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ABSTRACT

The Council of Chief State School Officers (CCSSO) is helping develop a system of state-by-state and national indicators of the condition of science and mathematics education in an effort to assist local, state, and national policymakers in making informed decisions. The report, "State Indicators of Science and Mathematics Education-1990," established baseline data for this system of indicators. This report includes the trends analysis of state-by-state science-mathematics indicators based on data collected from the National Assessment of Educational Progress (NAEP), the 1991 Schools and Staffing Survey, and CCSSO data collected from state departments of education. Current data is reported on five key educational indicators: student outcomes, curriculum, course enrollments, teacher supply and quality, and school conditions. Student outcome indicators include mathematics proficiency on NAEP and Advanced Placement results. Curriculum content indicators include an opportunity to learn index and teacher emphasis on areas of mathematics. Instructional time and participation indicators include elementary class time on science and mathematics, science and mathematics course enrollments, trends in course enrollments from 1990 to 1992, and equity in science and mathematics opportunities for students. Teacher quality, supply, and shortage indicators include teacher supply in mathematics and science, equity in the teaching force, and teacher preparation in science and mathematics. School condition indicators include class size, teachers' perceptions of the availability of materials and resources, and use of calculators. Appendices, making up half of the report, contain 39 tables with course enrollments in public schools and characteristics of teachers in public school by state, a technical appendix, and a directory of state course titles by reporting categories. Contains 75 references. (MDH)

State Indicators of Science and Mathematics Education 1993

State and National Trends: New Indicators from the 1991-92 School Year

Council of Chief State School Officers
State Education Assessment Center

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State and National Trends:
New Indicators from the 1991-92 School Year

Rolf K. Blank
Doreen Gruebel

The State Science and Mathematics Indicators are supported by a grant from the National Science Foundation. The indicators were developed and reported through the cooperation of 52 state education agencies and the National Center for Education Statistics of the U.S. Department of Education.

The Council of Chief State School Officers (CCSSO) is a nationwide non-profit organization of the 57 public officials who head departments of public education in every state, the District of Columbia, the Department of Defense Dependents Schools, and five extra-state jurisdictions. CCSSO seeks its members' consensus on major education issues and expresses their view to civic and professional organizations, to federal agencies, to Congress, and to the public. Through its structure of standing committees and special task forces, the Council responds to a broad range of concerns about education and provides leadership on major education issues. The State Education Assessment Center is a permanent, central part of the Council of Chief State School Officers. This Center was established through a resolution by the membership of CCSSO in 1984.

The State Science and Mathematics Indicators were developed through cooperation of the Council with all of the state departments of education, the National Science Foundation, and the U.S. Department of Education. The Indicators were selected and designed to provide valid, comparable state-by-state and national data on the condition of science and mathematics education in elementary and secondary schools. Data are reported every two years using a consistent set of indicators.

The Council's work on Science and Mathematics Indicators is supported by a grant from the Division of Research, Evaluation, and Dissemination of the National Science Foundation, Education and Human Resources Directorate. The views or conclusions expressed in the report do not necessarily reflect the position of the National Science Foundation.

COUNCIL OF CHIEF STATE SCHOOL OFFICERS

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ACKNOWLEDGEMENTS

This report is the result of successful cooperation of the Council of Chief State School Officers with the state departments of education, the National Science Foundation (NSF), and the U.S. Department of Education. The State Science and Mathematics Indicators were initiated in 1986 as a result of the commitment of the National Science Foundation to improving the quality of information on science and mathematics education in the nation's schools. The Council's proposal to develop state-level indicators of science and mathematics education was made possible by the collective decision of the state superintendents and commissioners in 1984 to develop valid, comparable state-by-state data to assess educational progress.

The Science and Mathematics Indicators have received strong support from each of the state superintendents and commissioners. State data managers, curriculum specialists, and assessment directors have willingly given their time, expertise, and assistance to the project. State education staff have played active roles in the selection of indicators and design of a data reporting system, and some indicators are based on data from state education information systems.

The Council staff and the states have benefitted greatly from the insightful recommendations and suggestions of the Indicators advisors. The scientists, mathematicians, and education researchers who advised us have ensured that the indicators are soundly based on research and that they provide important information for policy and program decisions.

The Council very much appreciates the strong support by the National Science Foundation for development and continuation of the State Science and Mathematics Indicators. We particularly acknowledge the leadership of Luther Williams, the NSF Assistant Director for Education and Human Resources; Kenneth Travers, head of the Division of Research, Evaluation, and Dissemination; and Larry Suter, our program officer, who has provided important guidance over the past two years. Susan Snyder of the NSF staff has offered very useful suggestions since the early stages of the project. Richard Berry (retired) was the NSF program officer when the state science and mathematics indicators were initially proposed and conceptualized.

The National Center for Education Statistics (NCES) of the U.S. Department of Education provided state-by-state data analyses from the Schools and Staffing Survey for this report. Results from the NAEP Trial State Assessment in mathematics are also reported as state indicators. We very much appreciate the support and assistance of NCES.

The Science and Mathematics Indicators were initiated by Ramsay Selden as part of the State Education Assessment Center's program of state education indicators. Iris Weiss of Horizon Research served as a Project consultant and had an important role in the selection of state indicators and the design for data reporting. Westat, Inc. provided expert assistance with the development of the data forms and analyzed data from the National Transcript Studies. Rolf Blank is the director of the Council's Science and Mathematics Indicators and Doreen Gruebel is the project assistant. Paula Delo produced this publication. Winifred Campbell assisted in the production.

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OVERVIEW OF STATE INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION—1993

"The United States has established ambitious goals for student performance in mathematics and science education and the opportunity students have to learn these subjects. To know whether we reach these goals, the nation and the states must have good reports on the current status of mathematics and science education and a well developed system to trace progress over a decade. This report provides essential base line information for the work of the 1990s."
— Gordon Ambach, Executive Director, Council of Chief State School Officers.

"For the remainder of the decade and into the next century, our nation faces both challenge and opportunity in science and mathematics education. A national consensus has emerged that the United States must renew and improve its science and mathematics education enterprise. Our ultimate goal is to create and sustain a national atmosphere that values and encourages scientific thinking and scientific endeavors by all of our citizens. When we succeed, every student will be able to study mathematics and science and become knowledgeable in these vital areas."
— Luther Williams, Assistant Director for Education and Human Resources, National Science Foundation.

Improving student learning in mathematics and science has been declared a high priority for our elementary and secondary schools. The national educational goals of the President and Governors, set in 1989, state that science and mathematics achievement of American high school graduates will be first in the world by the year 2000. The National Education Goals Panel has established standards for measuring progress towards the goals, and the Panel strongly emphasizes that state and national efforts to improve science and mathematics education require a system of reliable indicators for tracking progress (NEGP, 1991; 1992).

The Council of Chief State School Officers is providing leadership in developing a system of state-by-state and national indicators of the condition of science and mathematics education. Since 1985, the Council has been a strong advocate for improving the quality and comparability of assessments and data systems which can produce indicators of the health of our elementary and secondary schools. Through the support of the National Science Foundation, the Council and the states have established a network for developing and reporting science and mathematics indicators. The first product of this cooperative effort was *State Indicators of Science and Mathematics Education—1990* (Blank and Dalkilic, 1991), a report that established baseline data for a system of state and national indicators. The new report presented here includes the first trends analysis ever of state-by-state science-mathematics indicators and presents current data on indicators of student outcomes, curriculum, course enrollments, teacher supply and quality, and school conditions.

The Council's goal for the science and mathematics indicators is to assist national, state, and local managers and policymakers in making informed decisions. Efforts to reform and restructure science and mathematics education need to be based on a sound assessment of current conditions, the rate of improvement, and problems in the system. This report focuses on science and mathematics indicators at state and national levels. The Council also encourages and assists states in reporting the science-mathematics indicators at district and school levels.

SUMMARY OF INDICATORS FOR 1993

Trends in Course Enrollments

• *Mathematics.* From 1990 to 1992, enrollments in higher level mathematics courses (above algebra 1) increased in three-fourths of the states. For example, the percent of students taking algebra 2 enrollments increased an average of 6 percent during the period. Nationally, 55 percent of students take algebra 2 by graduation, which indicates the proportion of graduates completing three high school mathematics courses.

• *Science.* Enrollments in higher level science courses (above first-year biology) increased in 80 percent of states from 1990 to 1992. For example, chemistry enrollments increased an average of four percent, with increases in all but one state. Nationally, 49 percent of students take chemistry by graduation, which indicates the proportion of graduates completing three high school science courses.

• *State policies.* States with higher graduation requirements in mathematics and science (2.5 to 3 credits) had greater overall enrollments in science and mathematics and greater enrollments in chemistry, physics, and algebra 2 in 1992 than states with lower requirements (2 credits or less). The rate of enrollment increase from 1990 to 1992 was slightly greater for states with higher graduation requirements.

Gender and Race/Ethnic Trends in Course Enrollments

• *Gender.* Differences in advanced science and mathematics course taking by gender declined slightly from 1990 to 1992, continuing a 10-year pattern. In 1992, males and females had equivalent course enrollment rates up to the advanced levels of mathematics and science, in 20 reporting states. Females comprise 46 percent of students taking calculus, 52 percent taking chemistry, and 44 percent taking physics. Nationally as of 1982, females comprised 42 percent of students taking calculus, 48 percent taking chemistry, and 33 percent taking physics.

• *Minority trends in science.* Our schools made some progress in increasing the participation of minority students in science and mathematics during the 1980's. From 1982 to 1990, chemistry enrollments increased 24 percent among Hispanic students and 19 percent among African-Americans, based on national sample data. In 1990, 40 percent of students in these groups were taking chemistry by graduation. By comparison, chemistry enrollments increased 18 percent among whites (to 52 percent), and 13 percent among Asian-Americans (to 64 percent).

• *Minority trends in mathematics.* Algebra 2 enrollments increased 18 percent among Hispanic students and 15 percent among African-Americans from 1982 to 1990. In 1990, 39 percent of these minority students were taking algebra 2 by graduation. Algebra 2 enrollments went up 13 percent among whites (to 52 percent), and 3 percent among Asian-Americans (to 59 percent).

Student Achievement Trends

• *Mathematics NAEP by state.* The 1992 National Assessment of Educational Progress (NAEP) in mathematics showed that 18 states had significant improvement in student proficiency at grade 8 since 1990. Average mathematics proficiency declined in no states. Nationally, 61 percent of grade 8 students scored at or above the Basic achievement level, 23 percent were at or above the Proficient level, and 3 percent were at or above the Advanced level.

• *Minority students.* Only two states had significant improvement in African-American students' mathematics proficiency on NAEP, and four states had improved proficiency among Hispanic students.

• *Advanced Placement examinations.* Four percent of grade 12 students took the Advanced Placement (AP) calculus examination in 1992, and 4.4 percent took an AP examination in biology, chemistry, or physics. The percent of 12th grade students taking an AP exam in science or mathematics varied by state from less than 1 percent to over 6 percent. Over 60 percent of students taking AP exams in calculus or biology received a qualified score.

Elementary Class Time

• The average grade 4-6 class spends 4.8 hours per week on mathematics and 3.1 hours on science, according to elementary teachers in the 1991 Schools and Staffing Survey. From 1988 to 1991, the average class time on grade 4-6 science increased by 10 minutes per week, while average math time did not change.

• *State variation.* Class time on grade 4-6 mathematics varied by state from an average of 3.8 hours per week (45 minutes per day) to over 5.5 hours per week. Science class time varied by state from an average of 2.3 hours per week (28 minutes per day) to 4.3 hours per week.

Trends in Supply and Preparation of Teachers

• *Number of teachers.* The nation's public high schools had 117,000 teachers of mathematics in fall 1991 and 94,000 teachers of science in biology, chemistry, physics, or earth science, based on state education data. The number of mathematics teachers increased 7 percent from 1990 to 1992 as compared to a 3 percent increase in mathematics course enrollments. The number of science teachers remained constant, while enrollments increased 3 percent.

• *Major in field.* The percent of mathematics teachers in the nation with a major in mathematics or mathematics education did not change from 1988 to 1991 (remaining at 63 percent), according to data from the NCES Schools and Staffing Survey. The percent of science teachers with a science or science education major increased by 6 percent (to 70 percent). The percent of teachers with a mathematics major varies by state from 25 percent to 87 percent, and the percent of teachers with a science major varies from 41 percent to 85 percent.

• *Students per teacher.* A comparison of the science and mathematics teaching force in the nation (estimated FTEs) with the high school student population indicates: 149 students per mathematics teacher, 217 students per biology teacher, 447 students per chemistry teacher, and 971 students per physics teacher. The students/teacher ratios vary widely by state.

• *New science and math teachers.* Nationally, 5 percent of high school mathematics teachers were new, first-year teachers and 7 percent were new hires in 1991-92. In science, 4 percent of teachers were in their first-year of teaching and 7 percent were new hires. Only five states had more than 6 percent new, first-year teachers. In nine states, over half of new hires were experienced teachers.

• *Grades 7 and 8 teachers.* In fall 1991, there were 63,100 teachers of mathematics and 55,600 teachers of science in grades 7-8, according to state data.

Other Science and Mathematics Indicators

High School Mathematics Enrollments. In October 1991, 87 percent of public high school students were taking a mathematics course, which represented a 3 percent increase from fall 1989. Slightly more than one-third of students were taking higher level courses (above algebra 1), one in five were taking first-year algebra or integrated mathematics, and one fourth of high school students were taking prealgebra or general mathematics courses.

By high school graduation, the Council estimates that 91 percent of students take algebra 1, 61 percent take geometry, 55 percent take algebra 2, 29 percent take trigonometry or precalculus, and 11 percent take calculus. Slightly more than half of graduates take three years of high school mathematics by the time they graduate. Course enrollments vary by state at all levels; for example, enrollments in algebra 2 by graduation vary by state from 31 to 73 percent.

High School Science. In October 1991, a total of 75 percent of public high school students were taking a science course, which represented a 3 percent increase from fall 1989. One-fourth of students were taking higher level science courses (above first-year biology), one-fourth were taking first-year biology, and slightly less than one-fourth were taking an introductory course in earth, physical, or general science or integrated science.

By high school graduation, the Council estimates that 95 percent of students take first-year biology. 49 percent take chemistry, and 21 percent take physics. One-half of U.S. students take three years of high school science by graduation. Course enrollments in science vary by state at all levels; for example, enrollments in chemistry by graduation vary by state from 33 to 67 percent.

Teacher Certification. Among high school teachers in 32 states, 12 percent of mathematics teachers were not state certified in mathematics, and 9 percent of biology teachers, 8 percent of chemistry teachers, 13 percent of physics teachers, and 19 percent of earth science teachers were not state certified in these fields. These percentages include teachers with an emergency or temporary certification or certification in another field. Compared to 1990 state data, the percentage of noncertified mathematics teachers increased by 3 percent and the percent of noncertified science teachers did not change. One-third of states reported more than 5 percent noncertified teachers in math or science, and one-fifth of states have over 10 percent noncertified teachers in math or science.

Among teachers in grades 7 and 8, 10 percent of mathematics teachers and 11 percent of science teachers were not state certified in these fields. State data also show that 24 percent of grade 7-8 mathematics teachers and 19 percent of science teachers were certified in general elementary, middle grades, or secondary teaching.

Equity in the Teaching Force—Gender. State data reported to CCSSO show that the majority of high school science and mathematics teachers are male, but the gender distribution varies by field. In mathematics, 45 percent of teachers are female, while 22 percent of physics teachers and 37 percent of biology teachers are female. The percent of female teachers in mathematics varies by state from 21 to 69 percent, and the percent of females in physics teaching varies from 10 to 49 percent.

Equity in the Teaching Force—Race/Ethnicity. In our elementary and secondary schools, 31 percent of the student population is from a race/ethnic minority group. This statistic can be compared to state data which show 11 percent of high school mathematics teachers and 8 percent of science teachers from a minority group. In virtually all states there is a large disparity between the supply of minority mathematics and science teachers and the population of minority students. The percent of new minority teachers is slightly greater than the current minority representation in the science-mathematics teaching force, and the percent of female teachers is substantially greater.

New Teachers in Large Cities. The Council conducted a small study of science and mathematics indicators for large city schools in five states. The data for new science and math teachers confirmed that schools in large cities have difficulty in attracting and hiring science and mathematics teachers. The percent of new, first-year teachers in large city schools is the same as state averages—5 percent—but city schools have fewer experienced teachers among all newly hired teachers. The initial results indicate that a larger portion of the teachers hired in large city schools are first-year teachers.

Teacher Age. The distribution of teacher ages is a useful indicator of state teacher supply and potential shortage. A total of 19 percent of mathematics teachers and 22 percent of science teachers are over age 50. By comparison, 21 percent of all high school teachers are over age 50. The proportion of mathematics and science teachers over age 50 varies by state from 10 percent to over 30 percent.

Class Size in Mathematics and Science. The average class in high school mathematics varies by state from 16 to 26 students, and the average science class varies by state from 16 to 27 students. In advanced mathematics, five states have over 20 percent of classes with more than 30 students, and 12 states have less than 1 percent with more than 30 students. From 1988 to 1991, the average mathematics class remained at 21 students, while the average science class increased from 22 to 23 students.

Instructional Materials and Resources. In the 1990 NAEP mathematics assessment, teachers reported their views on availability of materials and resources they need to teach grade 8 mathematics. The percent of mathematics teachers reporting they had "some or none" of needed materials and resources varied by state from over 45 percent of teachers to less than 20 percent. A high percentage of teachers in a state reporting a problem with materials and resources was associated with lower average state mathematics proficiency on NAEP.

