing to Latvian-speaking schools. Because coverage fell below 65%, the Latvian results have been labeled Latvia (LSS), for Latvian Speaking Schools, in the tables presenting results for the physics assessment. Italy was unable to include 4 of its 20 regions.

Within the national desired population, countries could define a population that excluded a small percentage (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). Some countries also excluded students in particular tracks or school types. These exclusions are also shown in Table B.4. The countries with particularly high exclusions are so footnoted in the achievement tables in the report.

Table B.4

Coverage of TIMSS Target Population

The International Desired Population is defined as follows:
Population 3 - All students in final year of secondary school*

	International Desired Population		National Desired Population	
Country	Country Coverage	Notes on Coverage	Sample Exclusions	Notes on Exclusions
Australia	100%		5.5%	
Austria	100%		18.2%	Colleges and courses lasting less than 3 years excluded
Canada	100%		8.9%	
Cyprus	100%		22.0%	Private and vocational schools excluded
Czech Republic	100%		6.0%	
Denmark	100%		2.3%	
France	100%		1.0%	
Germany	100%		11.3%	
Greece	100%		85.0%	Only students having taken advanced mathematics and physics included
Hungary	100%		0.2%	
Iceland	100%		0.1%	
Israel	74%	Hebrew public education system	0.0%	
Italy	70%	Four regions did not participate	0.9%	
Latvia (LSS)	50%	Latvian speaking students	85.0%	Only students having taken physics included
Lithuania	84%	Lithuanian speaking students	0.0%	
Netherlands	100%		21.6%	Apprenticeship programs excluded
New Zealand	100%		0.0%	
Norway	100%		3.8%	
Russian Federation	100%		43.0%	Vocational schools and non-Russian speaking students excluded
Slovenia	100%		6.0%	
South Africa	100%		0.0%	
Sweden	100%		0.2%	
Switzerland	100%		2.5%	
United States	100%		3.7%	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

TIMSS Coverage Index

A further difficulty in defining the desired population for the final-year assessment is that many students drop out before the final year of any track. This is addressed in the TIMSS final-year assessment by the calculation of a TIMSS Coverage Index (TCI) that quantifies the proportion of the entire school-leaving age cohort that is covered by the TIMSS final-year sample in each country. The TCI was defined as follows:

$$TCI = \frac{Total\ Enrollment\ in\ TIMSS\ Grades\ 1995}{(Total\ National\ Population\ Aged\ 15-19\ in\ 1995)/5}$$

The *numerator* in this expression is the total enrollment in the grades tested by TIMSS, estimated from the weighted sample data. This estimate corresponds to the size of the population to which the TIMSS results generalize, and makes appropriate provision for student non-response. It does not include students who are no longer attending school, or students who were excluded from the sample on grounds of physical or other disability. It also does not include students who were repeating the final grade. Because some students repeat the final year of a track, or take the final year in more than one track at different times, they may be in the final year of a track but, in fact, are not completing their secondary education that year. On the one hand, students who are not completing their education still have the potential to gain further knowledge in additional years of schooling, and thus will not have attained their full yield at the time of the TIMSS assessment. On the other hand, and of more serious concern, the presence both of students who are repeating the final track, and of those who will repeat that track, can contribute a substantial downward bias to the estimated achievement of the population. Repeating students would be represented twice in the population, and are likely to be lower-achieving on average than those who do not repeat. The only practical way for TIMSS to deal with this problem was to exclude students who were repeating the final year. Thus, the population of final-year students is formally defined as those students taking the final year of one track of the secondary system for the first time.

The *denominator* in the expression is an estimate of the school-leaving age cohort size. Since the age at which students in upper secondary may leave school varies, TIMSS estimated the size of the school-leaving age cohort by taking the average of the size of the 1995 age cohorts for 15, 16, 17, 18, and 19-year-olds in each country. (Although the general procedure was to base the estimate on the 15-19 age group, there were exceptions in some countries. For example, in Germany, the estimate was based on the 17-19 age group.) This information was provided by National Research Coordinators from official population census figures in their countries. This approach reflects the fact that students in the final year of secondary school are likely to be almost entirely a subset of the population of 15- to 19-year-olds in most countries. Table B.5 presents the computation of the TCI for each country.

Table B.5

Computation of TCI: Estimated Percentage of School-Leaving Age Cohort Covered by TIMSS Sample

Final Year of Secondary School*

Country	Estimated School-Leaving Age Cohort Size (A)	Estimated Number of Students Represented by Sample (B)	Estimated Number of Students Excluded from Sample (C)	Estimated Number of Other Students Not Represented by Sample (D)	TIMSS Coverage Index (TCI)† (B/A)
Australia	250,852	170,849	9,944	70,059	68%
Austria	93,168	70,721	15,682	6,765	76%
Canada	374,499	263,241	25,559	85,699	70%
Cyprus	9,464	4,535	1,279	3,650	48%
Czech Republic	177,180	137,467	8,821	30,892	78%
Denmark	65,683	37,872	872	26,939	58%
France	760,452	637,935	6,509	116,008	84%
Germany	870,857	655,916	83,514	131,427	75%
1 Greece	146,400	14,668	83,119	48,613	10%
Hungary	170,524	111,281	201	59,042	65%
Iceland	4,231	2,308	2	1,921	55%
Israel	-	-	-	-	-
Italy	739,268	380,834	3,459	354,975	52%
2 Latvia (LSS)	33,096	979	5,548	26,569	3%
Lithuania	52,140	22,160	0	29,980	43%
Netherlands	187,087	145,916	40,293	878	78%
New Zealand	53,284	37,549	4	15,731	70%
Norway	52,180	43,806	1,747	6,627	84%
Russian Federation	2,145,918	1,031,187	777,913	336,818	48%
Slovenia	30,354	26,636	1,706	2,012	88%
South Africa	766,334	374,618	0	391,716	49%
Sweden	101,058	71,333	168	29,557	71%
Switzerland	79,547	65,174	1,671	12,702	82%
United States	3,612,800	2,278,564	88,642	1,245,594	63%

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

† TIMSS Coverage Index (TCI): Estimated percentage of school-leaving age cohort covered by TIMSS sample.

1 Greece only sampled students having taken advanced mathematics and physics.

2 Latvia (LSS) only sampled students having taken physics.

A dash (-) indicates data are not available

The International Study Center tried to maximize standardization across countries in defining the students in the final year of secondary school. However, the precise definition of the mathematics and physics subpopulations was necessarily a consultative process. Each country identified the group of students that it wished to compare internationally, based on the general content of the tests and practical considerations in sampling and administration. In order to quantify the coverage of the advanced mathematics and physics samples and assist in interpreting the achievement results for these students, TIMSS computed a Mathematics TIMSS Coverage Index (MTCI) and a Physics TIMSS Coverage Index (PTCI). The MTCI is the overall TCI multiplied by the percentage of the final-year sample having taken advanced mathematics, and the PTCI is the overall TCI multiplied by the percentage of the final year sample having taken physics. The MTCI and the PTCI are estimates of the percentage of the entire school-leaving age cohort covered by the TIMSS sample of advanced mathematics and physics students respectively. These indices are presented in Table 3 of the Introduction and in the achievement tables for advanced mathematics and physics, respectively.

Samples Sizes and Participation Rates

Within countries, TIMSS used a two-stage sample design for the final year of secondary school assessment, where the first stage involved sampling 120 public and private schools in each country. Within each school, the basic approach required countries to use random procedures to select 40 students. The actual number of schools and students selected depended in part on the structure of the education system – tracked or untracked – and on where the student subpopulations were in the system.[9] School sample sizes for the literacy, advanced mathematics, and physics assessments are shown in Tables B.6, B.7, and B.8, respectively. Within each sampled school, eligible students were classified as OO, MO, OP, or MP (see TIMSS Test Design section for descriptions of these groups), and a sample of each group was drawn. Test booklets were assigned to students based on their classification. Student sample sizes by assessment type are shown in Table B.9.

Countries were required to achieve a participation rate of at least 85% of both schools and students, or a combined rate of 75% (the product of school and student participation with or without replacement schools). Tables B.10, B.11, and B.12 present the participation rates for the mathematics and science literacy, advanced mathematics, and physics assessments, respectively.

[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 B.6

School Sample Sizes - Mathematics and Science Literacy

Final Year of Secondary School*

Country	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	132	132	71	16	87
Austria	182	182	74	95	169
Canada	389	389	333	4	337
Cyprus	29	28	28	0	28
Czech Republic	150	150	150	0	150
Denmark	130	130	122	0	122
France	71	71	56	0	56
Germany	174	174	121	31	152
Hungary	204	204	204	0	204
Iceland	30	30	30	0	30
Israel	125	125	52	0	52
Italy	150	150	93	8	101
Lithuania	168	142	142	0	142
Netherlands	141	141	52	27	79
New Zealand	79	79	68	11	79
Norway	171	171	122	9	131
Russian Federation	175	165	159	4	163
Slovenia	172	172	79	0	79
South Africa	185	140	90	0	90
Sweden	157	157	145	0	145
Switzerland	401	401	378	5	383
United States	250	250	190	21	211

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Table B.7

School Sample Sizes - Advanced Mathematics
Final Year of Secondary School*

Country	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	132	132	68	15	83
Austria	182	119	48	66	114
Canada	389	389	306	3	309
Cyprus	29	21	21	0	21
Czech Republic	90	90	90	0	90
Denmark	130	130	115	0	115
France	69	69	61	0	61
Germany	76	76	53	23	76
Greece	60	60	45	15	60
Israel	125	125	44	0	44
Italy	59	59	41	1	42
Lithuania	29	29	29	0	29
Russian Federation	132	117	112	1	113
Slovenia	172	159	73	0	73
Sweden	157	157	101	0	101
Switzerland	198	198	195	2	197
United States	250	250	180	19	199

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Table B.8

School Sample Sizes - Physics

Final Year of Secondary School*

Country	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	132	132	69	16	85
Austria	182	119	48	66	114
Canada	389	389	304	3	307
Cyprus	29	21	21	0	21
Czech Republic	90	90	90	0	90
Denmark	130	130	77	0	77
France	69	69	61	0	61
Germany	74	74	52	22	74
Greece	60	60	45	15	60
Israel	125	125	46	0	46
Italy	29	29	20	0	20
Latvia (LSS)	45	45	38	0	38
Norway	70	70	63	3	66
Russian Federation	132	98	83	1	84
Slovenia	172	172	52	0	52
Sweden	157	157	101	0	101
Switzerland	198	198	195	2	197
United States	250	250	184	19	203

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table B.9

Student Sample Sizes
Final Year of Secondary School*

Country	Number of Students Sampled in Participating Schools	Number of Students Withdrawn†	Number of Students Excluded	Number of Students Eligible	Number of Students Absent
Australia	4130	24	13	4093	1040
Austria	3693	119	21	3553	398
Canada	11782	256	476	11050	1470
Cyprus	1224	14	1	1209	38
Czech Republic	4188	43	0	4145	326
Denmark	5208	0	0	5208	672
France	4096	275	0	3821	600
Germany	6971	94	117	6760	1666
Greece	1246	261	0	985	180
Hungary	5493	265	0	5228	137
Iceland	2500	131	3	2366	663
Israel	2568	0	0	2568	29
Italy	2426	105	46	2275	192
Latvia (LSS)	780	0	6	774	66
Lithuania	4196	0	1	4195	574
Netherlands	1882	158	43	1681	211
New Zealand	2687	549	32	2106	343
Norway	4056	0	141	3915	349
Russian Federation	5356	492	44	4820	182
Slovenia	3755	36	2	3717	282
South Africa	3695	906	0	2789	32
Sweden	5362	61	135	5166	589
Switzerland	5939	230	28	5681	262
United States	14812	279	617	13916	3082

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
† Sampled students who reported that they were repeating the final year, were incorrectly classified, or were otherwise ineligible.

Table B.9 (Continued)

Student Sample Sizes

Final Year of Secondary School*

Country	Number of Participating Students		
	Literacy	Advanced Mathematics	Physics
Australia	1844	548	564
Austria	1779	599	594
Canada	4832	2381	1967
Cyprus	473	330	307
Czech Republic	1899	833	819
Denmark	2604	1278	544
France	1590	796	835
Germany	2182	2189	616
Greece	0	346	349
Hungary	5091	0	0
Iceland	1703	0	0
Israel	1045	641	541
Italy	1578	360	107
Latvia (LSS)	0	0	708
Lithuania	2887	734	0
Netherlands	1470	0	0
New Zealand	1763	0	0
Norway	2518	0	1048
Russian Federation	2289	1364	985
Slovenia	1387	1301	512
South Africa	2757	0	0
Sweden	2816	749	760
Switzerland	2976	1072	1039
United States	5371	2349	2678

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table B.10

Participation Rates – Mathematics and Science Literacy Final Year of Secondary School*

Country	School Participation: School Participation Before Replacement (Weighted Percentage)	School Participation: School Participation After Replacement (Weighted Percentage)	Student Participation (Weighted Percentage)	Overall Participation: Overall Participation Before Replacement (Weighted Percentage)	Overall Participation: Overall Participation After Replacement (Weighted Percentage)
Australia	48.8	66.2	78.1	38.1	51.8
Austria	35.9	90.9	79.7	28.6	72.5
Canada	82.2	82.6	82.7	68.0	68.3
Cyprus	100.0	100.0	98.2	98.2	98.2
Czech Republic	100.0	100.0	92.2	92.2	92.2
Denmark	54.9	54.9	88.9	48.8	48.8
France	80.3	80.3	85.6	68.7	68.7
Germany	88.7	100.0	80.1	71.0	80.1
Hungary	100.0	100.0	97.7	97.7	97.7
Iceland	100.0	100.0	73.6	73.6	73.6
Israel	48.8**	48.8**	98.3**	48.0**	48.0**
Italy	59.9	65.0	94.8	56.8	61.6
Lithuania	97.1	97.1	87.9	85.4	85.4
Netherlands	35.8	56.3	87.6	31.3	49.3
New Zealand	87.0	100.0	80.6	70.1	80.6
Norway	74.1	80.0	88.9	65.9	71.1
Russian Federation	93.0	99.3	90.9	84.6	90.3
Slovenia	45.6	45.6	92.8	42.3	42.3
South Africa	65.0	65.0	99.4	64.6	64.6
Sweden	95.3	95.3	86.5	82.4	82.4
Switzerland	87.0	89.1	95.0	82.6	84.6
United States	77.1	85.1	74.6	57.6	63.5

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

Table B.11

Participation Rates – Advanced Mathematics

Final Year of Secondary School*

Country	School Participation		Student Participation (Weighted Percentage)	Overall Participation	
	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)		Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)
Australia	47.3	63.6	86.7	40.9	55.2
Austria	36.7	95.5	84.6	31.0	80.8
Canada	84.6	85.2	90.4	76.4	76.9
Cyprus	100.0	100.0	96.0	96.0	96.0
Czech Republic	100.0	100.0	92.1	92.1	92.1
Denmark	54.9	54.9	89.2	49.0	49.0
France	89.9	89.9	86.1	77.4	77.4
Germany	78.6	100.0	77.6	61.0	77.6
Greece	76.2	100.0	86.5	65.9	86.5
Israel	48.8 **	48.8 **	99.6 **	48.6 **	48.6 **
Italy	70.3	70.9	95.1	66.9	67.5
Lithuania	100.0	100.0	92.1	92.1	92.1
Russian Federation	97.6	99.4	96.5	94.2	95.9
Slovenia	45.6	45.6	93.0	42.4	42.4
Sweden	95.3	95.3	92.9	88.6	88.6
Switzerland	99.0	99.0	88.2	87.4	87.4
United States	75.7	84.7	79.6	60.2	67.4

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

Table B.12

Participation Rates - Physics
Final Year of Secondary School*

Country	School Participation: School Participation Before Replacement (Weighted Percentage)	School Participation: School Participation After Replacement (Weighted Percentage)	Student Participation (Weighted Percentage)	Overall Participation: Overall Participation Before Replacement (Weighted Percentage)	Overall Participation: Overall Participation After Replacement (Weighted Percentage)
Australia	63.2	63.9	84.9	53.7	54.2
Austria	36.7	95.5	84.6	31.0	80.8
Canada	79.7	80.2	91.0	72.6	73.0
Cyprus	100.0	100.0	96.0	96.0	96.0
Czech Republic	100.0	100.0	92.1	92.1	92.1
Denmark	54.9	54.9	86.1	47.3	47.3
France	89.9	89.9	86.1	77.4	77.4
Germany	76.8	100.0	81.7	62.7	81.7
Greece	76.2	100.0	86.5	65.9	86.5
Israel	48.8 **	48.8 **	99.6 **	48.6 **	48.6 **
Italy	69.3	69.3	96.6	67.0	67.0
Latvia (LSS)	84.4	84.4	90.8	76.6	76.6
Norway	77.7	94.3	88.0	68.4	83.0
Russian Federation	97.6	98.8	96.2	93.9	95.1
Slovenia	45.6	45.6	94.2	43.0	43.0
Sweden	95.3	95.3	92.9	88.6	88.6
Switzerland	99.0	99.0	88.2	87.4	87.4
United States	77.0	84.3	80.3	61.8	67.7

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Compliance With Sampling Guidelines

Figures B.4, B.5, and B.6 show how countries have been grouped in tables reporting achievement results for literacy, advanced mathematics, and physics, respectively. Countries that complied with the TIMSS guidelines for school and student sampling, and that achieved acceptable participation rates (see above) are shown in the first panel. Countries that met the guidelines only after including replacement schools are so noted.