Use of Calculators. Nineteen percent of grade 8 students reported having unrestricted use of hand calculators in their mathematics classes, on the 1990 NAEP in mathematics. The level of unrestricted use of calculators varied by state from 2 to 38 percent, and the percent of students with unrestricted calculator use was positively associated with average state mathematics proficiency.

Summary

The science and mathematics indicators presented in this report provide state-by-state comparisons and national indicators as of the 1991-92 school year. State trends in key science-mathematics indicators are analyzed from 1990 to 1992, and national trends are analyzed from 1982 to 1992. The indicators are intended for use by policymakers, educators, and researchers. Many of the state-level indicators are reported here for the first time, and the Council encourages others to use indicators and state data for further analyses within states and among states.

DESIGN FOR STATE SCIENCE AND MATHEMATICS INDICATORS

The Council of Chief State School Officers (CCSSO) has worked with the state departments of education since 1986 to develop a system of Science and Mathematics Indicators. The central management and reporting of the indicators at the Council has been supported by the National Science Foundation (NSF). The states have collected and analyzed data and disseminated the science-mathematics indicator results to policymakers and educators. The National Center for Education Statistics (NCES) of the U.S. Department of Education has assisted in the development of the system of science-mathematics indicators through national surveys analyzed and reported at the state level.

Interests in Education Indicators

In 1984, the Council changed a long-standing resistance to state-level comparisons to approve an overall policy backing a system of state-by-state education indicators. The Council recognized the need for reliable, valid indicators of the condition of education and took the lead in efforts to develop high-quality, comparable indicators, such as expansion of the NAEP to state-level reporting. The plan for state indicators approved by the Council has three components: (1) student outcomes, (2) education policies and practices, and (3) state context. The Council received a grant from NSF to develop and report state-level and national indicators of science and mathematics education as a part of the Council's overall indicators plan.

Following the National Science Board's 1983 report outlining the need for better regularly-reported information about the quality of U.S. science and mathematics education, the NSF has led efforts to develop and report educational indicators at the elementary and secondary levels. In addition to the Council's work, a number of studies have been supported by NSF that have identified key science and mathematics education indicators and collected and reported new data on these indicators (Shavelson, McDonnell, Oakes, & Carey, 1987; Murnane & Raizen, 1988; Weiss, 1987; Oakes, 1990 a, b). NSF initiated a chapter on precollege science and mathematics education in the biennial *Science Indicators* (1985-1991) and in 1993 will be releasing a new comprehensive report on education indicators.
The science and mathematics indicators developed by CCSSO meet three kinds of interests in indicators:

- State and national indicators to track progress toward the National Education Goals;

- Periodic, state-comparable data to assess the effects of state education policy reforms;

- Measures of the quality of science and mathematics education that are useful to educators and policy-makers to plan programs and recommend new initiatives.

National Goals.

The first report of the NEGP (1991) outlined indicators for measuring progress towards the six national goals. The Panel recommended measuring progress in student achievement, particularly higher order thinking and problem solving, rates of student participation in advanced mathematics and science courses, methods of instruction, and teacher preparation in their teaching field.

"Reaching a new standard of excellence requires clear educational objectives, strong leadership and firm commitment at all levels. Goals must be set and press toward those goals assessed...The Federal government should finance and maintain a national mechanism for measuring student achievement and participation [in mathematics, science and technology education] in a manner that allows national, state and local evaluation and comparison of educational progress."

— Educating Americans for the 21st Century, National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983.

State Policy Reforms

In the 1980s, states initiated a broad set of policy reforms in responding to *A Nation at Risk* (National Commission on Excellence in Education, 1983) and other national commission reports,[1] which cited many problems in our schools, and particularly the poor performance of American students in science and mathematics as compared to students in other industrialized countries. States increased course credit requirements for graduation (particularly in mathematics and science), raised standards for teacher preparation, mandated teacher tests for certification, set higher levels for teacher pay, developed state curriculum guidelines and frameworks, and established new statewide student assessments [National Governors' Association (NGA), 1986; Blank & Espenshade, 1988; Goertz, 1988; Blank & Dalkilic, 1992]. The Council's system of science and mathematics indicators provide state-by-state data to track

[1]For example, National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, 1983; Task Force on Education for Economic Growth, 1983; Twentieth Century Fund, 1983.

these policy changes over time and to analyze the relationship of state policies to change in student learning, opportunities to learn for all students, and the supply and quality of science and mathematics teachers.

"At a time of major educational reform, the data on science and mathematics indicators are essential in providing comparisons among the states. The information is also vital to good decision making."
— *William Spooner, North Carolina Department of Education, and President, Council of State Science Supervisors, November 1992.*

Education Quality

A third interest in state science-mathematics indicators is to assist state policymakers, administrators, and specialists in planning and evaluating programs and developing new initiatives. For example, all state education agencies administer the federally funded Eisenhower Science-Mathematics Program for teacher professional development, and each state needs data on the characteristics of the teaching force. NSF has cooperative agreements with 21 states in support of Statewide Systemic Initiatives (SSI) for reforming science and mathematics education, and comparable state-level data are needed to describe conditions across the states and to track change among and within states.

There are other ways in which the science and mathematics indicators have had practical applications. State administrators have used course enrollment data to analyze differences in the level of course-taking in their state as compared to states in their region and states with similar demographic characteristics. Policymakers have been able to compare the proportion of science and mathematics teachers with a degree in their teaching field with recommended and proposed standards for teacher preparation. Teacher educators have identified teacher shortages by science specialization and by gender and race in order to target teacher recruitment and professional development programs.

FIGURE 1
PRIORITY STATE INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION
(Approved by CCSSO, November 1987)

PRIORITY SCIENCE-MATHEMATICS INDICATOR	DATA SOURCE
Student Outcomes	
Student Achievement	NAEP
Student Attitudes/Intentions	NAEP
Instructional Time/Participation	
Grades 7-12 Course Enrollment	State Data (CCSSO)
Elementary Minutes Per Week	Schools/Staffing Survey (SASS) (NCES)
Curriculum Content	
Students' "Opportunity-to-Learn"	Data Not Available
School Conditions	
Class Size by Subject/Course	SASS (NCES)
No. of Course Preparations Per Teacher Course Offerings Per School	State Data
Resources and Materials	
Teacher Quality	
Courses/Credits in Science/Mathematics	SASS (NCES)
Teaching Assignments by Field/Subject By Age, Gender, Race/Ethnicity	State Data (CCSSO)
Teaching Assignments by Certification Field/Subject (Number of Teachers Out-of-Field)	State Data (CCSSO)
Equity	
Gender and Race/Ethnicity By Student or Teacher	All Sources

Policy Issues and Indicators

Considering these interests in indicators, the system of state and national science-mathematics indicators being reported by the Council are aimed at key policy questions, such as:

1. Is student achievement in science and mathematics improving? Are more students learning challenging subject matter in science and mathematics?

2. How much instruction do students receive in science and mathematics in elementary and secondary school? Do students have equal opportunities for advanced high school study?

3. Do we have a sufficient supply of well-qualified teachers in science and mathematics?

4. How do opportunities and conditions for science and mathematics vary among the states?

In 1991, the Council published the first report providing state-by-state indicators of science and mathematics education for the 1989-90 school year (Blank & Dalkilic, 1991). The present report on indicators for the 1991-92 school year is the second in a biennial series that will be reporting and analyzing trends in the condition of science and mathematics education. The indicators have been used in other national and state reports, such as the NEGP annual reports (1991, 1992), the NSF biennial indicators on science and mathematics education (National Science Board, 1991), the annual report on education indicators of the Council (CCSSO, 1987-93), and in publications of the National Science Teachers Association (1992) and the American Association of School Administrators (Blank, 1991a). Other reports and papers from the Council have analyzed the state indicators, including *Has Science and Mathematics Education Improved Since A Nation at Risk?* (Blank & Engler, 1992), *State Policies on Science and Mathematics Education* (Blank & Dalkilic, 1992), and "Developing a System of Education Indicators" (Blank, 1993).

Selection and Development of Science and Mathematics Indicators

The science and mathematics indicators being reported were selected through a process of research and consensus development. The Council's efforts with developing a system of education indicators are based on three basic premises:

- Indicators should reflect the needs of users of education data, such as policymakers and educators.
- Indicators should be selected with consideration and input from the providers of data, such as state data managers, districts, and schools.
- Indicators should be derived from a research-based model of the education system, including education inputs, processes, and outcomes; and selected indicators should be measured with valid, reliable data.

Figure 1 displays the "priority state indicators of science and mathematics education" that were approved by the Council in 1987 and that continue to form the basis for CCSSO's indicator development and reporting. The first step in selecting the priority indicators was developing a conceptual framework for the state science and mathematics indicators (Blank, 1986). The framework was based on an inputs-processes-outcomes education model as recommended by Shavelson et al. (1987) and Porter (1991) and as used in the chapter on "Precollege Science and Mathematics Education" in the NSF report on *Science and Engineering Indicators* (National Science Board, 1991). The framework for state science-mathematics indicators was also shaped by the Council's indicators model (1985) which recommended three kinds of indicators at the state level:

(1) educational outcomes,
(2) state policies and practices, and
(3) state context.

The second step in selecting priority state indicators was compiling a list of desired, or ideal, indicators based on review of the research on indicators and recommendations on the needs for science and mathematics education indicators (NGA, 1986; National Science Board, 1983; Oakes, 1986; Shavelson et al., 1987; Murnane & Raizen, 1988). The strategy of outlining desired, ideal indicators and then selecting those it be given highest priority for development work was outlined by Murnane and Raizen in report of the National Research Council (1988). A survey of states and analysis of existing national surveys provided the basis for determining data availability on desired indicators and the potential for new data collection for the indicators (CCSSO, 1988a). Based on the conceptual framework, six categories of ideal indicators were specified: student outcomes, instructional time/participation, curriculum content, teacher quality, school conditions, and equity. (Blank & Selden, 1987)

Third, the Council convened a task force of state science and mathematics specialists (data users) and data managers (providers), education researchers, and federal education staff to weigh the desired indicators against the quality and feasibility of data. Based on the group's discussion and analysis, a consensus was produced for the priority list of indicators. The task force recommended 12 priority science-mathematics indicators across six areas *(see Figure 1)*. The group decided that each area should have at least one priority indicator, but the total number of priority indicators should be limited to reduce the length of reports and to focus resources on a small number of critical indicators that can realistically be developed.[2]

As the development and reporting of state indicators has proceeded, new research on indicators (Oakes, 1989; Porter, 1991; National Study Panel on Education Indicators, 1991; Clune, White, Sun, & Patterson, 1991; Koretz, 1992; Stecher, 1992) and reports on science and mathematics education and indicators [American Association for the Advancement of Science (AAAS), 1989; National Council of Teachers of Mathematics (NCTM), 1989; National Science Board, 1991; NEGP, 1992] have been reviewed to ensure that the Council's indicators are consistent with current knowledge and forward looking in science and mathematics education. The Council's priority indicators and data sources for the indicators were reviewed by an advisory panel in July 1991 (Blank, 1991b), following publication of the 1990 report; and small modifications and additions were made for the 1991-92 indicators, such as requesting state data on new teachers in science and mathematics and reporting on variation in indicators within states.

Data Sources

Three sources of data are used to report the science-mathematics indicators for 1993. The NAEP mathematics assessment is the source for student achievement in mathematics by state (Mullis, et al., 1993). The 1991 Schools and Staffing Survey is the source for state-representative data on teacher preparation and school conditions for science and mathematics (NCES, 1993). Finally, the Council collected data from state departments of education on indicators of course enrollment, teacher assignments, and teacher certification, and new teachers.

CCSSO requested that all states collect data on the science and mathematics indicators as of October 1, 1991. Then, states were asked to report state aggregate numbers on the indicators to CCSSO using a common reporting form and common categories and

[2] Indicators of "state context," including inputs to education such as student characteristics, financial resources, and parental background were not included in the priority science-math indicators for development. However, these indicators are part of the Council's general annual report on State Education Indicators, and these data are used as contextual information where appropriate.

definitions (CCSSO, 1991). The data were reported on students and teachers in public schools only. Each state's data codes were cross-walked with the Council's data reporting categories. In 1991-92, a total of 47 state education departments reported data on one or more of the requested indicators. In succeeding biennial cycles of data reporting, CCSSO will be working to have complete 50 state participation.

The state and national indicators of science and mathematics education are organized and reported according to the framework developed by the Council in cooperation with the states, project advisers, and NSF. The indicators are reported in five categories: **Student Outcomes, Instructional Time and Participation, Curriculum Content, Teacher Quality, School Conditions.** Also, indicators of educational equity are incorporated in the five categories. For each indicator, new data are reported for the 1991-92 school year, and indicator trends over time are analyzed.

INDICATORS OF STUDENT OUTCOMES

Policy Issues:

•Has student achievement in science and mathematics improved over time and how does achievement compare state to state?

•Are students learning challenging content in science and mathematics?

•Are schools improving the performance of all students?

The 1990 NAEP mathematics assessment provided the first comparable state-by-state indicator of student achievement. The NCES reported the results of the NAEP Trial State Assessment for eighth grade mathematics in June 1991. In January 1993, the national averages from the 1992 NAEP mathematics assessment were reported, and the state-by-state results were released in April 1993. Results from these two NAEP mathematics assessments provide indicators of student outcomes in mathematics. Another source of state-by-state student outcomes is the number of students taking advanced placement examinations in mathematics and science and the percentage receiving a qualified score on the exams.

Mathematics Proficiency on NAEP

Table 1 provides summary statistics for state-by-state and national results from the 1992 NAEP mathematics assessment in grade 8. The state NAEP results for mathematics showed that 18 states had significant improvements in NAEP mathematics proficiency from 1990 to 1992, and the average proficiency declined in no states. Nationally, 63 percent of grade 8 students scored at or above the Basic achievement level, 25 percent were at or above the Proficient level, and 4 percent were at or above the Advanced level. Thirty-seven percent of students scored below the Basic achievement level.

From 1990 to 1992, the average NAEP mathematics proficiency improved significantly at grades 4, 8, and 12. In the 1992 NAEP mathematics assessment, the average proficiency of grade 8 students was 268 on a scale of 0 to 500, as compared to the 1990 average of 263. The 1992 average grade 4 proficiency was 218, as compared to 213 in 1990. The 1992 grade 12 average was 299 as compared to 294 in 1990. The 1992 grade 8 proficiency varied by state from 283 to 222, and the grade 4 proficiency varied by state from 231 to 191.

The Council makes two recommendations in using NAEP results as a state-by-state indicator. First, comparing state ranks per se on NAEP should be avoided. State averages cluster together, and many of the differences are not meaningful. As a result, the state rank by itself provides little information about what mathematics 8th grade students know and can do. For example, in the 1990 NAEP mathematics assessment Pennsylvania had an average mathematics proficiency of 266 (on a scale from 0 to 500) and there was no statistically significant difference between the Pennsylvania score and the score of 16 other states. The average proficiency score also needs to be interpreted with other information that gives it meaning, such as the achievement levels, which define the mathematics knowledge and skills related to a specific NAEP proficiency score. In the 1992 mathematics assessment, Iowa had the highest average state proficiency of 283 at grade 8, but only 37 percent of Iowa's eighth grade students scored at or above the Proficient achievement level of 294, which is the level expected of all students in the 8th grade. Nationally, 25 percent of students were at or above the Proficient level.[1]

Our second recommendation about using the NAEP results as a state indicator is to examine a state's mathematics proficiency in the content areas of mathematics that are assessed at the eighth grade. Five content areas—Numbers and Operations; Measurement; Geometry; Data Analysis, Statistics, and Probability; and Algebra and Functions—were selected for the 1990 NAEP in mathematics by the NAEP Consensus Planning Project headed by the Council (CCSSO, 1988b), and a sixth area of reporting—Estimation—was added for the 1992 NAEP. The selection of content areas was strongly influenced by the NCTM *Curriculum and Evaluation Standards* (1989). By analyzing results for each of these content areas, policymakers and educators can identify strengths and weaknesses in the state's mathematics curriculum and instruction as indicated by students' performance in those areas. Appendix Table A-1 gives the average proficiency at grade 8 for each content area in 1992. In most states, student proficiency in Numbers and Operations was from 4 to 8 points higher than performance in the other areas, but some states had differences of 10 to 15 points between Numbers and Operations and the

[1]The National Assessment Governing Board established achievement levels for interpreting the NAEP mathematics scores at grades 4, 8, and 12. The levels at grade 8 were summarized as follows. Basic—Eighth grade students should exhibit evidence of conceptual and procedural understanding of the five NAEP content areas. This level of performance signifies an understanding of arithmetic operations, including estimation on whole numbers, decimals, fractions, and percents. Proficient—Eighth grade students should apply mathematical concepts and procedures consistently to complex problems in the five content areas. Advanced—Eighth grade students should be able to reach beyond the recognition, identification, and application of mathematical rules in order to generalize and synthesize concepts and principles in the five NAEP areas (Mullis, et al., 1993).

TABLE 1
AVERAGE GRADE 8 MATHEMATICS PROFICIENCY AND ACHIEVEMENT LEVELS ON 1992 NAEP

PUBLIC SCHOOLS	Average Proficiency	% at or Above Basic Level	% at or Above Proficient Level	% at or Above Advanced Level
STATES				
Alabama	251	44 %	12 %	1 %
Arizona	265 >	61 >	19	2
Arkansas	255	50	13	1
California	260	55	20	3
Colorado	272 >	69 >	26 >	2
Connecticut	273 >	69	30 >	4
Delaware	262	57	18	3
Dist. of Columbia	234 >	26 >	6	1
Florida	259	55	18	2
Georgia	259	53	16	1
Hawaii	257 >	51 >	16	2
Idaho	274 >	73	27	3
Indiana	269	66	24	3
Iowa	283 >	81 >	37 >	5
Kentucky	261 >	57 >	17	2
Louisiana	249	42	10	1
Maine	278	77	31	4
Maryland	264	59	24	4
Massachusetts	272	68	28	3
Michigan	267	63	23	3
Minnesota	282 >	79 >	37 >	6 >
Mississippi	246	38	8	0
Missouri	270	68	24	3
Nebraska	277	75	32	4
New Hampshire	278 >	77 >	30 >	3
New Jersey	271	67	28	4
New Mexico	259 >	54	14	1
New York	266	62	24	4
North Carolina	258 >	53 >	15 >	1
North Dakota	283	82	36	4
Ohio	267	64	22	2
Oklahoma	267 >	65	21	2
Pennsylvania	271	67	26	3
Rhode Island	265 >	62 >	20	2
South Carolina	260	53	18	2
Tennessee	258	53	15	1
Texas	264 >	58 >	21 >	4
Utah	274	72	27	3
Virginia	267	62	23	3
West Virginia	258	53	13	1
Wisconsin	277	76	32	4
Wyoming	274 >	73	26	2
TERRITORIES				
Guam	234 >	30	7	1
Virgin Islands	222 >	13	1	0
NATION	**268 >**	**63 >**	**25 >**	**4**
Northeast	267	59	25	5
Southeast	258	53	16	1
Central	273	70	28	3
West	267	62	24	4

Note > = Significantly higher than 1990 NAEP mathematics proficiency at about the 95% confidence level
Source Mullis et al., NAEP 1992 Mathematics Report Card for the Nation and the States. *U S Department of Education 1993 (see for standard errors of estimates)*
Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1993

areas of Measurement, Geometry, and Algebra and Functions. Nine states had significant improvement in Numbers and Operations from 1990 to 1992, and 14 states improved significantly in the area of Measurement. Ten states had significant improvement in the area of Algebra and Functions, but only four states improved student proficiency in Geometry.

With further analysis, states can analyze performance differences for specific groups of schools and students within a state, such as rural vs. urban, boys vs. girls, and students in low ability groupings vs. students not ability grouped.

One of the Council's priority indicators on science and mathematics education includes assessing the degree of equity that has been achieved in educational opportunity, conditions, and outcomes. Equity can be analyzed by disaggregating state averages according to differences in students' race/ethnicity and gender. Toward this goal, Table 2 shows the NAEP 1992 mathematics results by state and race/ethnic groups. The table shows the percentage of students above the Basic achievement level for the three largest race/ethnic groups in each state, and the difference between the percentage for white students and the percentage of the largest minority group in each state. Each state can be compared with the national difference of 47 percent, that is, 73 percent of white students at or above basic vs. 26 percent of black students. Over time, the percentage differences for each can be used as a comparative measure of states' effectiveness in increasing equity in mathematics achievement. The data show that all states, except Hawaii, have a significant disparity between the average mathematics proficiency and the proficiency of the largest minority group. Between 1990 and 1992, only 12 states made any progress in decreasing the difference score, and the national average on difference between whites and black proficiency increased by seven percent. The only states to close the gap more than two percent were Colorado, Minnesota, North Dakota, West Virginia, and Wisconsin.

From 1990 to 1992, there was no national increase in proficiency for any minority groups. Average mathematics proficiency at grade 8 improved significantly among black students in two states and among Hispanic students in four states. This lack of change indicates slowing of the substantial improvements in NAEP proficiency during the 1980s. For example, from 1982 to 1990, average mathematics proficiency of black students increased 17 points at age 17 (grade 12) and 9 points at age 13 (grade 8) (NCES, 1991).

No gender differences were found in average mathematics proficiency at the fourth and eighth grade levels (Mullis, et al., 1993). The 1992 national NAEP results in mathematics show slightly more males than females scoring at the Advanced level at grade 12, and the average proficiency for males is higher than females at the 12th grade.

The 1990 NAEP Science Assessment showed a similar pattern in gender differences at the national level (state data not available). At grade 4 there was no significant difference in boys' and girls' science scores. At grade 8, 21 percent of boys scored above the 300 level (similar to Proficient) as compared to 15 percent of girls, with no differences at the lower levels. At grade 12, twice as many boys (13 vs. 6 percent) scored above the advanced 350 level, while 49 percent of boys and 40 percent of girls scored above 300 (Jones, Mullis, Raizen, Weiss, & Weston, 1992). The recent NAEP results for mathematics and science show that gender differences in student achievement appear at the advanced levels of performance as students leave eighth grade and proceed through high school.

Advanced Placement Results

A second indicator of student outcomes for states and the nation is the proportion of students taking advanced placement examinations and the proportion who receive a passing (qualified) score (College Board, 1992). The Council is reporting AP examination state results for the first time and will report trends in future reports. Table 3 provides state-by-state data on the numbers of students taking AP exams in calculus and biology, and the percentage of exam-takers who receive a qualified score. (The numbers of students taking AP exams in chemistry, physics, and computer science are reported in Appendix Table A-2). The data show a national total of over 89,000 students took the calculus AP exam in 1992, or about 4 percent of 12th grade students.[4] The percentage of students varied by state from under .5 percent to 8 percent (New York, District of Columbia). In the nation, 68 percent of students received a qualified score (3,4, or 5) for calculus AP. The state percentages for qualified scores varied from 37 percent (Indiana) to 80 percent (Utah). A total of 4.4 percent of 12th grade students took an AP examination in biology, chemistry, or physics. In biology, over 40,000 students took the AP exam, or about 2 percent of 12th grade students. State percentages of students taking the biology AP exam varied from under 0.5 percent (several states) to 5 percent (Utah). The state percent receiving a qualified score varied from 27 percent (Indiana) to 77 percent (New Hampshire).

The calculus and biology numbers are disaggregated by student gender and race/ethnicity to assist policymakers in examining progress in advanced science and mathematics of students for all students. Nationally, 26 percent of students taking the calculus

[4]Total includes public and private schools. Nationally, 80 percent of all AP exams were taken by public school students.

TABLE 2
COMPARISON OF MATHEMATICS PROFICIENCY BY RACE/ETHNIC GROUP PERCENTAGE OF 8TH GRADE STUDENTS AT OR ABOVE BASIC ACHIEVEMENT LEVEL ON 1992 NAEP

	% White at or Above Basic Level	% Black at or Above Basic Level		% Hispanic at or Above Basic Level		% Difference Score: White Minus Largest Minority
Alabama	59 %	19 %	(32)	15 %	(4)	40 %
Arizona	74	42	(4)	40	(28)	34
Arkansas	61	18	(22)	23	(4)	43
California	73	26	(7)	34	(36)	39
Colorado	77	33	(4)	48	(18)	29
Connecticut	81	32	(12)	32	(12)	49
Delaware	69	31	(25)	33	(6)	38
Dist of Columbia	—	26	(85)	22	(10)	—
Florida	70	27	(23)	40	(18)	43
Georgia	69	29	(35)	27	(4)	40
Hawaii	62	53	(66) *	34	(11)	11
Idaho	76	51	(3) *	46	(8)	30
Indiana	70	34	(8)	46	(4)	36
Iowa	83	—	(2)	53	(4)	30
Kentucky	61	30	(9)	26	(3)	31
Louisiana	59	22	(39)	21	(5)	37
Maine	79	60	(3) *	—	(2)	19
Maryland	74	30	(29)	33	(6)	44
Massachusetts	74	35	(5)	30	(8)	44
Michigan	75	22	(18)	44	(5)	53
Minnesota	81	—	(2)	48	(3)	33
Mississippi	59	19	(44)	12	(6)	40
Missouri	75	30	(12)	38	(3)	45
Nebraska	81	25	(5)	47	(6)	34
New Hampshire	78	—	(1)	56	(3)	22
New Jersey	82	32	(17)	41	(14)	50
New Mexico	72	41	(4) *	40	(49)	32
New York	78	25	(17)	38	(14)	53
North Carolina	63	29	(27)	28	(3)	34
North Dakota	84	57	(3) *	—	(3)	27
Ohio	72	24	(14)	38	(4)	48
Oklahoma	72	28	(8)	46	(6)	44
Pennsylvania	73	28	(11)	38	(3)	45
Rhode Island	69	32	(6)	22	(8)	47
South Carolina	70	30	(35)	21	(6)	40
Tennessee	62	21	(21)	23	(3)	41
Texas	76	33	(12)	40	(36)	36
Utah	75	—	(—)	47	(7)	28
Virginia	71	35	(22)	50	(5)	36
West Virginia	55	31	(4)	19	(3)	24
Wisconsin	81	38	(7)	43	(4)	43
Wyoming	77	39	(4) *	53	(9)	24
NATION	**73 %**	**26 %**	**(16)**	**37 %**	**(10)**	**47 %**

Note Alabama Black 19% (32) Figure in parenthesis (32) is percent of all students in minority group
**Hawaii - Asian/Pacific Islander Idaho. Maine. New Mexico. North Dakota. Wyoming - American Indian*
— Respondents too few for a reliable state estimate
Source Mullis et al NAEP 1992 Mathematics Report Card for the Nation and the States. *U S Department of Education. 1993 (see for standard errors of estimates)*
Council of Chief State School Officers. State Education Assessment Center. Washington DC. 1993

TABLE 3-A
STUDENTS TAKING ADVANCED PLACEMENT EXAMINATION IN CALCULUS BY GENDER AND RACE/ETHNICITY (1992)

	AP Calculus				
STATE	Total Taking Exam	% of Grade 12	% Qualified Score	% Minority Students Taking	% Female Students Taking
Alabama	924	2%	55%	19%	48%
Alaska	208	3	58	16	48
Arizona	1,066	3	68	22	44
Arkansas	282	1	59	15	42
California	14,034	5	71	53	43
Colorado	1,282	4	70	22	41
Connecticut	1,535	5	72	16	39
Delaware	378	6	78	18	44
Dist of Columbia	267	8	67	29	44
Florida	4,898	5	64	29	43
Georgia	1,952	3	70	20	42
Hawaii	585	6	81	76	49
Idaho	245	2	76	5	37
Illinois	4,798	5	73	27	44
Indiana	2,434	4	37	11	42
Iowa	355	1	81	7	37
Kansas	307	1	77	15	34
Kentucky	858	2	49	6	47
Louisiana	466	1	68	24	45
Maine	372	3	53	5	45
Maryland	2,413	6	70	25	44
Massachusetts	3,216	6	73	18	41
Michigan	2,945	3	71	16	40
Minnesota	891	2	76	9	40
Mississippi	318	1	63	13	48
Missouri	679	1	76	16	41
Montana	56	1	45	7	45
Nebraska	199	1	70	7	44
Nevada	257	2	66	24	38
New Hampshire	568	5	75	14	42
New Jersey	4,230	6	72	27	41
New Mexico	556	3	60	25	42
New York	10,908	8	66	27	46
North Carolina	2,315	4	66	14	46
North Dakota	66	1	79	9	32
Ohio	3,076	3	70	15	40
Oklahoma	542	2	68	18	44
Oregon	596	2	73	13	39
Pennsylvania	3,610	3	67	15	42
Rhode Island	302	4	70	18	43
South Carolina	2,183	6	59	19	51
South Dakota	36	0	61	3	42
Tennessee	1,299	3	70	18	42
Texas	3,472	2	74	31	42
Utah	1,787	6	80	6	39
Vermont	230	4	55	7	42
Virginia	3,399	6	67	20	47
Washington	1,267	2	70	20	38
West Virginia	368	2	47	11	41
Wisconsin	1,140	2	74	7	37
Wyoming	144	2	69	4	35
NATION	**89,559**	**4%**	**68%**	**26%**	**43%**

Note State totals include public and private schools Minority students - sum of black, Hispanic, Asian/Pacific Islander, American Indian.

Source: The College Board, Advanced Placement Program, National and 50 States Summary Reports, *New York 1992*
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

AP exam were minority students, and 43 percent were female. States with more than 30 percent minority participation were California, Colorado, and Texas. In biology, 25 percent of students taking the AP exam were minority students, and 52 percent were female. States with over 30 percent minority participation were California, Maryland, District of Columbia, Illinois, and Texas. Appendix Table A-2 provides the rates for calculus and biology disaggregated by five race/ethnic groups, and the number of students taking AP exams in chemistry, physics, and computer science. Minority participation is highest among Asian students (18 percent calculus, 17 percent biology). Four percent of black and Hispanic students took AP exams in calculus and biology.

INDICATORS OF CURRICULUM CONTENT

Policy Issues:

- How does the content students are taught in mathematics and science vary by state and by school and classroom?
- What proportion of students at a given grade level are taught with challenging curriculum content?

The publication of national curriculum standards in mathematics (NCTM, 1989) and the current effort to develop national science standards by the National Academy of Sciences/National Research Council are leading examples of a major focus of current on reform on the content of curriculum. States are developing and revising their curriculum frameworks to more clearly define the content knowledge and student skills that schools should aim for in their curricula (Blank & Dalkilic, 1992). With the movement toward a common set of curriculum standards, there is increased recognition of the need for data to assess the nature of instruction that students receive in the classroom.

Opportunity to Learn

A promising approach to measuring the implemented curriculum is with a teacher survey of students "opportunity to learn." International studies of mathematics and science have made effective use of "opportunity to learn" surveys to determine the differences in curriculum content and material as important explanations of variation in student achievement scores (McKnight, et al., 1987; Schmidt, 1992). Survey questions on opportunity to learn are generally completed by classroom teachers based on what has been taught in a specific grade and subject or course. A few states have developed teacher surveys of opportunity to learn in conjunction with their state assessment programs. State-by-state data are not currently available at the level of detail on curriculum content and instructional methods that are collected in the international studies.

The Council is currently working with U.S. experts designing the Third International Mathematics and Science Study (TIMSS) to determine if the instruments for collecting data on opportunity to learn at grades 4, 8, and 12 can be adapted to regular, periodic surveys to produce state-level indicators (CCSSO,1992). The TIMSS design will collect data on curriculum coverage by topic, time spent on the topic, teaching approach, and expected student knowledge or skill.

Teacher Emphasis on Areas of Mathematics

NAEP teacher questionnaires include items on the broad curriculum areas that teachers emphasize in teaching a subject. These data do *not* provide adequate indicators of curriculum content or opportunity to learn. However, the data do offer some idea of

TABLE 3-8
STUDENTS TAKING ADVANCED PLACEMENT EXAMINATION IN BIOLOGY BY GENDER AND RACE/ETHNICITY (1992)

	AP Biology				
STATE	Total Taking Exam	% of Grade 12	% Qualified Score	% Minority Students Taking	% Female Students Taking
Alabama	416	1%	51%	18%	56%
Alaska	54	1	44	7	57
Arizona	244	1	54	19	52
Arkansas	118	0	75	14	49
California	6,574	3	69	47	48
Colorado	627	2	63	15	55
Connecticut	716	3	71	15	52
Delaware	143	2	79	12	42
Dist. of Columbia	233	7	56	37	48
Florida	2,368	2	49	29	52
Georgia	794	1	65	26	55
Hawaii	228	2	74	71	58
Idaho	143	1	69	5	49
Illinois	1,862	2	68	29	56
Indiana	1,004	2	27	11	57
Iowa	149	0	69	7	40
Kansas	41	0	93	5	39
Kentucky	501	1	46	2	54
Louisiana	167	0	66	29	51
Maine	115	1	70	3	62
Maryland	1,034	3	65	33	60
Massachusetts	1,390	3	71	15	53
Michigan	1,171	1	66	18	53
Minnesota	243	0	70	8	45
Mississippi	164	1	47	11	51
Missouri	351	1	67	17	51
Montana	69	1	74	3	45
Nebraska	94	1	64	7	41
Nevada	93	1	41	16	47
New Hampshire	164	2	77	10	62
New Jersey	1,992	3	68	26	53
New Mexico	168	1	47	26	52
New York	6,206	4	70	23	53
North Carolina	1,073	2	57	13	58
North Dakota	28	0	64	0	39
Ohio	968	1	70	20	51
Oklahoma	139	0	60	20	53
Oregon	287	1	72	13	44
Pennsylvania	1,350	1	58	11	53
Rhode Island	223	3	70	8	43
South Carolina	978	3	61	16	57
South Dakota	25	0	64	12	56
Tennessee	648	1	67	21	53
Texas	1,360	1	66	33	52
Utah	1,331	5	70	7	44
Vermont	147	3	70	5	54
Virginia	1,381	2	64	21	57
Washington	340	1	65	15	49
West Virginia	210	1	41	9	62
Wisconsin	316	1	61	7	44
Wyoming	18	0	61	6	44
NATION	**40,458**	**2%**	**64%**	**25%**	**52%**

Note State totals include public and private schools Minority students = sum of black, Hispanic, Asian/Pacific Islander, American Indian
Source The College Board, Advanced Placement Program, *National and 50 States Summary Reports*, New York, 1992
Council of Chief State School Officers, State Education Assessment Center, Washington, DC 1993

the variation across states in differences in approach to the curriculum at a given grade level. In the 1990 NAEP mathematics assessment, teachers were asked to indicate the degree to which they gave heavy, moderate, or little or no emphasis in their mathematics instruction to: Numbers and Operations, Measurement, Data Analysis and Statistics, Geometry, and Algebra and Functions. The initial report of the results showed that at the national level [illegible] a strong association between the topics teach- [illegible] asize and student proficiency in those areas ([illegible] ams et al., 1991). Students tend to do better in one of those five areas when teachers emphasize it, whether it is Numbers and Operations or Algebra and Functions. In other words, students achieve more in the areas where more teaching effort is placed.