Countries that did not reach at least 50% school participation without the use of replacements schools, or that failed to reach the sampling participation standard even with their use, are shown in the second panel of Figures B.4-B.6. Countries that did not meet the guidelines for student sampling are shown in the third panel, and countries that met neither these requirements nor participation rate requirements are shown in the bottom panel. Unweighted results for Israel are included in Appendix D because Israel had difficulties meeting several sampling guidelines. Physics achievement results for Italy are presented in Appendix D because the sample size was inordinately low.

Figure B.4

Countries Grouped for Reporting of Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates Mathematics and Science Literacy

Final Year of Secondary School*

Countries satisfying guidelines for sample participation rates and sampling procedures	
[2] Cyprus	† New Zealand
Czech Republic	[2] Russian Federation
Hungary	Sweden
[1] Lithuania	Switzerland
Countries not satisfying guidelines for sample participation rates	
Australia	Iceland
[2] Austria	[1] Italy
Canada	Norway
France	United States
Countries with unapproved student sampling	
† Germany	
Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia
[2] Netherlands	South Africa

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included.

[1] National Desired Population does not cover all of International Desired Population.

[2] National Defined Population covers less than 90 percent of National Desired Population.

Figure B.5

Countries Grouped for Reporting of Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates Advanced Mathematics

Final Year of Secondary School*

Countries satisfying guidelines for sample participation rates and sampling procedures	
Canada	[†] Greece
[2] Cyprus	[1] Lithuania
Czech Republic	[2] Russian Federation
France	Sweden
[†] Germany	Switzerland

Countries not satisfying guidelines for sample participation rates	
Australia	[1] Italy
[2] Austria	United States

Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
† Met guidelines for sample participation rates only after replacement schools were included.
1 National Desired Population does not cover all of International Desired Population.
2 National Defined Population covers less than 90 percent of National Desired Population.

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Figure B.6

Countries Grouped for Reporting of Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates – Physics

Final Year of Secondary School*

Countries satisfying guidelines for sample participation rates and sampling procedures	
Canada	[1] Latvia (LSS)
[2] Cyprus	† Norway
Czech Republic	[2] Russian Federation
France	Sweden
† Germany	Switzerland
† Greece	

Countries not satisfying guidelines for sample participation rates	
Australia	United States
[2] Austria	

Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
† Met guidelines for sample participation rates only after replacement schools were included.
[1] National Desired Population does not cover all of International Desired Population.
[2] National Defined Population covers less than 90 percent of National Desired Population.

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 test 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 quality control and for describing this effort as part of the NRC's documenting procedures used in the study. In addition, the TIMSS International Study Center considered it essential to establish some method to monitor compliance with standardized procedures. Each NRC was asked to nominate a person, such as a retired school teacher, to serve as the quality control monitor for that country, and in almost all cases the International Study Center adopted the NRC's 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 administration and interviewed school coordinators in 37 countries, and interviewed school coordinators or test administrators in 3 additional countries.[11]

The results of the interviews indicate that, in general, NRCs were well prepared for the data collection and, despite the heavy demands of the schedule and limited resources, were in a position to conduct it 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 and distributing materials from the national centers and returning them to it.

[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.

[11] The TIMSS quality assurance program covered all three TIMSS populations, and was not confined to the final-year population.

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 used 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, represents a diagnostic code used to identify specific types of approaches, strategies, or common errors and misconceptions. Although not emphasized in this report, analyses of responses based on the second digit should provide insight into ways to help students better understand mathematics and science concepts and problem-solving approaches.

To meet the goal of implementing reliable scoring procedures based on the TIMSS rubrics, the TIMSS International Study Center prepared guides containing the rubrics and explanations of how to implement them, together with example student responses for the various rubrics. These guides, together with more examples of student responses for practice in applying the rubrics, were used as the basis for an ambitious series of regional training sessions. The sessions were designed to help representatives of national centers who would then be responsible for training personnel in their countries to apply the two-digit codes reliably.[12]

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 coded independently by two readers. Tables B.13, B.14, and B.15 show the average and range of the within-country percentage of exact agreement between scorers on the free-response items in the literacy test, advanced mathematics test, and physics test, respectively. Unfortunately, lack of resources prevented several countries from providing this information. A very high percentage of exact agreement was observed for all three tests. For the literacy test, averages across items for the correctness score ranged from 91% to 98% and the overall average was 95% across the 13 countries. For the advanced mathematics test, averages across items for the correctness score ranged from 93% to 99% with an overall average of 96% across the 10 countries. For the physics test, averages across items for the correctness score ranged from 89% to 100% with an overall average of 95% across the 11 countries.

[12] 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 B.13

TIMSS Within-Country Free-Response Coding Reliability Data
Mathematics and Science Literacy
Final Year of Secondary School*

Country	Correctness Score Agreement			Diagnostic Code 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	94	81	99	83	61	99
Canada	91	75	99	81	60	99
Czech Republic	97	84	100	91	79	100
Denmark	95	83	100	88	68	99
France	98	91	100	95	87	99
Germany	92	70	100	82	59	100
Italy	96	88	100	89	73	99
Netherlands	92	73	100	82	62	100
New Zealand	97	91	100	92	80	100
Norway	96	83	100	90	69	100
Russian Federation	98	91	100	95	88	100
Sweden	93	81	100	85	57	100
United States	93	82	100	83	69	99
AVERAGE	95	83	100	87	70	100

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each item part, and each part was treated as a separate item in computing averages and ranges.

Table B.14

TIMSS Within-Country Free-Response Coding Reliability Data
Advanced Mathematics
Final Year of Secondary School*

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	93	77	100	81	62	96
Canada	94	76	100	84	64	94
Czech Republic	95	87	100	87	74	97
Denmark	93	76	100	84	62	98
France	99	92	100	97	85	100
Germany	96	81	100	84	68	100
Italy	98	92	100	90	75	100
Russian Federation	98	89	100	96	89	100
Sweden	99	88	100	90	79	100
United States	96	89	100	87	65	95
AVERAGE	96	85	100	88	72	98

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each item part, and each part was treated as a separate item in computing averages and ranges.

Table B.15

TIMSS Within-Country Free-Response Coding Reliability Data – Physics
Final Year of Secondary School*

Country	Correctness Score Agreement			Diagnostic Code 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	90	56	100	77	46	97
Canada	92	79	100	78	61	92
Czech Republic	99	94	100	92	76	100
Denmark	90	58	100	78	43	95
France	100	96	100	95	72	100
Germany	89	65	100	74	50	95
Italy	99	86	100	97	67	100
Norway	97	90	100	93	82	100
Russian Federation	97	88	100	92	84	100
Sweden	96	80	100	90	63	100
United States	95	84	100	84	63	97
AVERAGE	95	80	100	86	64	98

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each part, and each part was treated as a separate item in computing averages and ranges.

To provide information about the cross-country agreement among scorers, TIMSS conducted a special study at Population 2, where 39 scorers from 21 participating countries evaluated common sets of students' responses to more than half of the free-response items. Unfortunately, resources did not allow an international reliability study to be conducted for Population 3; however, the results of the study at Population 2 demonstrated a very high percentage of exact agreement on the correctness and diagnostic scores. 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.[13]

Test Reliability

Table B.16 displays for each country the median KR-20 reliability coefficient for the literacy item clusters, the advanced mathematics item clusters, and the physics item clusters. The international median, shown in the last row of the table, is the median of the reliability coefficients for all countries.

Data Processing

To ensure the availability of comparable, high-quality data for analysis, TIMSS took a rigorous set of quality control steps to create the international database.[14] TIMSS prepared manuals and software for countries to use in entering their data so that 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 Center, the data from each country underwent an exhaustive cleaning process. This process involved several iterative steps and procedures designed to identify, document, and correct deviations from the international instruments, file structures, and coding schemes. It 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, the TIMSS 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. Six countries had one or more mathematics items deleted (in most cases, just 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] 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.

[14] 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 B.16

Cronbach's Alpha Reliability Coefficients[1]

Final Year of Secondary School*

Country	Mathematics and Science Literacy	Advanced Mathematics	Physics
Australia	0.79	0.82	0.64
Austria	0.75	0.72	0.63
Canada	0.77	0.78	0.66
Cyprus	0.74	0.76	0.72
Czech Republic	0.80	0.82	0.70
Denmark	0.74	0.73	0.72
France	0.72	0.71	0.51
Germany	0.79	0.76	0.76
Greece	-	0.81	0.60
Hungary	0.76	-	-
Iceland	0.74	-	-
Israel	0.83	0.67	0.65
Italy	0.77	0.75	0.48
Latvia (LSS)	-	-	0.78
Lithuania	0.77	0.78	-
Netherlands	0.77	-	-
New Zealand	0.79	-	-
Norway	0.78	-	0.77
Russian Federation	0.77	0.85	0.80
Slovenia	0.77	0.78	0.71
South Africa	0.84	-	-
Sweden	0.77	0.68	0.73
Switzerland	0.76	0.78	0.69
United States	0.80	0.77	0.50
International Median	0.78	0.77	0.70

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[1] The reliability coefficient for each country is the median KR-20 reliability across clusters in each subject. The international median is the median of the reliability coefficients for all countries.