The NAEP data were analyzed by state to determine if there are patterns among the states in teacher emphasis on areas of the mathematics curriculum and to determine if these differences by state are related to differences in student mathematics proficiency.

First, several of the curriculum areas were found to be interrelated. The state-level analysis showed a strong correlation ($r = .93$) between the percentage of students receiving heavy emphases in Numbers/Operations and in Measurement. There is also a high correlation ($r = .81$) between the percentage of students receiving heavy emphases in Geometry and in Algebra/Functions. States providing large percentages of their students with heavy emphases in *both* Numbers/Operations and Measurement may be offering rather traditional programs of study, while those giving heavy emphasis to the Geometry and Algebra/Functions areas at the eighth grade level may be moving toward a richer, more ambitious program of study, similar to that called for by the NCTM *Standards*.

Results of the state-by-state analysis of the 1990 NAEP data showed that the relative emphasis that teachers in a state give to different areas of the eighth grade mathematics curriculum is strongly related to the level and type of mathematics proficiency of students in the state. The percentage of students receiving heavy teacher emphasis in Numbers/Operations and Measurement varied from 22 percent (Colorado) to 45 percent (Georgia and Texas). Teachers in eight states gave the largest proportions of students heavy emphasis in Numbers/Operations and Measurement: Georgia, Texas, Virgin Islands, Alabama, Guam, Arkansas, Kentucky, and Florida, in decreasing order. The eight states where teachers gave the lowest proportion of their students a heavy emphasis in these areas were: Colorado, Oregon, Wisconsin, Minnesota, Wyoming, Montana, New Hampshire, and Nebraska.

Appendix Table A-3 in Appendix A shows the proportion of students in a state receiving heavy emphasis in Numbers/Operations and Measurement by average mathematics proficiency score (see Table A-5 for state percentages by area). The state percentages for emphasis on Numbers/Operations and Measurement are expressed by quintile averages. States with higher proficiency tend to have fewer students receiving heavy emphasis on Numbers/-Operations and Measurement. The states in the top quintile of mathematics proficiency had an average of 27 percent of students receiving heavy emphasis on Numbers/Operations and Measurement, while the states in the bottom quintile of mathematics proficiency had an average of 37 percent of students receiving emphasis in these areas.[1]

The percentage of students receiving heavy teacher emphasis in Geometry and Algebra/Functions varied from 23 percent (Hawaii) to 46 percent (New Jersey). Teachers in eight states gave the most emphasis on Geometry and Algebra/Functions: New Jersey, Texas, New York, Montana, Illinois, North Dakota, New Mexico, and Georgia. (Some states' data show high emphasis in both "types" of curriculum.) Appendix Table A-4 in Appendix A shows the proportion of students receiving heavy emphasis on Geometry and Algebra/Functions by average mathematics proficiency score. States with higher proficiency tend to have more students receiving heavy emphasis on Geometry and Algebra/Functions. The states in the top quintile of mathematics proficiency had an average of 37 percent of students receiving curriculum emphasis on Geometry and Algebra/Functions, whereas the states in the bottom quintile of mathematics proficiency had an average of 31 percent of students receiving emphasis in these areas.

[1] The statistical analysis of NAEP results by state showed that the socioeconomic status (SES) background of students is strongly related to average math proficiency and to curriculum emphasis of teachers, and the average SES of students in a state can account for most of the variance in math proficiency. The analysis in this section attempts to show differences in curriculum emphasis of teachers by state, with the understanding that at least part of the state differences are due to the influence and expectations of parents and the resources available in the school community (represented by a measure of SES).

INDICATORS OF INSTRUCTIONAL TIME AND PARTICIPATION

The amount of instruction students receive in science and mathematics has consistently been demonstrated to be a strong predictor of student learning (Husen, 1967; Walberg, 1984; Rock, Braun, & Rosenbaum, 1985; Jones, Davenport, Bryson, Bekhuis, & Zwick, 1986; Sebring, 1987; Dossey, Mullis, Lindquist, & Chambers, 1988; Jones, Mullis, Raizen,Weiss, & Weston, 1992). Research has also shown that instructional time, course enrollments, and the science and mathematics curriculum students are taught vary widely according to differences in school and classroom demographics (Goodlad, 1984; Weiss, 1987; McKnight et al., 1987; Oakes, 1989; Mullis, et al., 1991; Horn & Hafner, 1992). Thus, indicators of instructional time and student enrollments in courses are important for tracking the performance of our schools.

In *A Nation at Risk*, the National Commission on Excellence in Education (1983) highlighted the poor performance of American students on international science and mathematics assessments and drew a relationship to the relatively low amount of science and mathematics received by many students in our schools. The Commission recommended that three high school mathematics courses and three science courses be required of all students for graduation. The Commission also stated that science should be a "new basic" in elementary education.

Many state reforms were aimed at setting higher standards for mathematics and science instruction in schools. From 1980 to 1989, 44 states increased mathematics course requirements, and 43 states increased science requirements. Additionally, 12 states established advanced or honors diplomas that require additional, higher level courses in science and mathematics (Blank & Dalkilic, 1992). (See Appendix Table A-9 for current state requirements.)

Since the initial wave of higher state graduation requirements, many states have also developed or revised state curriculum frameworks or guides in science and mathematics. The state frameworks are typically aimed at raising standards for content and instruction at elementary and secondary levels. Currently, 41 states have a mathematics curriculum framework, 30 states have a science framework. Four states are developing mathematics frameworks and 15 states are developing science frameworks (Blank & Dalkilic, 1992).

ELEMENTARY CLASS TIME ON SCIENCE AND MATHEMATICS

Policy Issues

- **Does the average elementary student have adequate opportunity to learn science and mathematics, including time for instruction, demanding curriculum content, appropriate teaching methods, and adequate materials and equipment?**

- **How do states differ in class time for mathematics and science (understanding that time is only an initial, basic indicator)?**

The amount of class time spent on science and mathematics in elementary schools was selected as a priority state indicator. Many states have an interest in this indicator because of the state role in defining curriculum frameworks and goals. Reported time spent in instruction provides only basic information about elementary science and mathematics. Educators, policymakers, and researchers would like state-level information on curriculum content and teaching practices. However, at this time, differences in time spent on science and mathematics may be useful as an initial indicator at the elementary level.

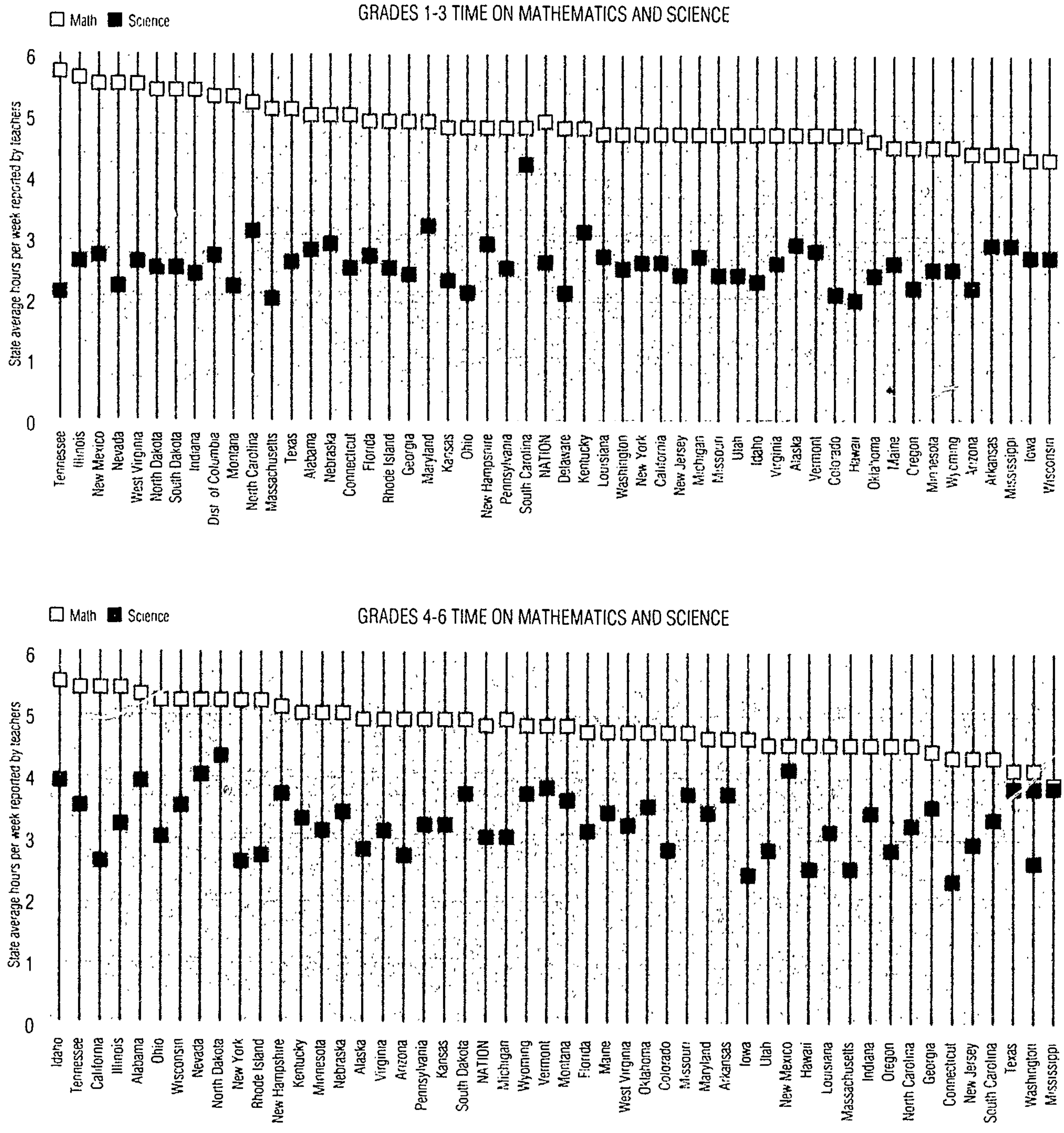
State-by-state data on elementary class time are available from the 1991 Schools and Staffing Survey (SASS), and the results are in Figure 2. The Survey was conducted with a national- and state-representative sample of teachers. Elementary teachers were asked how much time they spent in the previous full week on four core academic subjects.

The SASS results show the average grade 1-3 class spends 4.9 hours per week on mathematics and 2.6 hours on science. Comparing 1988 SASS data to 1991, the average time on science increased by 20 minutes per week, while average math time did not change. Mathematics class time in grade 1-3 varied by state from an average of 4.4 hours per week (53 minutes per day) to 5.6 hours per week. Science class time varied by state from an average of 2 hours per week (24 minutes per day) to 4 hours per week.

The average grade 4-6 class spends 4.8 hours per week on mathematics and 3.1 hours on science, according to elementary teachers. From 1988 to 1991, the average time on grade 4-6 science increased by 10 minutes per week, while average math time per week did not change. Class time on grade 4-6 mathematics varied by state from 3.8 hours per week (45 minutes per day) to 5.5 hours per week. Science class time varied by state from 2.3 hours per week (28 minutes per day) to 4.3 hours per week. (See Appendix Table A-6 for data on individual states.)

As part of the analysis of SASS time, we compared the average time for mathematics and science in classes with primarily low achieving students (based on teacher reports) with the average time in classes not differentiated by achievement levels. No significant differences in time for mathematics or science were found between the two types of classes at the state or national levels.

FIGURE 2
ELEMENTARY CLASS TIME ON MATHEMATICS AND SCIENCE



Note Class time - State average of teacher-reported hours spent teaching subject "last week" (self-contained elementary classes) Standard errors for national average are 05 math, 05 science State standard errors vary for math from 14 (Alaska) to 61 (Illinois), and for science from 10 (California) to 61 (South Carolina)
Source NCES, Schools and Staffing Survey, Public School Teachers, Spring 1991
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

SCIENCE AND MATHEMATICS COURSE ENROLLMENTS

Policy Issues:

- **What proportion of students take academically demanding courses in mathematics and science?**

- **What are trends in mathematics and science course taking for students reported by gender and race/ethnicity?**

Enrollments in Grades 7 and 8

States reported course enrollment data for science and mathematics in grades 7 and 8. The complete data by state are shown in Appendix Tables A-7 and A-8. These data are useful to educators in two ways. First, the enrollment rates for different mathematics and science courses shows the distribution of courses in the middle grades curriculum. Secondly, the course level of students in mathematics is related to their level of achievement in mathematics and progress in high school mathematics. The NAEP 1990 mathematics assessment found that students taking algebra in grade 8 scored an average of 296, while the average for students in regular eighth grade mathematics was 251 (Mullis, et al., 1991). In analyzing data from the Longitudinal Study of American Youth, Miller (1993) found that student performance in eighth grade mathematics was a strong predictor of student attainment in high school mathematics for students at all socioeconomic status (SES) levels.

PERCENT OF STUDENTS IN GRADES 7-8 TAKING MATHEMATICS AND SCIENCE COURSES (1991-92)

Mathematics	Grade 7	Grade 8
Remedial	5	5
Regular	77	67
Accelerated/Enriched	13	10
Algebra 1	—	13
Science	**Grades 7-8**	
General	28	
Life	25	
Earth	17	
Physical	10	
Integrated	7	

The state data show that 23 percent of grade 8 students were taking algebra or accelerated-/enriched mathematics in 1992. In grade 7, 13 percent were taking an accelerated mathematics course. These results imply that about one fourth of grade 8 students are receiving instruction in algebra and more advanced topics by grade 8. Results from the National Educational Longitudinal Study confirm that curriculum content is differentiated by course level at grade 8 (Horn & Hafner, 1992). The NCTM *Curriculum and Evaluation Standards* (1989) recommend that all students be taught algebra concepts beginning before grade 8, and that other areas of mathematics, including geometry and statistics, as well as algebra should be taught in grade 8.

In science, 17 percent were taking earth science, 25 percent life science, 10 percent physical science, and 28 percent general science. In 1992, the Council began collecting data on "integrated science," such as the science curriculum reforms being developed through the Scope, Sequence, and Coordination (SS&C) projects. In the 36 reporting states, a sum of 7 percent of students were reported taking integrated science. Twelve states reported students enrolled in integrated science.

High School Mathematics

States collected and reported data on all high school mathematics courses as of October 1991. Working with state mathematics supervisors, the Council developed a course taxonomy which categorizes high school mathematics courses under categories of Review Mathematics (e.g., general mathematics); Informal Mathematics (e.g., prealgebra); and Formal High School Mathematics (e.g., algebra, geometry, trigonometry). In each of the three categories, courses are placed in hierarchial levels from 1 to 5. This course taxonomy provides a basis for comparison of mathematics enrollments across states. The taxonomy incorporates both the traditional high school mathematics course sequence (algebra, geometry, algebra 2, etc.) and the movement toward courses with integrated mathematical topics recommended by the NCTM *Standards* (see Appendix D).

Mathematics course enrollments were aggregated to four levels using the taxonomy in order to give an overall snapshot of where students are in each state in the high school curriculum. Table 4 shows the total state percentage of students taking mathematics as of October 1991 and the percentages enrolled at four levels: (1) Review Mathematics (general, applied mathematics); (2) Informal Mathematics (prealgebra); (3) Formal Mathematics Level 1 (algebra 1, integrated mathematics 1); and (4) Formal Mathematics Levels 2-5 (geometry, algebra 2, integrated mathematics 2-3, trigonometry, calculus).

COURSE ENROLLMENTS IN HIGH SCHOOL MATHEMATICS BY LEVEL (Percent of Grade 9-12 Students in October 1991)

Review Mathematics (general, consumer)	16 %
Informal Mathematics (prealgebra)	11
Formal Mathematics 1 (algebra 1, integrated mathematics 1)	22
Formal mathematics 2-5 (geometry, algebra 2, trig., calculus)	36
Total	**87 %**

TABLE 4
COURSE ENROLLMENTS IN HIGH SCHOOL MATHEMATICS BY LEVEL AS A PERCENT OF STUDENTS IN GRADES 9—12
(October 1991)

STATE	Review Math (General, Applied)	Informal Math (Prealgebra)	Formal Math 1 (Algebra 1/ Integrated Math 1)	Formal Math 2—5 (Geom.-Calc.)	Total Math	% Change Formal Math 2—5 1990 to '92
Alabama	21 %	4 %	20 %	31 %	76 %	3 %
Alaska	—	—	—	—	—	—
Arizona	—	—	—	—	—	—
Arkansas	26	8	24	36	94	5
California	17	7	21	29	77	0
Colorado	9	11	18	36	74	—
Connecticut	14	20	17	42	94	4
Delaware	15	13	14	28	70	-5
Dist. of Columbia	5	19	22	32	78	2
Florida	29	13	19	30	91	1
Georgia	—	—	—	—	—	—
Hawaii	37	16	14	22	89	1
Idaho	8	—	16	40	72	2
Illinois	—	—	—	—	—	—
Indiana	14	8	21	36	78	3
Iowa	19	6	25	46	96	3
Kansas	8	16	23	41	90	9
Kentucky	14	14	21	39	88	4
Louisiana	—	—	—	—	—	—
Maine	—	—	21	50	—	—
Maryland	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—
Michigan	—	—	—	—	—	—
Minnesota	10	—	23	45	77	4
Mississippi	16	8	24	38	87	0
Missouri	15	7	24	37	85	1
Montana	8	11	21	44	84	3
Nebraska	17	—	24	39	87	3
Nevada	17	15	18	29	78	3
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	18	13	26	33	91	3
New York	13	12	21	34	84	0
North Carolina	17	11	19	40	88	3
North Dakota	6	5	27	52	91	8
Ohio	19	8	20	38	84	2
Oklahoma	8	11	24	35	81	1
Oregon	11	18	17	32	79	—
Pennsylvania	16	15	24	46	99	0
Puerto Rico	41	—	27	19	87	—
Rhode Island	—	—	—	—	—	—
South Carolina	33	10	18	36	98	2
South Dakota	—	—	—	—	—	—
Tennessee	11	10	22	35	79	7
Texas	9	22	25	38	94	3
Utah	8	15	20	45	88	—
Vermont	11	11	17	37	78	—
Virginia	14	15	16	42	88	2
Washington	—	—	—	—	—	—
West Virginia	29	5	18	34	89	4
Wisconsin	15	—	26	47	98	18
Wyoming	9	3	21	41	76	16
SUM (38 states)	**16 %**	**11 %**	**22 %**	**36 %**	**87 %**	**+ 3 %**

Note Total includes average of 2% "Other Mathematics." Delaware, Kansas, Wisconsin, and Wyoming changed data collection instruments between 1989 and 1991 — Data not available

Source State Departments of Education. Data on Public Schools. Fall 1991. California Fall 1990. NCES. CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center. Washington. DC. 1993

Several observations can be made about the totals for mathematics in 1991-92 and the two-year trends since 1989-90. Total enrollment in mathematics has increased 3 percentage points, with almost 9 of 10 high school students taking a mathematics course in fall 1991. State totals vary from 72 (Idaho) to 98 percent (South Carolina, Wisconsin). Many states and school districts have placed strong emphasis on encouraging more students to take algebra, geometry, and more advanced courses. The overall increase in mathematics over two years is mostly explained by a 2-percent increase in formal mathematics 2-5 (geometry through calculus). To examine state differences, the percentage of change in upper-level mathematics enrollments is shown by state in Table 4.

The percentage of high school students taking algebra 1 or integrated mathematics 1 as of Fall 1991 shows only a 1 percent increased as compared to Fall 1989. However, this percentage does not include approximately 13 percent of grade 8 students taking algebra. It also understates the overall amount of instruction in algebra in high school because many states and districts have integrated algebra and geometry concepts in high school vocational and applied mathematics courses, which are classified by the CCSSO taxonomy under "review mathematics." However, using the course titles data as reported by states, over *one-fourth* of all high school mathematics credits were earned in 1992 in a course prior to algebra 1 in the mathematics curriculum (sum of general and applied mathematics, 16 percent, and prealgebra, 11 percent). The percentage of students in mathematics below algebra 1 did not change from 1990 to 1992.

Table 5 reports the estimated percentage of public high school students that take selected high school mathematics courses by the time they graduate.

PERCENT OF STUDENTS TAKING SELECTED MATHEMATICS COURSES BY GRADUATION (1991-92)

Algebra 1 or Integrated mathematics 1	91 %
Geometry or Integrated mathematics 2	61
Algebra 2 or Integrated mathematics 3	55
Trigonometry/Pre-Calculus	29
Calculus	11

Research on student achievement in science and mathematics shows that successful completion of algebra 1 and geometry, or integrated mathematics, differentiate students who have higher achievement in high school and college (Jones, et al., 1986; Sebring, 1987), and particularly for minority students (Pelavin & Kane, 1990). Enrollment in algebra 2, or integrated mathematics 3, is an indicator of the proportion of students that take a third course in high school mathematics, as recommended by the National Commission on Excellence in Education

TABLE 5
PERCENTAGE OF HIGH SCHOOL STUDENTS TAKING SELECTED MATHEMATICS COURSES BY GRADUATION (1991-92)

STATE	Algebra 1/ Integrated Math 1	Geometry/ Integrated Math 2	Algebra 2/ Integrated Math 3	Trigonometry/ Precalculus	Calculus
Alabama	83 %	56 %	50 %	19 %	7 %
Alaska	—	—	—	—	—
Arizona	—	—	—	—	—
Arkansas	95 +	60	55	27	6
California	89	47	42	21	9
Colorado	80	59	48	32	9
Connecticut	81	63	59	38	14
Delaware	67	37	42	28	11
Dist. of Columbia	95 +	66	41	17	6
Florida	78	53	46	23	7
Georgia	—	—	—	—	—
Hawaii	58	36	31	19	4
Idaho	74	63	66	24	13
Illinois	—	—	—	—	—
Indiana	85	58	53	30	10
Iowa	95 +	76	67	32	12
Kansas	95 +	67	62	32	11
Kentucky	89	67	61	30	7
Louisiana	—	—	—	—	—
Maine	91	88	73	51	—
Maryland	—	—	—	—	—
Massachusetts	—	—	—	—	—
Michigan	—	—	—	—	—
Minnesota	95 +	71	62	34	13
Mississippi	95 +	64	64	29	4
Missouri	95 +	64	63	16	11
Montana	90	78	58	36	6
Nebraska	95 +	67	58	22	14
Nevada	80	51	43	19	5
New Hampshire	—	—	—	—	—
New Jersey	—	—	—	—	—
New Mexico	95 +	56	51	23	8
New York	83	56	45	28	13
North Carolina	88	67	54	40	8
North Dakota	95 +	81	76	49	6
Ohio	86	62	50	35	10
Oklahoma	95 +	53	63	23	6
Oregon	80	51	46	23	10
Pennsylvania	88	60	60	50	19
Puerto Rico	95 +	65	—	9	—
Rhode Island	—	—	—	—	—
South Carolina	76	58	54	35	9
South Dakota	—	—	—	—	—
Tennessee	81	58	57	29	5
Texas	87	65	67	26	7
Utah	95 +	71	66	34	15
Vermont	70	57	53	30	11
Virginia	90	65	58	37	14
Washington	—	—	—	—	—
West Virginia	79	55	49	27	7
Wisconsin	95 +	81	58	34	21
Wyoming	95 +	63	59	28	16
NATION	**91 %**	**61 %**	**55 %**	**29 %**	**11 %**

Note Each state percent is a statistical estimate of course taking of public high school students by the time they graduate based on the total course enrollment in grades 9—12 in fall 1991 divided by the estimated number of students in a grade cohort during 4 years of high school The statistical estimating method is imprecise above 95% Algebra 1 percentages include grade 8 Algebra 1, except Indiana, Texas and Vermont — Data not available Nation = Percent of all public high school students estimated to take each course, including imputation for nonreporting states
Source State Departments of Education. Data on Public Schools. Fall 1991. California. Fall 1990
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

TABLE 6
PERCENTAGE OF STUDENTS IN EACH GRADE TAKING ALGEBRA (October 1991)

Algebra 1/Integrated Math 1

STATE	% of Grade 8	% of Grade 9	% of Grade 10	% of Grade 11	% of Grade 12
Alabama	10	46	17	7	1
California	14	40	26	4	1
Connecticut	17	41	15	6	2
Dist. of Columbia	29	31	30	13	6
Florida	9	26	25	13	7
Idaho	14	33	13	2	3
Kentucky	12	51	15	6	3
New York	11	59	10	1	.1
North Carolina	18	32	26	10	3
North Dakota	20	76	19	7	2
Ohio	13	25	22	21	9
Puerto Rico	—	8	68	16	8
South Carolina	14	41	15	3	.4
Utah	35	27	21	8	3
West Virginia	12	37	19	8	3

Algebra 2/Integrated Math 3

STATE	% of Grade 8	% of Grade 9	% of Grade 10	% of Grade 11	% of Grade 12
Alabama	—	2	12	29	8
California	—	3	8	23	7
Connecticut	—	2	14	31	11
Dist. of Columbia	—	1	10	18	13
Florida	—	1	11	20	14
Idaho	—	11	25	24	4
Kentucky	—	3	14	31	13
New York	—	.2	6	36	2
North Carolina	—	1	13	25	16
North Dakota	—	1	21	44	10
South Carolina	—	2	15	32	5
Utah	—	6	18	21	9
West Virginia	—	2	17	21	10

Source State Departments of Education, Data on Public Schools, Fall 1991 California Fall 1990 NCES, CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center, Washington DC 1993

(1983). Calculus (level 5) is an indicator of students intending to major in sciences, engineering, or mathematics in college.

The state percentages in Table 5 are based on the total population of public high school students in 1991-92. A total of 91 percent of students take first-year algebra or integrated mathematics by the time they graduate. The state percentages of students taking algebra[6] vary from over 95 percent (15 states) to 58 percent (Hawaii). The percentages for algebra 1/integrated mathematics 1 include enrollments during high school as well as in grade 8. State enrollments in algebra 2 vary from 73 percent (Maine) to 31 percent (Hawaii), with the national average at 55 percent. In calculus, state percentages vary from 21 percent (Wisconsin) to 4 percent (Mississippi, Hawaii), with the national average at 11 percent.

[6]Enrollments in first-year algebra comprise the large majority of enrollments at the Formal Math Level 1. However, following the NCTM Curriculum Standards, many states and districts advocate an integrated mathematics sequence in high school mathematics to replace the algebra, geometry, algebra 2 sequence of separate courses.

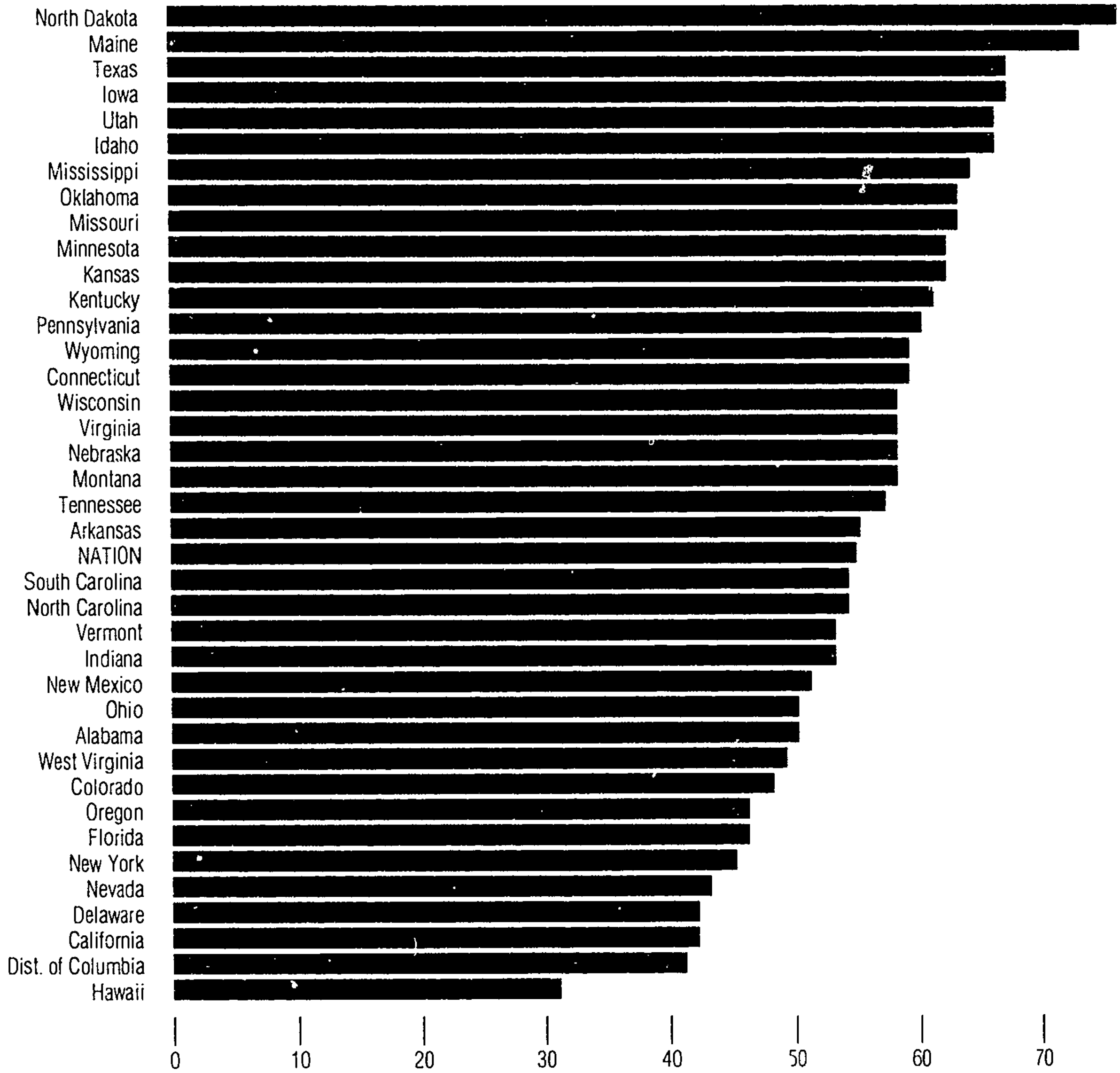
Many states and districts established a goal of increasing the proportion of students that take algebra 1, or integrated mathematics, as well as more advanced high school mathematics courses, to meet their graduation requirements. Many states have worked toward this goal through state curriculum standards and frameworks for districts and schools to use in organizing the mathematics curriculum. Louisiana and North Carolina have a state graduation requirement that students pass algebra 1 or integrated mathematics 1.

Figure 3 illustrates a rank-ordered bar graph of the proportion of students taking formal mathematics level 3 by graduation. If we use the completion of algebra 2 or integrated mathematics 3 as an indicator of the proportion of graduates taking three high school mathematics courses, as recommended by the National Commission, 55 percent of U.S. students are meeting this goal set in 1983. States vary from 31 to 76 percent of students meeting the three-course goal.

Another way to analyze course taking in science and mathematics is to examine the patterns of enrollment during secondary education. Table 6 provides a disaggregation of the algebra 1 and 2 enrollments by grade. Among the 15 states that collect course data by grade, 9 states (Alabama, California, Connecticut, District of Columbia, Kentucky, New York, North Dakota, South Carolina, and Utah) have over 50 percent of students taking algebra 1 or integrated mathematics 1 by the ninth grade. The sum of the grade-by-grade data is over 100 percent for 3 reporting states (District of Columbia, North Dakota, and Puerto Rico), indicating that some students repeat the course at two grade levels. Enrolling more students in algebra 1 by ninth grade does have a positive relationship to advanced course taking in mathematics. Five of these states exceed the national average for students taking advanced mathematics courses at level 4 or above. The grade-level data on algebra 2 show differences between states in enrollment patterns, with the percentage taking algebra 2 before grade 11 varying from 6 percent (New York) to 36 percent (Idaho). The most common grade for taking algebra 2 is grade 11, accounting for half of the algebra 2 enrollment. Seven states had more than 10 percent of 12th grade students taking this course.

The total percentage of students who take algebra 2 is clearly related to further mathematics study in high school. Of the 20 states with more than 55 percent of students taking algebra 2 (see Table 5), 16 states exceeded the average of 40 percent of students taking trigonometry or calculus. Only two states (New York, Ohio) had algebra 2 enrollments below the national average (55 percent) but advanced enrollments above the national average (40 percent).

FIGURE 3
PERCENTAGE OF HIGH SCHOOL STUDENTS TAKING ALGEBRA 2/INTEGRATED MATH 3 BY GRADUATION (1991-92)



Source State Departments of Education. Data on Public Schools. Fall 1991. California Fall 1990
Council of Chief State School Officers State Education Assessment Center. Washington. DC. 1993

High School Science

The Council staff worked with state science supervisors to develop a science course taxonomy and to determine which courses and levels should receive primary emphasis in reporting state data. In the 1990 and 1992 reports, enrollments in biology, chemistry, and physics are used as major indicators of student participation and progress in high school science. Enrollments in these subjects were collected at four levels: first-year basic/applied, first-year general, second-year advanced, and advanced placement. In addition, states reported high school enrollments in introductory high school science courses in earth science, physical science, and general science, and enrollments in new "integrated science" courses.

Because states reported data on all science courses, total state enrollments in science can be aggregated by both level and subject.

Table 7 shows the total percentage of students taking a science course as of October 1991. High school science enrollments were aggregated to three levels: (1) introductory courses (general science, physical science, first-year earth science, or integrated science, i.e., courses typically taken at grade 9); (2) first-year biology and life science (often taken at grade 10 or grade 9); and (3) first-year chemistry and physics and advanced or second-year science.