* See Appendix A for characteristics of the students sampled.

A dash (-) indicates the data are not available.

IRT SCALING

TIMSS used an item response theory (IRT) scaling method (Rasch model) to summarize achievement on the three tests.[15] Scaling averages students' responses to the subsets of items they took in a way that accounts for differences in the difficulty of those items. An IRT approach was preferred for developing comparable estimates of performance for all students, since within each of the three components of the testing students answered different test items depending upon which of the 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.

Because of the need for each of the three tests to achieve broad coverage within a limited amount of student testing time, each student was administered relatively few items within each of the subareas covered. In order to achieve reliable indices of student proficiency in this situation, it was necessary to make use of multiple imputation or "plausible values" methodology.[16] The proficiency scale scores or plausible values assigned to each student are actually random draws from the estimated ability distribution of students with similar item response patterns and background characteristics. The plausible values are intermediate values that are used in statistical analyses to provide good estimates of parameters of student populations. Although intended for use in place of student scores in analyses, plausible values are designed primarily to estimate population parameters, and are not optimal estimates of individual student proficiency.

The scaling model used in TIMSS was based on the multidimensional random coefficients logit model. The scaling was carried out with the *ConQuest* software[17] that was developed in part to meet the needs of TIMSS.

The item response model was fit to the data in two steps. In the first step the data from all countries were pooled and an international calibration of the items was undertaken using the pooled data. The data were weighted so that each country contributed equally to the calibration process. In a second step the model was fitted separately to the data for each country within the item parameters fixed at values estimated in the first step.

[15] See Adams, R.J., Wu, M., and Macaskill, G. (1997). "Scaling Methodology and Procedures," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume II.* Chestnut Hill, MA: Boston College.

[16] See Mislevy, R.J., Johnson, E.G., and Muraki, E. (1992). Scaling Procedures in NAEP. *Journal of Educational Statistics.* 17, 131-154.

[17] Wu, M.L., Adams, R.J., and Wilson, M. (1997). *Conquest: Generalized Item Response Modelling Software - Manual.* Melbourne: Australian Council for Educational Research.

The plausible values produced by the scaling procedure were in the form of logit scores that were on a scale that ranged generally between -3 and +3. For reporting purposes, these scores were mapped by a linear transformation onto an international scale with a mean of 500 and a standard deviation of 100. Each country was weighted to contribute the same when the international mean and standard deviation were set.

For the literacy test, mathematics literacy and science literacy achievement were summarized on two separate scales, each with a mean of 500 and a standard deviation of 100. The composite results for mathematics and science literacy represent an average of the results on the mathematics and science literacy scales. The overall results for advanced mathematics were derived by scaling all of the mathematics items together, also on a scale with a mean of 500 and standard deviation of 100. In a separate multidimensional scaling, achievement on items in numbers and equations, calculus, and geometry was summarized on three separate scales, each with a mean of 500[18] and a standard deviation of 100. Ten items from other content areas (probability and statistics, and validation and structure) were excluded from the content area scaling but were included in the scaling for the overall advanced mathematics test. For the physics test, achievement was summarized on five separate scales: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity, each with a mean of 500 and a standard deviation of 100. The overall results for physics were derived from a separate scaling of all of the physics items together. In all, TIMSS conducted six separate scaling efforts for the final year students: mathematics literacy, science literacy, advanced mathematics overall, a multidimensional scaling of three content areas in advanced mathematics, physics overall, and a multidimensional scaling of five content areas in physics.

In order to quantify the uncertainty in the estimate of individual student proficiencies, TIMSS drew five plausible values for each student on each of the scales. The differences between the five values are an indication of the variability introduced by the imputation process. For the TIMSS international reports, each student proficiency statistic was computed five times, once with each plausible value, and the results were averaged to get the final, published value.

[18] Although each scale was intended to have a mean of 500, final revisions to the data for advanced mathematics students and physics students resulted in a mean of 501 for some scales.

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 had 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 standard errors presented in the report quantify the uncertainty due to sampling variability, and also the uncertainty due to the imputation process. The use of confidence intervals, based on the standard errors, allows inferences to be made 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 C

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 that include providing detailed procedures for standardizing the population definitions, sampling, test translation, test administration, scoring, and database formation. Developing the TIMSS tests involved the interaction of experts in mathematics and the sciences with representatives of the participating countries and testing specialists.[1] The National Research Coordinators (NRCs) from each country formally approved the TIMSS tests, thus accepting them as being sufficiently fair to compare their students' achievement with that of students from other countries.

Although the TIMSS tests for final-year students having taken advanced mathematics and physics were developed to represent a set of agreed-upon advanced mathematics and physics topics, there are differences among the participating countries with respect to curricula in these fields.[2] Moreover, the amount of advanced mathematics and physics the tested students may have had varied across and within countries, depending on how each country defined the subpopulations of advanced mathematics and physics students. To restrict test items to not only the topics common to the curricula of all countries but also to those studied by all students in each country would severely limit test coverage and restrict the research questions about international differences that TIMSS is designed to examine. 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 advanced mathematics test and the TIMSS physics test for students in their final year of secondary school who had taken these subjects. It was also intended to show how student performance in individual countries varied when based only on the test questions that were judged to be relevant to their own curriculum.[3]

To gather data about the extent to which the TIMSS advanced mathematics and physics 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 for students having taken these subjects. The NRC was asked to choose a person or persons very familiar with the curricula to make the determination. Since an item might be in the curriculum for some but not all students in a given country who had taken advanced mathematics or physics, it

[1] See Appendix B for more information on the test development.

[2] The TCMA was conducted for the advanced mathematics and physics assessments, but not for the mathematics and science literacy component of the TIMSS final-year assessment.

[3] 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 national curricula.

was deemed 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. Thirteen countries participated in the analysis for advanced mathematics and twelve countries in that for physics. Tables C.1 and C.2 present the TCMA results for advanced mathematics and physics, respectively.

The first row of Table C.1 indicates that by and large the countries considered the advanced mathematics items to be appropriate for their students. The number of score points represented by the selected items ranged from approximately 75% (62 out of 82) in Sweden to 100% in Austria and the United States.[4] About half of the countries selected items representing at least 85% of the score points. Table C.1 also shows that the different sets of items countries selected for this analysis generally did not affect their relative standing on the advanced mathematics test.

The first column in Table C.1 shows the overall average percentage correct for each country on the advanced mathematics test.[5] 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 percentage correct for the students in that country on the items selected by each country listed across the top of the table. For example, France, where the average percentage correct was 57% on its own set of items, had 60% for the items selected by Australia, 58% for those selected by the Russian Federation, 59% for those selected by Switzerland, 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 items selected by Switzerland as an example, 59% of the French students answered these items correctly, on average, 53% of the Australian students, 54% of the Russian students, 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, Swiss students averaged 53% correct on the items identified by Switzerland for this analysis.

The international averages of each country's selected advanced mathematics items presented across the last row of the table show that the difficulty of the items selected by the participating countries was fairly consistent and similar to the difficulty of the entire test, ranging from 44% to 49%. The performance of countries on the various item selections did vary somewhat, but generally not significantly.[6]

[4] Of the 65 items in the advanced mathematics test, some were assigned more score points than others. In particular, some items had two parts, and some extended-response items were scored on a two- or three-point scale. The total number of score points available for analysis was 82. The TCMA uses the score points in order to give the same weight to items that they received in the test scoring.

[5] Note that the performance levels presented in Tables C.1 and C.2 are based on the average percentage correct, which differs from the average scale scores presented in Chapters 5 and 8. The cost and delay of scaling for the TCMA analyses would have been prohibitive.

[6] Small differences in performance in Tables C.1 and C.2 generally are not statistically significant. The standard errors for the estimated average percent correct statistics can found in Tables C.3 and C.4. We can say with 95% confidence that the value for the entire population will fall within the sample estimate plus or minus two standard errors.

Comparing the diagonal element for a country with its overall average percentage correct shows the difference between performance on the subset of items chosen by the country and on the test as a whole. In general, where there was an increase in a country's performance on its own subset of items, it was small. The largest differences were in Sweden and Denmark, where the average percentages correct were 47% and 49%, respectively, for all items and 52% and 54%, respectively, for their subsets of items.