TABLE 7
COURSE ENROLLMENTS IN HIGH SCHOOL SCIENCE BY LEVEL AS A PERCENT OF STUDENTS IN GRADES 9—12 (October 1991)

STATE	Introductory Courses	Biology 1st Year	Chemistry, Physics, & Advanced	Total Science	% Change Chemistry, Physics, & Adv'd: 1990 to '92
Alabama	24 %	27 %	20 %	72 %	2 %
Alaska	—	—	—	—	—
Arizona	—	—	—	—	—
Arkansas	35	25	19	80	8
California	17	24	16	59	1
Colorado	21	21	23	69	—
Connecticut	23	25	34	82	4
Delaware	19	25	18	64	-3
Dist. of Columbia	25	25	20	70	4
Florida	29	26	32	88	4
Georgia	—	—	—	—	—
Hawaii	31	25	18	77	-2
Idaho	26	22	20	70	3
Illinois	—	—	—	—	—
Indiana	20	26	24	70	0
Iowa	29	30	28	87	5
Kansas	27	29	24	84	3
Kentucky	13	27	24	64	1
Louisiana	—	—	—	—	—
Maine	—	23	28	—	—
Maryland	—	—	—	—	—
Massachusetts	—	—	—	—	—
Michigan	—	—	—	—	—
Minnesota	11	27	31	69	8
Mississippi	9	33	37	80	2
Missouri	28	24	31	84	4
Montana	24	25	27	76	3
Nebraska	25	28	23	80	7
Nevada	24	27	22	73	8
New Hampshire	—	—	—	—	—
New Jersey	—	—	—	—	—
New Mexico	23	30	18	72	4
New York	29	27	26	86	2
North Carolina	28	27	22	78	6
North Dakota	29	27	34	91	9
Ohio	24	24	24	73	4
Oklahoma	24	25	22	75	9
Oregon	20	22	19	67	—
Pennsylvania	22	24	29	76	2
Puerto Rico	30	23	22	75	—
Rhode Island	—	—	—	—	—
South Carolina	29	26	21	76	3
South Dakota	—	—	—	—	—
Tennessee	26	26	18	70	2
Texas	24	28	20	72	3
Utah	20	25	20	45	—
Vermont	20	21	26	72	—
Virginia	26	25	27	79	2
Washington	—	—	—	—	—
West Virginia	26	27	24	78	3
Wisconsin	24	28	30	88	2
Wyoming	24	21	19	67	1
SUM (38 states)	**23 %**	**26 %**	**24 %**	**75 %**	**+ 3 %**

Note Total includes average of 2% "Other Science." — Data not available
Source State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990 NCES CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center Washington, DC, 1993

COURSE ENROLLMENTS IN HIGH SCHOOL SCIENCE BY LEVEL
(Percent of Grade 9-12 Students in October 1991)

Introductory (earth, physical, general)	23 %
Biology, first year	26
Chemistry, Physics, & Advanced/second year	24
Total	**75 %**

The total national enrollment in science was 75 percent of grade 9-12 students, which is an increase of 3 percent from 1989-90. About 7 of 10 high school students were taking a science course in Fall 1991. State totals vary from 59 (California) to 91 percent (North Dakota). Student enrollments in chemistry, physics, and advanced/second-year science increased 3 percent (to 24 percent), which accounts for the overall increase in science. The percentage taking introductory and biology courses remained constant. The percentage of students in higher level science study varies by state from less than 1 in 5 students to more than 1 in 3 students.

Table 8 shows the proportion of public high school students who are estimated to take first-year biology, chemistry, and physics by the time they graduate. The national and state percentages are based on the population of public high school students in each state.

PERCENT OF STUDENTS TAKING SELECTED SCIENCE COURSES BY GRADUATION (1991-92)

Biology, 1st year	95 %
Chemistry, 1st year	49
Physics, 1st year	21

Most states have a very high proportion of students taking first-year biology by graduation. Based on 1991-92 data, 26 states have 95 percent or more students taking biology. It is likely that from 5 to 10 percent of students take first-year biology more than once, or take more than one course at this level, based on a comparison of the total from state data with the national transcript study (Westat, 1993). In many states, the increase to two or three graduation requirements in the 1980s means that the typical student now takes an introductory science course (earth, physical, general, or integrated science) and a course in biology. In a few states, such as Mississippi, biology is the first science course in high school. At least one course in biology is found in the science curriculum of virtually all U.S. students.

Most states reported data on enrollments in "general" first-year biology courses separately from "applied" first-year biology. On average, 16 percent, or one of six students, take an "applied" high school biology course. (State-by-state data are in Appendix Table A-12.)

Appendix Table A-10 shows state enrollments by

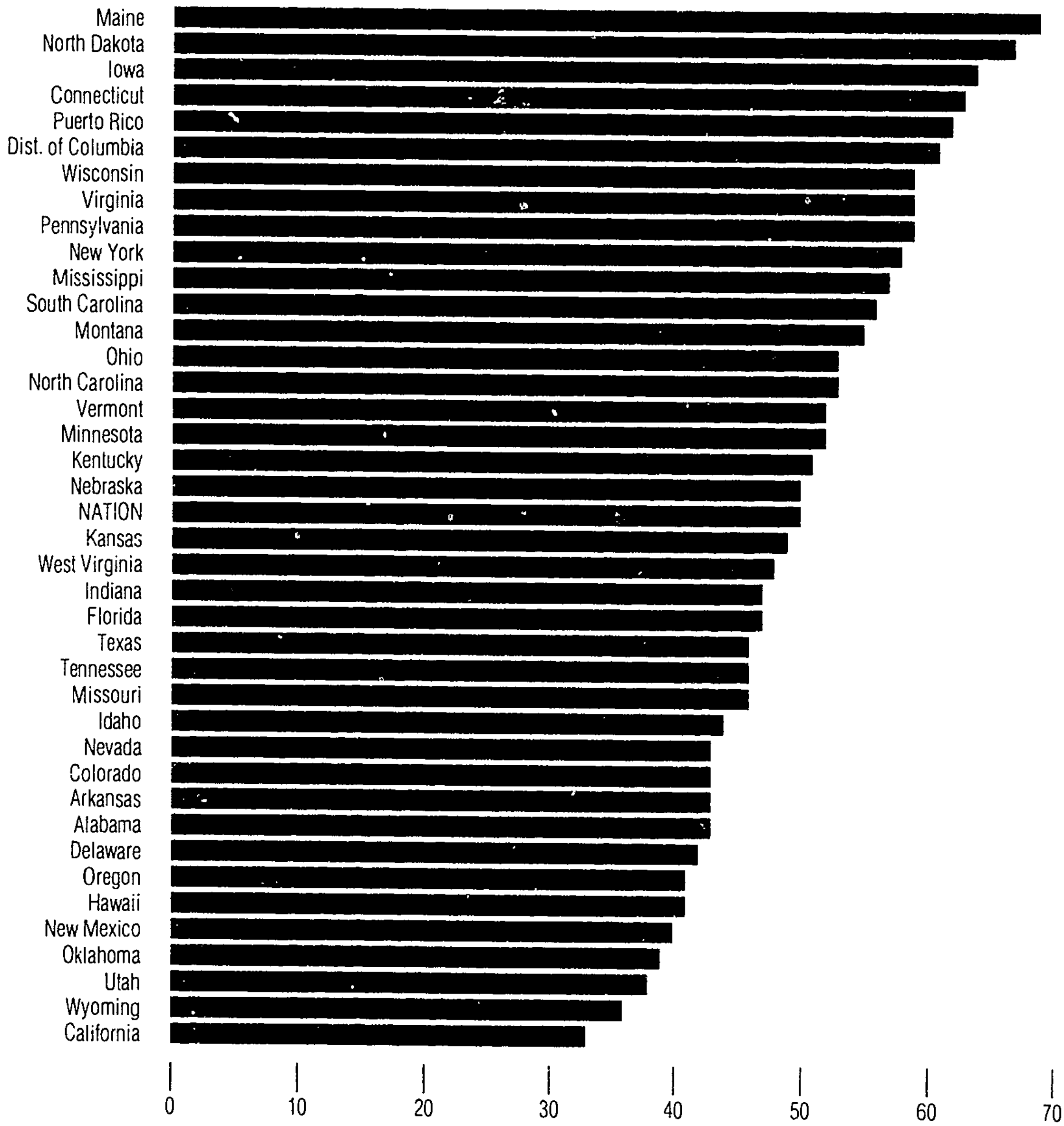
TABLE 8
PERCENTAGE OF HIGH SCHOOL STUDENTS TAKING SELECTED SCIENCE COURSES BY GRADUATION (1991-92)

STATE	Biology 1st Year	Chemistry 1st Year	Physics 1st Year
Alabama	95+ %	43 %	16 %
Alaska	—	—	—
Arizona	—	—	—
Arkansas	95 +	43	14
California	89	33	15
Colorado	82	43	22
Connecticut	95 +	63	37
Delaware	92	42	19
Dist. of Columbia	85	61	17
Florida	95 +	47	21
Georgia	—	—	—
Hawaii	95 +	41	24
Idaho	87	44	14
Illinois	—	—	—
Indiana	95 +	47	20
Iowa	95 +	64	30
Kansas	95 +	49	22
Kentucky	95 +	51	15
Louisiana	—	—	—
Maine	95 +	69	50
Maryland	—	—	—
Massachusetts	—	—	—
Michigan	—	—	—
Minnesota	95 +	52	25
Mississippi	95 +	57	17
Missouri	90	46	18
Montana	95 +	55	27
Nebraska	95 +	50	24
Nevada	95 +	43	18
New Hampshire	—	—	—
New Jersey	—	—	—
New Mexico	95 +	40	16
New York	95 +	58	28
North Carolina	95 +	53	15
North Dakota	95 +	67	28
Ohio	93	53	22
Oklahoma	95 +	39	11
Oregon	84	41	21
Pennsylvania	92	59	31
Puerto Rico	83	62	34
Rhode Island	—	—	—
South Carolina	95 +	56	17
South Dakota	—	—	—
Tennessee	95 +	46	13
Texas	95 +	46	15
Utah	95 +	38	16
Vermont	82	52	31
Virginia	95 +	59	25
Washington	—	—	—
West Virginia	95 +	48	13
Wisconsin	95 +	59	27
Wyoming	82	36	18
NATION	**95 +%**	**49 %**	**21 %**

Note Each state percent is a statistical estimate of course taking of public high school students by the time they graduate based on the total course enrollment in grades 9—12 in fall 1991 divided by the estimated number of students in a grade cohort during 4 years of high school The statistical estimating method is imprecise above 95% — Data not available Nation : Percent of all public high school students estimated to take each course including imputation for nonreporting states

Source State Departments of Education Data on Public Schools. Fall 1991 California Fall 1990 Council of Chief State School Officers. State Education Assessment Center Washington DC. 1993

FIGURE 4
PERCENTAGE OF HIGH SCHOOL STUDENTS TAKING CHEMISTRY BY GRADUATION (1991-92)



Source State Departments of Education. Data on Public Schools. Fall 1991 California. Fall 1990
Council of Chief State School Officers. State Education Assessment Center Washington, DC. 1993

grade for first-year biology, general and applied. In the 15 states that reported science course data by grade, over 65 percent of students take first-year general biology in grade 10. Three states have large enrollments in *basic* biology (California, Connecticut, Florida), and the largest proportion take the course in grade 10.

Figure 4 shows a bar graph of states rank-ordered by the proportion of students taking chemistry by graduation. As of 1991-92, a total of 49 percent of U.S. students were taking chemistry by graduation. If we use this course as an indicator of the proportion of graduates taking three high school science courses, the number recommended by the National Commission, the data show that one-half of students are meeting this goal. State enrollments vary from 69 percent (Maine) to 33 percent (California). Nineteen states are above the national average of 49 percent of students taking three high school science courses.

Physics enrollments vary by state from 50 percent (Maine) to 13 percent (West Virginia), and the national average is 21 percent of students taking physics by graduation.

Science and Mathematics Course Enrollments as Percent of 9th Grade Entrants

Enrollments in science and mathematics are generally analyzed in terms of percentage of *graduates* that take a given course (e.g., algebra 1), or percentage that reach a standard for course taking (e.g., three credits). Many policymakers and educators ask an additional question about science and mathematics: What proportion of all entering high school students take science and mathematics, including graduates as well as nongraduates?

The rate of science and mathematics course taking for all entering high school students can be estimated by the number of students enrolled in a given course in 1991-92 divided by the 9th grade student membership in the 1988-89 school year.

	Enrollments as a Percent of Graduates 1991-92	Enrollments as a Percent of All Students Entering 9th Grade in 1988-89
Algebra 1	91	78
Algebra 2	55	47
Biology, 1st year	95+	93
Chemistry, 1st year	49	42

The differences between the course-taking rates (e.g., 13 percent for algebra 1 and 7 percent for chemistry) represent the portion of students who drop out of school and are not educated in these subjects during the typical 4-year period of high school. These figures may represent a more accurate picture of the effectiveness of our schools in providing science and mathematics education opportunities. The state-by-state statistics on percentage of all entering high school students taking mathematics and science are reported in Appendix Table A-11.

TRENDS IN COURSE ENROLLMENTS: 1990 TO 1992

The Science-Mathematics Indicators are being reported biennially for the purpose of analyzing trends in indicators over time. The 1992 results provide strong evidence that enrollments in high school mathematics and science courses continue to rise in the early 1990s, as they did from 1982 to 1990.

National transcript studies conducted by NCES in 1982, 1987, and 1990 indicate upward trends in the 1980s (Kolstad & Thorne, 1989; Westat, 1993):

- Enrollments in Algebra 1 increased from 65 percent in 1982 to 80 percent in 1990, algebra 2 increased from 35 to 56 percent, and calculus increased from 5 to 9 percent.
- In science, biology increased from 75 percent in 1982 to 90 percent in 1990, chemistry increased from 31 percent to 51 percent, and physics increased from 14 percent to 22 percent.

Table 9 provides a summary of change in course enrollments by state from the 1989-1990 school year to the 1991-92 school year. Trends are analyzed for 24 states that had no changes in their data forms or codes.[7] The results show that 16 of 24 states experienced an increase in enrollments in algebra 1 (level 1), with increases varying from 2 to 13 percent. The 1992 state data show that 91 percent of students were taking algebra 1 or integrated mathematics 1 by graduation, while 82 percent were taking the course as of 1990, or an increase of 9 percent over 2 years.[8] Algebra 2 enrollments increased in 19 states, with increases from 3 percent to 17 percent. The 1992 total for algebra 2 was 55 percent, whereas the 1990 figure was 49 percent, or an increase of 6 percent. Total enrollment in calculus increased an average of 2 percent, with 19 of 24 states showing an increase of 1 to 3 percent.

In science, overall biology enrollments did not rise from 1990 to 1992 because almost all students were taking the course as of 1990, although enrollments did increase in 4 states. Chemistry enrollments increased in 23 of 24 states, and the percentage went up 4 percent nationally. Physics enrollments increased by 1 percent overall, with 19 of 24 states reporting enrollment increases of 1 to 3 percent.

In sum, the trend data on course taking in science and mathematics demonstrate that high school enrollments continue to increase in the early 1990s in a majority of reporting states. The state-by-state trends show that the pattern of increasing enrollments observed from 1982 to 1990 is continuing in the early 1990s.

Do Trends Reflect Watered-Down Science and Mathematics? Do More Courses Mean Higher Achievement?

On learning of increased course taking since states raised graduation requirements, some educators have asked whether these trends are real or cosmetic: Did schools simply change the names of existing courses or simplify more demanding science and mathematics courses to allow more students to pass? For example, in commenting on the state policy reforms in the 1980s, Diane Ravitch claimed that "in fact, what happened was that people took the same courses they were teaching anyway and retitled them" (Viadero, *Education Week*, 1993). New research has demonstrated that this view is not accurate. Porter and his colleagues at the University of Wisconsin-Madison have just completed a new study for the NSF on the effects of state requirements on course enrollments and course content. The results show that the curriculum content of college-prep courses such as algebra and chemistry were not "watered

[7] In 1990, the Science-Math Indicators reported high school course enrollment data for 38 states. Between the data collection periods of 1989 and 1991, 12 states changed their data collection forms. Changes in forms can produce significant differences in course enrollments for some categories. Due to budgetary restraints, 3 states reporting in 1990 could not report data for 1992, and 3 additional states began reporting the data in 1992.

[8] The state data may include students taking a course more than once, accounting for the 2 percent higher enrollment reported from state data as compared to the national transcript data (Westat, 1993).

TABLE 9
PERCENT CHANGE IN STUDENTS TAKING MATHEMATICS AND SCIENCE COURSES: 1990 TO 1992

STATE	Algebra 1/ Integrated Math 1	Algebra 2/ Integrated Math 3	Calculus	Biology	Chemistry	Physics
Alabama	13	4	1	0	5	-5
Arkansas	7	7	1	0	10	1
California	-3	-2	0	-2	0	-1
Connecticut	7	-2	0	0	1	1
Florida	0	4	-2	0	3	2
Hawaii	6	-2	0	7	1	3
Iowa	3	17	3	0	7	3
Kentucky	8	7	1	0	6	1
Maine	7	9	—	1	11	—
Minnesota	5	7	1	0	8	2
Mississippi	10	6	1	0	2	0
Missouri	0	5	3	4	5	2
Nebraska	10	4	8	0	4	3
New Mexico	0	4	0	0	7	1
New York	4	-1	1	0	2	0
North Dakota	0	12	3	0	13	4
Ohio	6	3	2	-2	4	2
Oklahoma	0	3	-2	2	2	1
Pennsylvania	0	3	3	0	3	2
South Carolina	7	-1	2	0	5	1
Tennessee	2	3	1	7	4	2
Texas	5	13	2	0	6	3
Virginia	9	3	3	0	2	2
West Virginia	6	7	5	0	8	2
NATION	**+9**	**+6**	**+2**	**0**	**+4**	**+1**

Note -- Data not available
Source State Departments of Education Data on Public Schools Fall 1991 California Fall 1990. NCES CCD Fall Membership 1991
Council of Chief State School Officers State Education Assessment Center Washington. DC. 1993

down" to accommodate new requirements and more students. The content of algebra 1 was quite consistent; and in schools that required the course of all students, the content was virtually the same as algebra 1 in schools in which the course is voluntary (Porter et al., 1992). The research did show that the content of first-year biology courses was highly varied, although the variation partly results from the major differences in content and approach among the various biology textbooks.

Recent data from the 1990 NAEP mathematics assessment confirm the results of previous studies that the level of mathematics reached in high school is strongly related to student achievement in mathematics. Data on mathematics course taking of 12th grade students in the 1990 NAEP showed significant increases in mathematics proficiency scores with each additional mathematics course. For example, students who did not take algebra had an average scale score of 266, completers of algebra 1 averaged 286, algebra 2 completers scored at 309, and students taking a fourth level of mathematics averaged 327. The same pattern of increases related to course enrollments held for students in all racial/ethnic and SES groups (Mullis, et al., 1991, p. 126-127).

Advanced Mathematics and Science Courses Enrollments

State data on student enrollments in advanced mathematics and science courses beyond first-year biology, chemistry, and physics provide another indicator of the proportion of students preparing for college majors in scientific fields. A useful state indicator is the proportion of students taking AP mathematics and science courses. Since AP courses use a standard curriculum, state enrollment figures provide a comparable measure of advanced instruction in mathematics and science.

NUMBER OF U.S. STUDENTS TAKING ADVANCED COURSES PER 1,000 12TH GRADE STUDENTS

	Advanced Placement	Other Advanced
Calculus	33	70
Biology	21	242 (2nd yr./advanced)
Chemistry	11	32
Physics	7	12
Earth Science	—	34

The state-by-state figures for enrollments in advanced courses, expressed as the number of students per 1,000, are reported in Table 10. For purposes of comparison, the 12th grade student membership is used as the basis for analysis, even though

TABLE 10
STUDENTS TAKING ADVANCED/SECOND-YEAR MATHEMATICS AND SCIENCE COURSES: ENROLLMENTS PER 1,000 GRADE 12 STUDENTS (OCTOBER 1991)

STATE	Student Membership Grade 12	Calculus per 1,000 AP	Calculus per 1,000 Regular	Biology per 1,000 AP	Biology per 1,000 Advanced/ 2nd Year	Chemistry per 1,000 AP	Chemistry per 1,000 Advanced	Physics per 1,000 AP	Physics per 1,000 Advanced	Earth Science per 1,000 2nd Year
Alabama	41,725	34	39	59	215	26	—	13	9	—
Arkansas	27,544	—	61	—	223	—	—	—	0	11
California	260,693	—	91	—	156	—	30	—	7	29
Colorado	33,108	—	98	—	224	—	91	—	—	42
Connecticut	28,339	62	79	22	294	13	17	12	—	65
Delaware	5,953	55	54	58	82	15	23	5	6	0
Dist. of Columbia	3,415	—	64	51	—	—	40	11	—	17
Florida	100,210	46	24	22	687	15	17	15	10	88
Hawaii	9,290	37	5	8	65	23	—	9	—	5
Idaho	14,097	43	86	62	181	22	9	6	—	7
Indiana	60,657	34	66	35	198	20	80	14	14	27
Iowa	31,648	—	118	—	218	—	—	—	9	—
Kansas	25,889	41	75	64	202	26	25	5	—	18
Kentucky	36,131	70	—	27	331	13	50	10	—	—
Minnesota	52,165	—	134	—	382	—	68	—	8	10
Mississippi	25,713	26	18	31	903	10	61	4	4	9
Missouri	49,503	—	106	—	556	—	94	—	1	56
Montana	9,597	2	57	68	158	25	22	0	0	44
Nebraska	18,106	—	140	—	218	—	—	—	—	—
Nevada	11,283	15	35	13	284	15	21	4	16	16
New Mexico	15,923	34	46	17	146	19	—	21	—	68
New York	141,546	98	36	52	121	23	5	25	39	57
North Carolina	64,061	46	39	32	200	17	25	5	9	28
North Dakota	7,821	—	65	—	391	—	47	—	0	31
Ohio	113,420	31	66	25	217	18	—	11	—	27
Oklahoma	35,684	20	38	7	412	9	27	9	—	10
Oregon	30,226	34	69	38	89	19	27	14	—	9
Pennsylvania	107,758	59	129	—	169	—	73	—	51	24
South Carolina	34,638	59	29	34	154	14	29	6	6	—
Tennessee	49,011	—	55	21	142	10	13	9	—	—
Texas	177,332	—	69	—	205	—	30	—	12	69
Utah	27,575	123	31	94	146	39	10	18	8	7
Vermont	5,529	32	82	47	175	7	15	5	0	25
Virginia	61,328	65	75	51	136	27	25	9	5	45
West Virginia	21,611	33	36	10	350	2	52	0	—	2
Wisconsin	53,734	86	124	31	187	27	60	14	39	19
Wyoming	6,425	34	129	15	180	7	48	—	—	—
SUM (37 states)		**33**	**70**	**21**	**242**	**11**	**32**	**7**	**12**	**34**

Note Data not available
Source State Departments of Education. Data on Public Schools. Fall 1991. California. Fall 1990 NCES. CCD Fall Membership 1991
Council of Chief State School Officers. State Education Assessment Center. Washington. DC 1993

students may actually be taking advanced courses before 12th grade. The state data show that in each subject area, some states exceed the national average.

States with more than 60 of 1,000 students taking AP calculus are Connecticut, Kentucky, New York, Utah, Virginia, and Wisconsin. In addition, states with more than 100 of 1,000 students taking regular or AP calculus are Delaware, Idaho, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Oregon, Pennsylvania, Vermont, and Wyoming.

Enrollments in AP science courses (sum of biology, chemistry, and physics) were over 60 of 1,000 students in Alabama, Delaware, District of Columbia, Idaho, Indiana, Kansas, Montana, New York, Oregon, Utah, Virginia, and Wisconsin.

A wide variety of courses are included under the category of second-year or advanced science (other than AP), and the courses vary from state to state. For example, schools in some states offer many options for second-year biology, such as botany, zoology, and anatomy and physiology, in addition to advanced biology. In several states, such as Mississippi, Missouri, and Oklahoma, a large portion of students take a second year of biology to meet graduation requirements. Other states have a narrower range of advanced or second-year science courses. Considering these differences, states with more than 300 of 1,000 students taking a second-year or advanced science courses (sum of biology, chemistry, physics, and earth science) were Colorado, Connecticut, Indiana, Kentucky, Minnesota, Mississippi, Missouri, Nevada, North Dakota, Oklahoma, Pennsylvania, Texas, West Virginia, and Wisconsin.

Relationship of State Policies to Course Enrollments

Policy Issues:

• Do states with policies setting higher course requirements for graduation have higher rates of course taking in science and mathematics?

• What is the role of state curriculum frameworks or guides in the level of student participation in science and mathematics?

National trends on course taking indicate enrollments rose from 1982 to 1990 after many states raised graduation requirements in science and mathematics. The first Council report on state-level science-mathematics indicators in 1990 analyzed differences in course enrollments between groups of states with different course requirement levels. Now, with the 1993 Council report, it is possible to track the rate of change in course enrollments in relation to individual state requirements.

A 1992 Council survey of state policies showed the following totals among the 50 states (Blank and Dalkilic, 1992):

Graduation Requirements

- 10 states require three credits of mathematics, 3 states require three science credits
- 3 states require two credits of mathematics and science plus one additional credit in mathematics or science
- 31 states require 2 mathematics credits, 36 states require two science credits
- 2 states require one credit in science
- 7 states leave the policy decision to local districts.

Curriculum Frameworks

- 17 states have an advanced or honors diploma with higher mathematics credit requirements, and 16 require higher science credits
- 41 states have state curriculum frameworks in mathematics and 4 states are developing frame works
- 30 states have curriculum frameworks in science and 15 states are developing frameworks.

Mathematics

To analyze the relationship of state requirements to course taking in Table 11, states were divided into three categories: (1) states requiring two and a half to three Carnegie course credits, (2) states requiring two credits, and (3) states requiring one credit or no state, only local, requirements.

- The states with higher requirements (2.5 to 3) had slightly fewer students taking algebra 1 (87 percent) but significantly more students taking algebra 2 (59 percent) than states requiring 2 credits (89 percent algebra 1, 50 percent algebra 2).
- The high-requirement states had slightly more students taking trigonometry/precalculus (32 vs. 27 percent).
- The five states relying on local policies had slightly higher algebra 1 enrollments (93 percent).
- In total mathematics enrollment, the states with high requirements (2.5 to 3) had 12 percent more students taking mathematics (94 percent) than states in the other two categories (both 82 percent).

All of the states with high course credit requirements, except Pennyslvania, have had state curriculum frameworks in place and have revised, or are revising, the state frameworks to meet the NCTM *Curriculum Standards.*

A state-by-state analysis of the percentages of change in mathematics enrollments from 1990 to 1992 (from Table 9) was categorized according to state credit requirements, and the results are in Appendix Table A-17. At the level of algebra 1 and 2, the average enrollment increases are slightly higher for high requirement states (2.5 to 3 credits) than states requiring 2 credits (4.8 percent vs. 4.4 for algebra 1; 4.3 vs. 4.0 for algebra 2). The rates of change in calculus do not differ. The three states that rely on local school boards to set requirements have very similar rates of increase as other states, except algebra 2 rose by 17 percent in Iowa and calculus increased 8 percent in Nebraska.

Science

Table 12 shows the differences in 1991-92 science enrollments by levels of state graduation requirements.

• The states with higher requirements (2.5 to 3) had more students taking chemistry (53 percent) and physics (25 percent) than states requiring two credits (47 percent, 19 percent).

• The science enrollments for the five states with local policies did not differ from the states with high state requirements.

• The total percent of students taking science among high requirements states (81 percent) was almost 10 percent greater than states in the other two categories (72 percent, 74 percent).

The states with high course credit requirements in science, except Pennsylvania, have also had state science curriculum frameworks in place.

An analysis of change in science enrollments from 1990 to 1992 by state requirements is shown in Appendix Table A-18. There are small differences in science enrollments between the three levels of requirements. The average increase in chemistry enrollments in high-requirement states was 4.5 percent, with Arkansas having a 10-percent increase. Among states requiring two credits, the average increase in chemistry was 4.9 percent, due mainly to more than 10 percent increases in Maine and North Dakota. Two local-policy states, Iowa and Minnesota, had above-average increases in chemistry.

One finding from the analysis of enrollment trends by state requirements is that states that rely on local board policies have higher enrollments than many states with state requirements. In practice, states relying on local boards to set policies on graduation requirements (e.g., Iowa, Minnesota, and Nebraska) may have higher requirements and rates of science-mathematics course taking due to local policies that consistently support science and mathematics education. Local policies in turn may reflect the views of science and mathematics professional organizations, admissions policies of higher education institutions, or curriculum recommendations from state education departments.

In sum, in 1991-92, the states with higher graduation requirements had significantly greater total enrollments in mathematics and science; and they had greater enrollments in algebra 2, chemistry, and physics than did the states with lower requirements. Individual states showed significant increases in enrollments at each level of graduation requirements, particularly in algebra 1, algebra 2, and chemistry. The average enrollment increases for these courses were slightly greater for high-requirement states than for other states.

TABLE 11
PERCENTAGE OF STUDENTS TAKING MATHEMATICS COURSES BY STATE GRADUATION REQUIREMENTS (1991-92)

STATE	Algebra 1/ Integrated Math 1	Algebra 2/ Integrated Math 3	Trigonometry/ Precalculus	Total Math
2.5 to 3 Credits				
Arkansas	95 +	55	27	94
Connecticut	81	59	38	94
Florida	78	46	23	91
Kentucky	89	61	30	88
New Mexico	95 +	51	23	91
Pennsylvania	88	60	50	95 +
South Carolina	76	54	35	95 +
Texas	87	67	26	94
Vermont	70	53	30	78
Virginia	90	58	37	88
SUM (10 states)	**87**	**59**	**32**	**94**
2 Credits				
Alabama	83	50	19	76
California	89	42	21	77
Delaware	67	42	28	70
Dist. of Columbia	95 +	41	17	78
Hawaii	58	31	19	89
Idaho	74	66	24	72
Indiana	85	53	30	78
Kansas	95 +	62	32	90
Maine	91	73	51	—
Mississippi	95 +	64	29	87
Missouri	95 +	63	16	85
Montana	90	58	36	84
Nevada	80	43	19	78
New York	83	45	28	84
North Carolina	88	54	40	88
North Dakota	95 +	76	49	91
Ohio	86	50	35	84
Oklahoma	95 +	63	23	81
Oregon	80	46	23	79
Tennessee	81	57	29	79
Utah	95 +	66	34	88
West Virginia	79	49	27	89
Wisconsin	95 +	58	34	95 +
SUM (23 states)	**89**	**50**	**28**	**82**
Local Board Policies				
Colorado	80	48	32	74
Iowa	95 +	67	32	96
Minnesota	95 +	62	34	77
Nebraska	95 +	58	22	87
Wyoming	95 +	59	28	76
SUM (5 states)	**93**	**59**	**31**	**82**
NATION	**91**	**55**	**29**	**87**

Source State Departments of Education Data on Public Schools. Fall 1991 California Fall 1990 Council of Chief State School Officers State Education Assessment Center, Washington DC 1993

TABLE 12
PERCENTAGE OF STUDENTS TAKING SCIENCE COURSES BY STATE GRADUATION REQUIREMENTS (1991-92)

STATE	Biology 1st Year	Chemistry 1st Year	Physics 1st Year	Total Science
2.5 to 3 Credits				
Arkansas	95 +	43	14	80
Florida	95 +	47	21	88
Pennsylvania	92	59	31	76
Vermont	82	52	31	72
Virginia	95 +	59	25	79
SUM (5 states)	**95 +**	**53**	**25**	**81**
1 to 2 Credits				
Alabama	95 +	43	16	72
California	89	33	15	59
Connecticut	95 +	63	37	82
Delaware	92	42	19	64
Dist. of Columbia	85	61	17	70
Hawaii	95 +	41	24	77
Idaho	87	44	14	70
Indiana	95 +	47	20	70
Kansas	95 +	49	22	84
Kentucky	95 +	51	15	64
Maine	95 +	69	50	—
Mississippi	95 +	57	17	80
Missouri	90	46	18	84
Montana	95 +	55	27	76
Nevada	95 +	43	18	73
New Mexico	95 +	40	16	72
New York	95 +	58	28	86
North Carolina	95 +	53	15	78
North Dakota	95 +	67	28	91
Ohio	93	53	22	73
Oklahoma	95 +	39	11	75
Oregon	84	41	21	67
South Carolina	95 +	56	17	76
Tennessee	95 +	46	13	70
Texas	95 +	46	15	72
Utah	95 +	38	16	45
West Virginia	95 +	48	13	78
Wisconsin	95 +	59	27	88
SUM (28 states)	**95 +**	**47**	**19**	**72**
Local Board Policies				
Colorado	82	43	22	69
Iowa	95 +	64	30	87
Minnesota	95 +	52	25	69
Nebraska	95 +	50	24	80
Wyoming	82	36	18	67
SUM (5 states)	**95 +**	**51**	**25**	**74**
NATION	**95 +**	**49**	**21**	**75**

Source: State Departments of Education Data on Public Schools, Fall 1991, California, Fall 1990. Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

EQUITY IN SCIENCE AND MATHEMATICS OPPORTUNITIES

Policy Issues:

- Is the gender gap closing in advanced science and mathematics?

- Are minority students increasing their participation in advanced science and mathematics courses?

Gender Differences

National studies have shown that differences in course enrollments between boys and girls decreased in the 1980s (Kolstad & Thorne, 1989; Westat, 1993). State data in the 1990 Council report showed that in most states, girls' and boys' participation in high school science and mathematics was about the same up to and including first-year chemistry and second-year algebra (level 3 mathematics). In 1990, boys had higher enrollments in advanced mathematics and advanced physical sciences. Data on gender differences in course taking are important for assessing progress in schools' efforts to reduce the gender gap in mathematics and science achievement demonstrated in the NAEP achievement scores.

The 1992 state course enrollment data by student gender are shown in Tables 13 and 14. A total of 21 states reported these data (which is an increase from the 16 states in 1990). In mathematics, the enrollments of boys and girls are virtually the same at the level of algebra 1/integrated mathematics 1 in all states. At the level of geometry, algebra 2, and trigonometry, the enrollment rates do not differ by gender in 10 states, and in the other 10 states slightly more girls are enrolled. Alabama, District of Columbia, Florida, Hawaii, North Carolina, South Carolina, and West Virginia have 6-10 percent more girls than boys taking advanced mathematics courses. At the level of calculus, an average of 6 percent more boys are enrolled than girls. The 1992 mathematics enrollments show an increase from 1990 in the proportion of girls enrolled in trigonometry from 49 to 51 percent and an increase in calculus from 45 to 46 percent.

In high school science, first-year biology enrollments were almost the same in all states. Twelve of 20 states had an average of 4 to 6 percent more girls taking chemistry, and all states had more girls taking advanced biology (sum of 54 percent girls). Among the reporting states, a sum of 12 percent more boys took physics (56 to 44 percent), 6 percent more boys took advanced chemistry, and 20 percent more boys took advanced physics. From 1990 to 1992, the proportion of girls taking physics increased two percent (from 42 to 44 percent). The proportion of girls taking advanced chemistry increased from 45 to 47 percent and the proportion of girls taking advanced physics increased from 36 to 40 percent.