Table C.2 presents the results of the TCMA for physics. The first row of the table shows that, as in advanced mathematics, by and large the countries considered the physics items to be appropriate for their physics students. The number of score points represented by the items selected by each country, however, varies more than for advanced mathematics (see Table C.1), ranging from approximately 47% (38 out of 81) in the Russian Federation to 100% in Austria and the United States.[7] Half of the countries, however, selected at least 85% of the score points.

The international averages for each country's selected physics items presented across the last row of the table show that items selected by the participating countries were fairly consistent in terms of difficulty, and similar to the difficulty of the entire test. Most ranged from 33% to 37%, although the Russian Federation's had an international average of 43%.

The items countries rejected tended to be difficult for their own students, but tended to be difficult for students in other countries as well. The analysis shows that omitting items considered to be inappropriate tends to improve the results for that country, but also those for all other countries, so that the relative standing of countries is largely unaffected. For example, in the Russian Federation, the average percentage correct was 42% for all physics items and 56% for its selected items, indicating that the latter were easier for these students than the test as a whole. The same subset of items, however, was also easier for students in other countries, as can be seen by looking down the column for the Russian Federation and at the international average.

In general, the selection of items has no major effect on the relationship among countries on either the mathematics or physics tests. Countries that had substantially higher or lower performance on the overall tests also had higher or lower relative performance on the different sets of items selected for the TCMA. For example, in advanced mathematics, France had the highest average percentage correct on the test as a whole and on all of the item selections, with Australia, the Russian Federation, and Switzerland among the four highest-performing countries in almost all cases. In physics, Slovenia, the Russian Federation, and Denmark were among the highest-performing countries on the test overall, as well as on the subset of items selected by each other country. 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.

[7] Similar to the advanced mathematics test, some physics items had two parts, and the extended-response items were awarded 2 points for full credit. The total number of score points available for the 65 physics items was 81.

Table C.1

Test-Curriculum Matching Analysis Results - Advanced Mathematics Final Year of Secondary School*

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table C.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*	France	*Australia*	Russian Federation	Switzerland	Cyprus	*Denmark*	Sweden	Canada	Czech Republic	*Slovenia*	Germany	*Austria*	*United States*
(Number of Score Points Included)	*82***	*80*	*71*	*67*	*72*	*76*	*65*	*62*	*70*	*80*	*81*	*65*	*82*	*82*
France	58 (1.1)	57	60	58	59	56	61	61	56	57	57	59	58	58
Australia	52 (2.2)	51	55	51	53	50	54	55	50	52	51	53	52	52
Russian Federation	52 (1.7)	52	55	56	54	52	56	56	51	52	52	55	52	52
Switzerland	50 (0.8)	50	52	50	53	48	54	54	48	50	49	52	50	50
Cyprus	49 (1.2)	48	51	50	50	48	52	52	47	49	48	50	49	49
Denmark	49 (0.8)	49	52	49	52	47	54	54	46	49	48	52	49	49
Sweden	47 (0.9)	47	50	46	49	45	51	52	46	47	47	50	47	47
Canada	47 (0.8)	46	49	46	49	45	51	51	46	47	46	49	47	47
Czech Republic	40 (1.9)	40	42	41	41	39	43	43	39	40	40	42	40	40
Slovenia	39 (1.7)	39	41	38	40	37	42	42	38	39	39	40	39	39
Germany	38 (1.1)	38	40	38	41	36	42	42	35	38	37	40	38	38
Austria	35 (1.2)	35	37	34	37	33	39	39	33	35	34	37	35	35
United States	35 (1.0)	35	37	34	37	33	38	39	34	35	34	37	35	35
International Average	**45 (1.3)**	**45**	**48**	**45**	**47**	**44**	**49**	**49**	**44**	**45**	**45**	**47**	**45**	**45**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Of the 65 items in the advanced mathematics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 82 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.5).

Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.2

Test-Curriculum Matching Analysis Results - Physics
Final Year of Secondary School*

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table C.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*	*Slovenia*	Russian Federation	*Denmark*	Germany	*Australia*	Cyprus	Switzerland	Canada	France	Czech Republic	*Austria*	*United States*
	(Number of Score Points Included)												
	81**	***78***	***38***	***73***	***78***	***78***	***78***	***43***	***59***	***60***	***77***	***81***	***81***
Slovenia	42 (2.5)	42	51	43	41	42	42	45	43	41	42	42	42
Russian Federation	42 (1.9)	42	56	42	41	42	42	44	42	42	43	42	42
Denmark	40 (0.9)	39	52	42	40	40	40	43	41	39	40	40	40
Germany	39 (2.0)	38	44	39	39	39	39	40	41	38	39	39	39
Australia	37 (0.9)	37	46	38	37	38	37	40	38	37	37	37	37
Cyprus	36 (0.9)	36	43	37	36	37	36	40	37	36	36	36	36
Switzerland	32 (0.6)	31	39	32	31	32	32	36	31	30	32	32	32
Canada	31 (0.6)	31	42	32	31	31	31	34	32	30	32	31	31
France	30 (0.6)	29	39	31	30	30	30	32	29	30	30	30	30
Czech Republic	28 (1.0)	27	37	28	27	27	28	31	27	26	28	28	28
Austria	25 (0.9)	24	32	25	25	25	25	28	25	23	25	25	25
United States	23 (0.5)	22	32	23	22	23	23	26	22	21	23	23	23
International Average	**34 (1.1)**	**33**	**43**	**34**	**33**	**34**	**34**	**37**	**34**	**33**	**34**	**34**	**34**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
** Of the 65 items in the physics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 81 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.6).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.3

Standard Errors for the Test-Curriculum Matching Analysis Results - Advanced Mathematics Final Year of Secondary School*

See Table C.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*	France	*Australia*	Russian Federation	Switzerland	Cyprus	*Denmark*	Sweden	Canada	Czech Republic	*Slovenia*	Germany	*Austria*	*United States*
	(Number of Score Points Included)													
	82*	***80***	***71***	***67***	***72***	***76***	***65***	***62***	***70***	***80***	***81***	***65***	***82***	***82***
France	58 (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
Australia	52 (2.2)	2.2	2.4	2.4	2.3	2.3	2.4	2.4	2.4	2.3	2.3	2.4	2.2	2.2
Russian Federation	52 (1.7)	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Switzerland	50 (0.8)	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8
Cyprus	49 (1.2)	1.2	1.2	1.2	1.2	1.3	1.2	1.1	1.3	1.2	1.2	1.2	1.2	1.2
Denmark	49 (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	0.7
Sweden	47 (0.9)	0.9	0.9	1.0	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9
Canada	47 (0.8)	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8
Czech Republic	40 (1.9)	2.0	2.0	2.0	1.9	2.0	1.9	2.0	2.0	1.9	1.9	2.0	1.9	1.9
Slovenia	39 (1.7)	1.7	1.8	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.7
Germany	38 (1.1)	1.1	1.1	1.1	1.2	1.0	1.2	1.1	1.0	1.1	1.1	1.1	1.1	1.1
Austria	35 (1.2)	1.2	1.2	1.2	1.3	1.1	1.3	1.3	1.1	1.2	1.2	1.3	1.2	1.2
United States	35 (1.0)	1.0	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
International Average	**45 (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**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Of the 65 items in the advanced mathematics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 82 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.5).

Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.4

Standard Errors for the Test-Curriculum Matching Analysis Results - Physics
Final Year of Secondary School*

See Table C.2 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*	*Slovenia*	Russian Federation	*Denmark*	Germany	*Australia*	Cyprus	Switzerland	Canada	France	Czech Republic	*Austria*	*United States*
	(Number of Score Points Included)												
	*81***	*78*	*38*	*73*	*78*	*78*	*78*	*43*	*59*	*60*	*77*	*81*	*81*
Slovenia	42 (2.5)	2.6	2.8	2.7	2.5	2.5	2.5	2.2	2.7	2.7	2.5	2.5	2.5
Russian Federation	42 (1.9)	1.9	2.0	1.9	1.9	1.9	1.9	1.7	1.8	1.9	1.9	1.9	1.9
Denmark	40 (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
Germany	39 (2.0)	2.0	1.6	2.0	2.0	2.0	2.0	1.6	2.2	2.0	2.0	2.0	2.0
Australia	37 (0.9)	0.9	1.1	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
Cyprus	36 (0.9)	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.0	1.0	1.0	0.9	0.9
Switzerland	32 (0.6)	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6
Canada	31 (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
France	30 (0.6)	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6
Czech Republic	28 (1.0)	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0
Austria	25 (0.9)	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9
United States	23 (0.5)	0.5	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4
International Average	**34 (1.1)**	**1.1**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Of the 65 items in the physics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 81 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.6).

Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Appendix D

Selected Achievement Results for Israel and Italy

Table D.1

Israel - Selected Achievement Results in Mathematics and Science Literacy Unweighted Data

Distributions of Mathematics and Science Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
484 (12.1)	17.7	281 (19.7)	402 (13.3)	488 (12.5)	569 (16.0)	677 (13.2)

Gender Differences in Mathematics and Science Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	509 (12.9)	42 (3.4)	458 (14.3)	52 (19.3)

Distributions of Mathematics Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
480 (12.2)	17.7	286 (14.4)	399 (13.9)	483 (14.0)	564 (15.2)	671 (9.7)

Gender Differences in Mathematics Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	504 (13.7)	42 (3.4)	455 (13.4)	49 (19.1)

Distributions of Science Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
487 (12.3)	17.7	263 (25.7)	402 (13.7)	492 (11.7)	580 (11.1)	697 (10.1)

Gender Differences in Science Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	515 (12.5)	42 (3.4)	460 (15.8)	54 (20.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.2

Israel - Selected Achievement Results in Advanced Mathematics – Unweighted Data

Distributions of Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
557 (5.3)	17.7	441 (10.4)	514 (5.9)	557 (5.7)	603 (7.3)	674 (16.5)

Gender Differences in Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	569 (6.7)	42 (3.4)	546 (4.0)	23 (7.8)

Achievement in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Numbers and Equations	Calculus	Geometry
547 (4.5)	538 (4.4)	562 (5.5)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.3

Israel - Selected Achievement Results in Physics – Unweighted Data

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
506 (6.4)	17.7	368 (10.3)	454 (4.2)	507 (9.7)	562 (8.4)	639 (11.4)

Gender Differences in Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
78 (1.6)	513 (6.7)	22 (1.6)	482 (8.7)	31 (11.0)

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics: Particle, Quantum and Astrophysics, and Relativity
548 (5.5)	557 (6.7)	478 (4.1)	444 (6.1)	476 (7.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.4

Italy - Selected Achievement Results in Physics (Small Sample Size)

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

PTCI†	Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
9%	436 (10.3)	19.0	305 (21.2)	377 (11.0)	438 (21.7)	490 (12.2)	562 (14.2)

Gender Differences in Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Males		Females		Difference	PTCI†
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement		
51 (3.2)	461 (14.8)	49 (3.2)	410 (11.4)	51 (18.6)	9%

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics: Particle, Quantum and Astrophysics, and Relativity
420 (14.4)	473 (10.5)	490 (8.4)	445 (15.5)	421 (9.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† The Physics TIMSS Coverage Index (PTCI) is an estimate of the percentage of the school-leaving age cohort covered by theTIMSS final-year physics student sample (see Appendix B for more information).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Appendix E

Percentiles and Standard Deviations of Achievement

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Table E.1

Percentiles of Achievement in Mathematics and Science Literacy Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	366 (20.6)	462 (12.5)	526 (9.4)	585 (9.7)	682 (15.7)
Austria	395 (6.6)	463 (6.1)	514 (7.6)	573 (4.7)	655 (11.5)
Canada	395 (6.3)	468 (3.4)	523 (3.8)	579 (5.0)	668 (4.8)
Cyprus	336 (5.8)	398 (4.3)	442 (3.0)	490 (4.0)	577 (8.8)
Czech Republic	344 (12.1)	411 (10.1)	463 (12.1)	531 (15.6)	649 (13.8)
Denmark	399 (8.2)	470 (4.9)	525 (4.1)	584 (4.7)	665 (3.9)
France	383 (10.2)	455 (5.1)	503 (5.9)	556 (5.6)	630 (4.3)
Germany	351 (14.5)	435 (12.0)	494 (4.9)	555 (5.0)	643 (11.4)
Hungary	351 (4.1)	416 (3.0)	469 (4.0)	531 (3.4)	628 (8.2)
Iceland	418 (8.7)	487 (3.4)	538 (3.7)	592 (4.0)	676 (6.9)
Italy	343 (10.2)	418 (6.8)	473 (6.6)	529 (4.9)	614 (19.3)
Lithuania	332 (12.1)	410 (8.5)	465 (8.5)	520 (6.7)	598 (8.7)
Netherlands	420 (7.2)	498 (8.5)	561 (7.5)	617 (6.4)	697 (8.1)
New Zealand	370 (20.2)	464 (3.9)	526 (5.7)	587 (3.9)	678 (5.4)
Norway	403 (6.3)	474 (3.4)	530 (6.0)	592 (7.5)	693 (9.7)
Russian Federation	350 (5.1)	418 (3.9)	468 (6.5)	531 (7.3)	623 (15.3)
Slovenia	378 (12.9)	457 (8.7)	516 (11.0)	568 (8.0)	653 (17.3)
South Africa	254 (5.7)	294 (3.4)	329 (3.6)	381 (16.2)	538 (27.0)
Sweden	413 (6.8)	490 (5.1)	549 (5.7)	615 (4.7)	716 (7.9)
Switzerland	389 (8.4)	472 (9.0)	529 (5.3)	590 (7.2)	678 (5.7)
United States	334 (7.9)	407 (4.2)	465 (4.1)	527 (3.3)	627 (4.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.2

Percentiles of Achievement in Mathematics Literacy

Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	357 (17.5)	459 (9.4)	523 (8.6)	585 (9.5)	684 (10.4)
Austria	393 (9.2)	461 (7.9)	515 (6.4)	573 (6.4)	653 (8.9)
Canada	375 (5.8)	457 (4.6)	516 (4.5)	579 (3.8)	674 (5.3)
Cyprus	329 (6.0)	395 (2.2)	442 (5.0)	493 (4.0)	572 (3.9)
Czech Republic	328 (12.2)	394 (10.3)	450 (15.9)	530 (16.5)	648 (13.6)
Denmark	406 (8.2)	487 (5.6)	548 (6.4)	609 (4.7)	689 (6.2)
France	392 (8.6)	468 (6.3)	523 (3.7)	578 (6.9)	655 (9.9)
Germany	347 (10.5)	432 (11.3)	494 (6.7)	554 (8.9)	652 (8.0)
Hungary	343 (3.8)	417 (3.1)	477 (3.8)	545 (3.5)	644 (6.6)
Iceland	393 (5.3)	472 (4.0)	531 (3.0)	592 (3.2)	683 (6.6)
Italy	336 (15.3)	417 (7.5)	475 (6.3)	534 (4.6)	619 (11.7)
Lithuania	329 (8.8)	412 (9.1)	470 (7.0)	529 (8.3)	606 (5.4)
Netherlands	407 (5.7)	498 (7.1)	565 (6.1)	622 (5.2)	704 (16.0)
New Zealand	358 (7.4)	453 (7.0)	523 (6.3)	589 (5.2)	685 (6.7)
Norway	384 (7.7)	461 (6.1)	523 (4.1)	592 (4.5)	691 (6.8)
Russian Federation	342 (6.4)	410 (4.8)	464 (6.0)	528 (7.8)	622 (16.6)
Slovenia	365 (13.7)	451 (8.5)	516 (7.4)	573 (6.6)	652 (5.7)
South Africa	264 (3.2)	304 (3.8)	337 (4.9)	380 (10.4)	532 (33.7)
Sweden	396 (6.4)	483 (5.1)	546 (4.8)	620 (4.1)	722 (6.8)
Switzerland	395 (7.4)	478 (7.9)	539 (7.9)	601 (5.5)	684 (5.3)
United States	325 (4.4)	395 (3.8)	454 (4.4)	521 (6.7)	621 (7.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.3

Percentiles of Achievement in Science Literacy Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	361 (14.5)	462 (12.2)	525 (8.5)	591 (13.6)	689 (4.0)
Austria	388 (5.6)	460 (8.3)	513 (7.3)	575 (9.6)	672 (23.5)
Canada	396 (7.1)	475 (5.8)	529 (3.6)	588 (3.8)	673 (5.2)
Cyprus	319 (8.7)	392 (11.6)	443 (5.6)	499 (7.5)	599 (10.8)
Czech Republic	349 (9.5)	424 (9.2)	477 (11.6)	540 (12.1)	655 (12.8)
Denmark	369 (6.1)	448 (4.9)	505 (5.6)	568 (7.0)	657 (5.4)
France	358 (7.9)	434 (5.4)	485 (8.4)	542 (7.9)	618 (5.6)
Germany	350 (12.2)	437 (7.4)	494 (6.7)	556 (6.3)	649 (11.1)
Hungary	342 (2.9)	410 (3.5)	463 (2.2)	524 (3.7)	624 (6.1)
Iceland	429 (5.0)	497 (1.9)	545 (3.3)	598 (2.1)	680 (3.8)
Italy	339 (11.4)	417 (6.5)	470 (4.6)	528 (6.0)	624 (17.2)
Lithuania	324 (13.5)	403 (7.5)	460 (7.4)	517 (4.6)	601 (9.1)
Netherlands	421 (9.0)	498 (6.1)	556 (6.4)	616 (10.5)	702 (19.8)
New Zealand	369 (16.8)	467 (8.9)	530 (7.0)	592 (4.4)	683 (5.2)
Norway	404 (6.9)	480 (5.2)	539 (2.7)	600 (7.4)	706 (11.6)
Russian Federation	338 (6.1)	418 (6.9)	476 (9.3)	541 (9.2)	638 (13.7)
Slovenia	384 (10.1)	459 (8.7)	514 (8.7)	571 (10.3)	662 (22.5)
South Africa	228 (4.8)	282 (4.3)	325 (6.3)	390 (18.2)	550 (22.1)
Sweden	420 (9.4)	495 (4.3)	551 (4.2)	617 (5.5)	724 (9.2)
Switzerland	375 (10.6)	459 (6.9)	521 (5.0)	584 (4.9)	681 (9.2)
United States	332 (8.0)	416 (4.6)	477 (3.3)	541 (4.9)	640 (8.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.4

Percentiles of Achievement in Advanced Mathematics

Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	337 (30.1)	456 (17.5)	530 (9.0)	597 (10.4)	692 (21.1)
Austria	283 (15.2)	379 (11.4)	443 (7.9)	497 (8.8)	577 (16.4)
Canada	352 (7.1)	443 (5.4)	508 (4.8)	576 (7.2)	676 (10.1)
Cyprus	371 (23.0)	465 (5.7)	523 (10.4)	574 (5.2)	651 (15.8)
Czech Republic	320 (12.7)	399 (9.2)	454 (10.4)	524 (15.6)	665 (20.2)
Denmark	403 (5.6)	474 (3.8)	523 (2.3)	572 (4.8)	643 (6.9)
France	439 (5.5)	511 (5.1)	558 (5.5)	603 (6.4)	673 (8.4)
Germany	328 (9.3)	408 (8.0)	463 (5.7)	522 (5.6)	605 (6.9)
Greece	321 (35.1)	454 (11.6)	521 (6.4)	585 (5.1)	668 (12.7)
Italy	314 (14.9)	419 (13.4)	477 (10.3)	534 (8.3)	622 (22.7)
Lithuania	388 (12.2)	461 (5.5)	512 (3.6)	567 (3.3)	666 (16.9)
Russian Federation	360 (9.3)	465 (9.3)	539 (12.7)	618 (9.4)	730 (22.4)
Slovenia	330 (10.2)	408 (9.5)	473 (10.1)	537 (8.5)	630 (20.4)
Sweden	375 (7.9)	458 (10.5)	513 (11.4)	568 (7.0)	653 (13.6)
Switzerland	401 (5.6)	473 (6.2)	525 (7.9)	587 (5.9)	691 (3.4)
United States	292 (3.8)	375 (7.1)	437 (6.4)	504 (6.1)	609 (8.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.5

Percentiles of Achievement in Physics Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	386 (11.8)	461 (3.3)	517 (6.6)	570 (8.5)	656 (11.9)
Austria	306 (11.9)	379 (11.3)	427 (5.9)	486 (10.1)	581 (22.3)
Canada	346 (5.1)	429 (2.9)	482 (4.4)	539 (7.3)	633 (14.3)
Cyprus	325 (8.0)	434 (10.9)	487 (4.9)	551 (9.0)	681 (28.8)
Czech Republic	337 (4.5)	397 (6.2)	440 (6.6)	493 (12.3)	605 (29.5)
Denmark	397 (8.4)	478 (4.3)	535 (5.9)	588 (6.1)	677 (15.2)
France	358 (9.4)	423 (6.8)	465 (4.1)	509 (3.1)	574 (8.3)
Germany	374 (13.2)	458 (16.2)	519 (12.0)	580 (19.1)	688 (10.1)
Greece	333 (18.9)	431 (5.7)	495 (7.7)	545 (6.3)	619 (8.2)
Latvia (LSS)	348 (12.2)	418 (15.7)	474 (19.2)	540 (36.5)	687 (31.5)
Norway	432 (6.3)	517 (11.1)	578 (6.3)	646 (7.2)	727 (6.1)
Russian Federation	368 (18.2)	468 (15.7)	544 (12.6)	619 (16.5)	722 (21.2)
Slovenia	332 (11.3)	457 (15.3)	528 (21.2)	598 (14.1)	689 (36.3)
Sweden	422 (12.2)	511 (8.9)	574 (6.6)	634 (6.6)	725 (6.7)
Switzerland	353 (20.6)	430 (7.6)	479 (4.7)	540 (5.2)	648 (9.9)
United States	331 (4.7)	384 (4.0)	420 (4.2)	458 (6.4)	520 (6.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.6

Standard Deviations of Achievement in Mathematics and Science Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	525 (9.5)	95 (4.8)	511 (9.3)	89 (5.4)	543 (10.7)	100 (5.8)
Austria	519 (5.4)	80 (3.1)	502 (5.5)	71 (3.2)	549 (7.8)	85 (4.5)
Canada	526 (2.6)	83 (1.6)	511 (3.4)	79 (1.9)	544 (3.4)	84 (2.2)
Cyprus	447 (2.5)	73 (2.3)	439 (3.0)	67 (2.9)	456 (4.9)	78 (3.9)
Czech Republic	476 (10.5)	92 (3.3)	452 (13.8)	84 (3.7)	500 (9.9)	93 (3.5)
Denmark	528 (3.2)	81 (2.3)	507 (3.7)	76 (2.5)	554 (4.5)	80 (3.0)
France	505 (4.9)	74 (2.7)	487 (4.8)	68 (2.6)	526 (5.9)	75 (3.6)
Germany	496 (5.4)	89 (3.2)	479 (8.5)	89 (4.6)	512 (8.2)	86 (4.0)
Hungary	477 (3.0)	84 (2.4)	468 (4.5)	76 (2.3)	485 (4.5)	91 (3.0)
Iceland	541 (1.6)	77 (1.2)	522 (1.9)	72 (1.3)	565 (2.9)	77 (2.0)
Italy	475 (5.3)	83 (4.0)	461 (5.7)	78 (5.0)	492 (6.9)	86 (4.8)
Lithuania	465 (5.8)	80 (3.3)	456 (7.4)	81 (3.5)	483 (6.7)	76 (3.3)
Netherlands	559 (4.9)	84 (4.0)	533 (5.9)	82 (4.7)	584 (5.5)	78 (4.2)
New Zealand	525 (4.7)	92 (2.4)	511 (5.5)	85 (3.1)	540 (5.7)	97 (3.3)
Norway	536 (4.0)	88 (2.1)	507 (4.5)	76 (2.6)	564 (5.0)	89 (3.1)
Russian Federation	476 (5.8)	83 (2.9)	462 (6.5)	81 (3.6)	499 (5.9)	81 (3.3)
Slovenia	514 (8.2)	82 (4.4)	492 (7.1)	73 (3.8)	538 (12.6)	84 (8.3)
South Africa	352 (9.3)	88 (8.7)	341 (11.8)	87 (13.6)	366 (10.3)	88 (8.4)
Sweden	555 (4.3)	91 (2.2)	533 (3.6)	80 (2.2)	579 (5.8)	96 (2.8)
Switzerland	531 (5.4)	88 (2.6)	511 (7.5)	85 (2.9)	547 (6.0)	87 (3.4)
United States	471 (3.1)	89 (2.1)	462 (3.5)	85 (3.0)	479 (4.2)	93 (2.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.7

Standard Deviations of Achievement in Mathematics Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	522 (9.3)	97 (4.9)	510 (9.3)	91 (5.1)	540 (10.3)	103 (6.1)
Austria	518 (5.3)	80 (2.8)	503 (5.5)	73 (2.9)	545 (7.2)	82 (4.1)
Canada	519 (2.8)	90 (1.7)	504 (3.5)	87 (2.6)	537 (3.8)	91 (2.7)
Cyprus	446 (2.5)	73 (2.6)	439 (3.7)	68 (2.9)	454 (4.9)	78 (4.0)
Czech Republic	466 (12.3)	99 (3.5)	443 (16.8)	92 (3.6)	488 (11.3)	101 (4.0)
Denmark	547 (3.3)	87 (2.8)	523 (4.0)	82 (2.6)	575 (4.0)	84 (3.8)
France	523 (5.1)	79 (2.8)	506 (5.3)	75 (2.8)	544 (5.6)	79 (3.6)
Germany	495 (5.9)	94 (3.2)	480 (8.8)	94 (4.5)	509 (8.7)	91 (4.4)
Hungary	483 (3.2)	92 (2.2)	481 (4.8)	85 (2.3)	485 (4.9)	99 (3.0)
Iceland	534 (2.0)	88 (1.4)	514 (2.2)	84 (1.2)	558 (3.4)	86 (2.4)
Italy	476 (5.5)	87 (3.9)	464 (6.0)	84 (5.2)	490 (7.4)	90 (5.0)
Lithuania	469 (6.1)	85 (3.5)	461 (7.7)	86 (3.6)	485 (7.3)	80 (4.2)
Netherlands	560 (4.7)	90 (3.5)	533 (5.9)	90 (4.4)	585 (5.6)	82 (3.8)
New Zealand	522 (4.5)	98 (2.2)	507 (6.2)	93 (3.0)	536 (4.9)	101 (3.0)
Norway	528 (4.1)	94 (1.9)	501 (4.8)	84 (2.5)	555 (5.3)	95 (2.9)
Russian Federation	471 (6.2)	85 (3.2)	460 (6.6)	84 (3.9)	488 (6.5)	86 (3.5)
Slovenia	512 (8.3)	87 (4.4)	490 (8.0)	79 (4.6)	535 (12.7)	87 (8.9)
South Africa	356 (8.3)	81 (8.5)	348 (10.8)	80 (13.3)	365 (9.3)	83 (8.2)
Sweden	552 (4.3)	99 (2.3)	531 (3.9)	89 (2.4)	573 (5.9)	103 (3.1)
Switzerland	540 (5.8)	88 (2.5)	522 (7.4)	86 (2.9)	555 (6.4)	88 (3.6)
United States	461 (3.2)	91 (1.9)	456 (3.6)	88 (2.6)	466 (4.1)	94 (2.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.8

Standard Deviations of Achievement in Science Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	527 (9.8)	100 (5.0)	513 (9.4)	94 (5.9)	547 (11.5)	104 (5.6)
Austria	520 (5.6)	87 (3.6)	501 (5.8)	75 (3.4)	554 (8.7)	94 (5.0)
Canada	532 (2.6)	85 (1.9)	518 (3.8)	80 (2.2)	550 (3.6)	86 (2.2)
Cyprus	448 (3.0)	83 (2.7)	439 (3.0)	76 (3.6)	459 (5.8)	88 (4.6)
Czech Republic	487 (8.8)	91 (3.0)	460 (11.0)	84 (3.6)	512 (8.8)	91 (3.2)
Denmark	509 (3.6)	87 (2.4)	490 (4.1)	82 (2.8)	532 (5.4)	87 (3.3)
France	487 (5.1)	79 (2.4)	468 (4.8)	71 (2.4)	508 (6.7)	81 (3.4)
Germany	497 (5.1)	91 (3.5)	478 (8.5)	91 (4.7)	514 (7.9)	87 (3.9)
Hungary	471 (3.0)	86 (2.5)	455 (4.3)	78 (2.3)	484 (4.2)	91 (3.0)
Iceland	549 (1.5)	75 (1.4)	530 (2.1)	69 (1.8)	572 (2.7)	76 (1.9)
Italy	475 (5.3)	87 (3.9)	458 (5.6)	81 (4.6)	495 (6.7)	89 (4.9)
Lithuania	461 (5.7)	84 (3.2)	450 (7.3)	84 (3.6)	481 (6.4)	79 (2.9)
Netherlands	558 (5.3)	86 (4.5)	532 (6.2)	82 (5.2)	582 (5.7)	82 (4.9)
New Zealand	529 (5.2)	94 (3.2)	515 (5.2)	87 (3.8)	543 (7.1)	100 (4.7)
Norway	544 (4.1)	91 (2.5)	513 (4.5)	79 (2.7)	574 (5.1)	93 (3.6)
Russian Federation	481 (5.7)	91 (2.8)	463 (6.7)	89 (3.2)	510 (5.7)	86 (3.7)
Slovenia	517 (8.2)	84 (4.7)	494 (6.4)	72 (3.4)	541 (12.7)	87 (7.8)
South Africa	349 (10.5)	100 (8.7)	333 (13.0)	100 (13.5)	367 (11.5)	98 (8.5)
Sweden	559 (4.4)	91 (2.2)	534 (3.5)	79 (2.2)	585 (5.9)	95 (2.8)
Switzerland	523 (5.3)	94 (2.7)	500 (7.8)	90 (3.4)	540 (6.1)	92 (3.3)
United States	480 (3.3)	94 (2.5)	469 (3.9)	89 (3.5)	492 (4.5)	98 (2.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.9

Standard Deviations of Achievement in Advanced Mathematics Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	525 (11.6)	109 (7.9)	517 (15.1)	110 (9.3)	531 (11.4)	108 (9.0)
Austria	436 (7.2)	91 (5.5)	406 (8.6)	87 (6.6)	486 (7.3)	76 (5.4)
Canada	509 (4.3)	98 (2.4)	489 (4.4)	89 (2.7)	528 (6.4)	103 (2.9)
Cyprus	518 (4.3)	85 (3.0)	509 (6.4)	77 (4.9)	524 (4.4)	90 (3.9)
Czech Republic	469 (11.2)	106 (9.3)	432 (8.9)	89 (6.4)	524 (13.0)	106 (12.0)
Denmark	522 (3.4)	73 (1.9)	510 (4.6)	68 (3.4)	529 (4.4)	76 (2.3)
France	557 (3.9)	70 (2.1)	543 (5.1)	67 (2.9)	567 (5.1)	70 (2.6)
Germany	465 (5.6)	85 (3.4)	452 (6.6)	81 (3.9)	484 (6.5)	86 (4.1)
Greece	513 (6.0)	105 (6.0)	505 (10.2)	88 (8.5)	516 (6.6)	111 (7.5)
Italy	474 (9.6)	95 (8.1)	460 (14.1)	95 (13.1)	484 (10.6)	94 (8.7)
Lithuania	516 (2.6)	85 (3.2)	490 (5.6)	78 (6.8)	542 (3.7)	84 (3.8)
Russian Federation	542 (9.2)	112 (5.6)	515 (10.2)	106 (8.0)	568 (9.7)	111 (4.4)
Slovenia	475 (9.2)	94 (3.8)	464 (11.0)	89 (3.5)	484 (11.5)	97 (5.4)
Sweden	512 (4.4)	86 (2.9)	496 (5.2)	78 (4.5)	519 (5.9)	88 (3.6)
Switzerland	533 (5.0)	90 (2.7)	503 (5.7)	77 (4.9)	559 (5.6)	93 (3.9)
United States	442 (5.9)	98 (4.1)	426 (7.1)	98 (5.6)	457 (7.8)	96 (4.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.10

Standard Deviations of Achievement in Physics

Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	518 (6.2)	82 (3.6)	490 (8.4)	75 (5.3)	532 (6.7)	82 (5.6)
Austria	435 (6.4)	83 (4.6)	408 (7.4)	71 (5.9)	479 (8.1)	82 (5.7)
Canada	485 (3.3)	87 (3.0)	459 (6.3)	75 (3.9)	506 (6.0)	90 (4.2)
Cyprus	494 (5.8)	105 (5.3)	470 (7.1)	96 (7.9)	509 (8.9)	108 (7.9)
Czech Republic	451 (6.2)	82 (5.9)	419 (3.9)	63 (5.1)	503 (8.8)	83 (5.4)
Denmark	534 (4.2)	85 (3.9)	500 (8.1)	74 (6.8)	542 (5.2)	87 (4.4)
France	466 (3.8)	66 (3.1)	450 (5.6)	61 (3.2)	478 (4.2)	67 (4.4)
Germany	522 (11.9)	94 (5.3)	479 (9.1)	80 (5.3)	542 (14.3)	93 (6.9)
Greece	486 (5.6)	87 (3.7)	468 (8.1)	79 (6.9)	495 (6.1)	90 (5.0)
Latvia (LSS)	488 (21.5)	100 (10.6)	467 (22.6)	97 (11.4)	509 (19.0)	99 (11.5)
Norway	581 (6.5)	91 (2.5)	544 (9.3)	88 (4.5)	594 (6.3)	88 (2.5)
Russian Federation	545 (11.6)	110 (5.0)	509 (15.3)	108 (9.1)	575 (9.9)	103 (3.8)
Slovenia	523 (15.5)	109 (8.7)	455 (18.7)	106 (6.4)	546 (16.3)	99 (10.8)
Sweden	573 (3.9)	92 (2.8)	540 (5.3)	78 (4.8)	589 (5.1)	94 (3.7)
Switzerland	488 (3.5)	88 (2.9)	446 (3.6)	69 (2.9)	529 (5.2)	86 (4.0)
United States	423 (3.3)	60 (3.2)	405 (3.1)	53 (1.8)	439 (4.3)	62 (5.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

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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.

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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 TIMSS International Study Center was supported in its work by several advisory committees. The TIMSS 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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