TABLE 13
GENDER DIFFERENCES IN STUDENTS TAKING MATHEMATICS COURSES
(1991-92)

STATE	% Female Taking Algebra 1/ Integrated Math 1	% Female Taking Algebra 2/ Integrated Math 3	% Female Taking Trigonometry/ Precalculus	% Female Taking Calculus
Arkansas	51	54	52	48
California	50	51	49	45
Colorado	49	51	49	43
Connecticut	51	52	49	47
Dist. of Columbia	53	60	61	55
Florida	51	54	53	47
Hawaii	52	56	55	55
Idaho	42	50	47	45
Iowa	50	52	48	45
Kansas	50	52	50	45
Nevada	52	52	48	40
North Carolina	52	56	54	52
Ohio	51	51	50	45
Pennsylvania	51	51	51	48
Puerto Rico	51	—	54	—
South Carolina	51	54	52	53
Utah	50	51	46	40
Vermont	51	49	50	49
West Virginia	52	54	52	—
Wisconsin	49	51	50	46
Wyoming	50	51	48	48
SUM: 1992 (21 states)	**50**	**52**	**51**	**46**
SUM: 1990 (16 states)	**50**	**52**	**49**	**45**

Note — Data not available
Source State Departments of Education, Data on Public Schools, Fall 1991 California Fall 1990
Council of Chief State School Officers, State Education Assessment Center Washington, DC 1993

Race/Ethnic Differences

National sample data in Table 15 are available to analyze differences in course taking by student race/ethnicity. The high school transcript studies conducted by NCES in 1982 and 1990 allow us to assess change in science and mathematics enrollments by race/ethnicity (Westat, 1993).

The trend data show that minority students are making some progress in increasing participation in higher level mathematics and science courses. For example, in 1982 the difference between algebra 1 enrollments of whites and black students was over 10 percent, and now the rates are virtually the same. However, the difference in white and black enrollments in algebra 2 has only closed about 2 percent (1990 difference at 13 percent). Hispanic students made the largest increases in algebra 1 and algebra 2 enrollments. Asian American students enroll in algebra 2 and calculus at a higher rate than any group, and the rate of increased enrollment in calculus is 3 times any other group.

In science, rates of enrollment in biology have increased for all race/ethnic groups to virtual parity at this level. Chemistry enrollments have also increased significantly for all groups. Hispanic enrollments more than doubled, whereas black students enrollment increased 19 percent and white students increased 18 percent. Asian students continue to have the highest enrollments in chemistry.

At this time, states that are developing education data systems based on student records (e.g., Florida, North Carolina, and Texas) can analyze course taking by race/ethnicity. However, these data were not required for the 1991-92 Council science-mathematics indicators. They are likely to be reported for 1993-94.

Another way to analyze variation in student enrollments in science and mathematics is to identify SES differences of students in the school. Oakes' (1990b) analysis of data from a national sample of secondary schools showed that students in inner-city and low-SES schools have less opportunity to study advanced courses in science and mathematics. Figure 5 shows the extent of lower opportunities in low-SES schools. Figure 5a shows that schools with a high proportion of students from poverty backgrounds have an average of 2.5 classes (sections) of college prep or advanced science per 100 students, whereas schools with a high proportion of wealthy students have over 3 classes of college prep or advanced science and fewer classes of general courses. The patterns are even more distinct in mathematics, with more college prep and advanced mathematics classes, and fewer general mathematics courses, in schools with more wealthy students as compared to

TABLE 14
GENDER DIFFERENCES IN STUDENTS TAKING SCIENCE COURSES
(1991-92)

STATE	Biology % Female First Year	Biology % Female Advanced/AP	Chemistry % Female First Year	Chemistry % Female Advanced/AP	Physics % Female First Year	Physics % Female Advanced/AP
Arkansas	49	56	53	—	44	—
California	49	54	51	45	43	41
Colorado	49	56	50	46	42	33
Connecticut	51	55	52	40	37	37
Dist. of Columbia	54	66	58	60	57	33
Florida	49	52	53	45	50	38
Idaho	47	52	49	49	35	27
Iowa	50	54	51	—	41	42
Kansas	49	55	50	44	35	34
Nevada	51	53	52	40	45	43
North Carolina	49	61	56	52	45	43
Ohio	51	52	52	45	42	36
Pennsylvania	50	57	52	50	47	44
Puerto Rico	51	—	52	—	54	—
South Carolina	50	54	54	50	43	36
Utah	48	52	46	35	33	32
Vermont	50	54	51	52	43	22
West Virginia	48	54	55	46	42	32
Wisconsin	49	54	52	47	40	35
Wyoming	49	56	50	49	32	—
SUM: 1992 (20 states)	**49**	**54**	**52**	**47**	**44**	**40**
SUM: 1990 (16 states)	**50**	**55**	**52**	**45**	**42**	**36**

Note — Data not available
Source State Departments of Education Data on Public Schools, Fall 1991, California, Fall 1990 NCES, CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993.

schools with more students from poverty backgrounds.

Similarly, Figure 5b shows that schools with high percentages of white students have more college prep and advanced mathematics and science classes, and fewer general level classes, than schools with lower percentages of white students (i.e., more minority students).

Results from the National Education Longitudinal Study of 1988 (Horn & Hafner, 1992) and the 1990 NAEP mathematics assessment (Mullis, et al., 1991) showed that twice as many eighth grade students from high-SES families took algebra in eighth grade than students from low-SES families.

Science and Mathematics Enrollments in Large Cities

In 1992, the Council began a pilot study of indicators of science and mathematics in large city school systems. State education representatives have expressed strong interest in analysis of variation in science and mathematics indicators within states, in addition to state-to-state analysis. Also, NSF is beginning an urban science and mathematics initiative that will focus support for education improvement in large cities. Five states reported data on their largest cities to the Council. As a result, data were collected on 32 of the 75 largest cities in the United States.

Table 16 displays the average enrollments in high school mathematics courses for the cities in comparison to the state averages. The high and low city is also reported for each state.* In California, Florida, and Texas, the average enrollments in mathematics for large cities are very similar to the state averages. The city averages are lower than the state in New York and Ohio. In each, there is substantial variation in the course enrollments among the cities; for example, in California, algebra 1 varies from over 95 percent in the city with a high enrollment to 54 percent in the city with the low enrollment, and calculus varies from 11 to 3 percent.

The data on science in Table 16 indicate that science enrollments in large cities are very similar to state averages, but there is considerable variation within states. For example, in Ohio, biology enrollments in cities vary from over 95 percent to 78 percent; and physics enrollments vary from 22 to 7 percent.

These data show that the science and mathematics enrollments differ significantly from city to city, but there is no overall pattern of city averages' being significantly lower than state averages. In some states, the composite average among the cities is very similar to the state average. Also, the average enrollment level for any large city school district is likely to

*By agreement with the five states, individual city names are not revealed because the data are part of a pilot study of the city indicators.

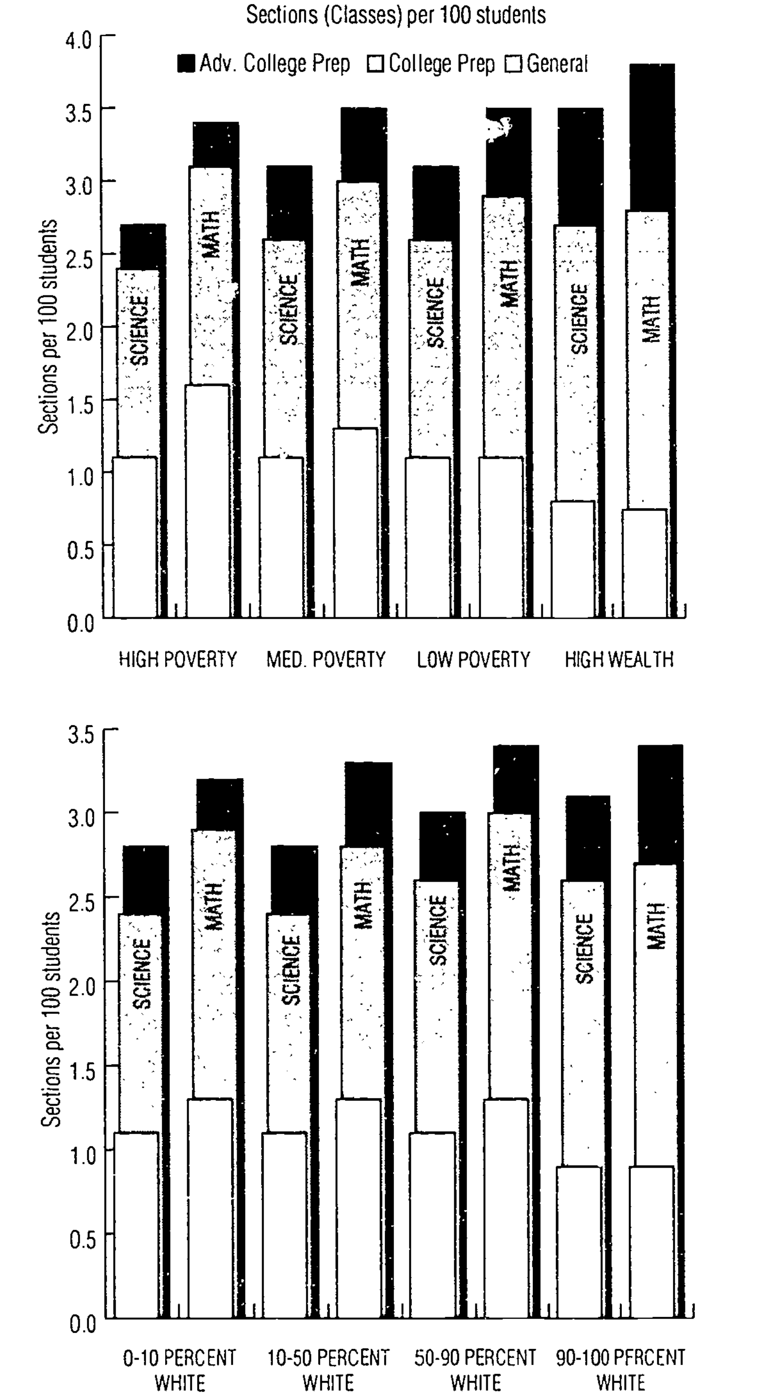
include wide variation in science and mathematics enrollments; thus a city average can mask differences among schools. Further analyses of science and mathematics in large cities can be conducted with state data to assess the variation in science and mathematics participation between and within large cities.

TABLE 15
CHANGES IN MATHEMATICS AND SCIENCE ENROLLMENTS BY RACE/ETHNICITY: 1982 TO 1990
(Percent of Students Taking Course by Graduation)

	1982	1990	Percent Change
Algebra 1			
Asian American	66	72	6
Black	57	78	21
Hispanic	55	81	26
White	68	77	9
Algebra 2			
Asian American	56	59	3
Black	24	39	15
Hispanic	21	39	18
White	39	52	13
Calculus (Regular & AP)			
Asian American	19	34	15
Black	2	4	2
Hispanic	2	7	5
White	8	11	3
Biology, 1st year			
Asian American	82	90	8
Black	71	91	20
Hispanic	67	90	23
White	77	92	15
Chemistry, 1st year			
Asian American	51	64	13
Black	21	40	19
Hispanic	15	39	24
White	34	52	18

Source Westat Inc The 1990 High School Transcript Study Tabulations, U S Department of Education, 1993.

FIGURE 5
OPPORTUNITIES TO ENROLL IN SCIENCE AND MATHEMATICS BY SCHOOL SOCIOECONOMIC STATUS (SES) AND RACIAL COMPOSITION
Sections (Classes) per 100 students



Source Oakes, J. Multiplying Inequalities. The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science. *Santa Monica, CA. 1990. p 36*
Council of Chief State School Officers. State Education Assessment Center, Washington, DC. 1993

TABLE 16
HIGH SCHOOL MATH AND SCIENCE IN LARGE CITIES:
PERCENTAGE OF HIGH SCHOOL STUDENTS TAKING SELECTED MATHEMATICS AND SCIENCE COURSES BY GRADUATION (1991-92)

STATE/City	Algebra 1/ Integrated Math 1	Algebra 2/ Integrated Math 3	Calculus	Biology 1st Year	Chemistry 1st Year	Physics 1st Year
California	89	42	9	89	33	15
11 Large City Districts. Average	91	42	8	90	33	16
High	95 +	63	11	95 +	50	40
Low	54	28	3	77	23	7
Florida	78	46	7	95 +	47	21
4 Large City Districts. Average	77	43	11	95 +	48	22
High	95 +	47	15	95 +	52	30
Low	70	41	8	90	45	18
New York	84	45	13	95 +	58	28
3 Large City Districts, Average	80	28	12	81	50	26
High	81	34	13	95 +	95 +	33
Low	51	28	8	79	48	26
Ohio	86	50	10	93	53	22
5 Large City Districts, Average	74	55	6	95	46	16
High	87	61	15	95 +	64	20
Low	55	43	3	78	26	7
Texas	87	67	7	95 +	46	15
9 Large City Districts. Average	90	67	7	95 +	46	14
High	95 +	83	10	95 +	71	27
Low	74	49	5	83	38	10

Note Includes Grade 8 enrollment in Algebra 1 Data were reported to CCSSO by state departments of education as part of a special study of science and math indicators in 32 of the 75 largest cities
Source State Departments of Education Data on Public Schools Fall 1991. California. Fall 1990
Council of Chief State School Officers. State Education Assessment Center Washington. DC. 1993

INDICATORS OF TEACHER QUALITY, SUPPLY, AND SHORTAGE

Policy issues:

• Has the supply of qualified teachers in science and mathematics improved?

• How well prepared are our science and mathematics teachers? Is there greater equity in the science and mathematics teaching force?

National commission reports of the 1980s highlighted the problem of underqualified teachers in science and mathematics and impending teacher shortages (National Science Board, 1983; Carnegie Forum on Education and the Economy, 1986). Some data showed that many well-qualified teachers were leaving science and mathematics teaching, few new college graduates were going into teaching, and a large portion of current teachers were not adequately prepared in science and mathematics (Aldrich, 1983; Johnston & Aldridge, 1984; Darling-Hammond, 1984).

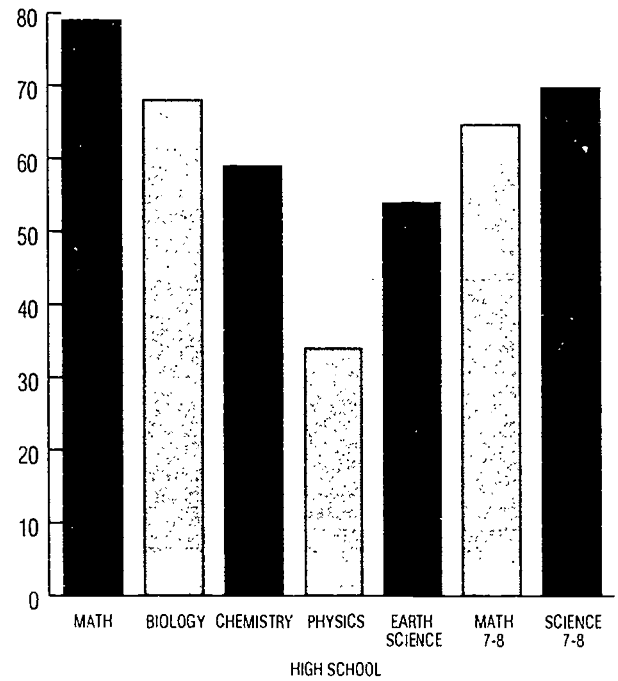
Many of the state policy initiatives in the 1980s were aimed at improving the supply of teachers by raising teacher pay, providing loans and grants for students entering teacher training, and developing alternative routes to teacher certification. Other state policy initiatives were aimed at raising the preparation and qualifications of teachers through higher standards for initial teacher certification, providing indicator programs for new teachers, and requiring additional education for recertification (NGA, 1986; Blank & Espenshade, 1988).

Indicators can assist policymakers and educators in determining the extent of change since the 1980s, particularly at the state level, where many decisions affect teachers. There are three key policy questions that need to be addressed by the indicators: first, whether states and school districts are attaining an adequate supply of science and mathematics teachers; second, the degree of improvement in the qualifications of the science and mathematics teaching force, as recommended by the NEGP; and third, the extent of improvement in equity of the teaching force.

TEACHER SUPPLY IN SCIENCE AND MATHEMATICS

A first level of analysis is whether the overall supply of teachers is sufficient. Under existing hiring standards, are school districts able to hire teachers for each classroom? National statistics do not show current shortages of teachers in science and mathematics. The rate of teacher attrition in science and mathematics is now relatively low—only 5 percent annually—the same figure as for all teachers (Bobbitt, et al., 1991). Also, the number of new college graduates with majors in science and mathematics education has gone up significantly in the 1980s (NCES, 1985, 1990). Furthermore, school districts are depending

FIGURE 6
PERCENTAGE OF TEACHERS WITH MAIN ASSIGNMENTS IN MATH AND SCIENCE



Source State Departments of Education, Data on Public Schools. Fall 1991. California, Fall 1990 Council of Chief State School Officers. State Education Assessment Center Washington. DC. 1993

less on new graduates and hiring more experienced teachers from the "reserve pool." In 1988, only 26 percent of new hires were first-year teachers (Rollefson, 1991).

However, the national averages do not identify shortages at state and local levels or shortages in specific teaching fields. The Council's 1990 science-mathematics indicators revealed a shortage of chemistry and physics teachers in at least 11 states, and shortages of mathematics teachers in states with high population growth and many small, rural districts (Blank & Dalkilic, 1991).

Teacher Supply in 1992

A starting point for assessing the current supply of science and mathematics teachers is the total number of teachers in each state by teaching field, or teaching "assignment." For the 1992 science-mathematics indicators, states reported the total number of high school teachers and middle grades teachers in mathematics and science and the number of teachers by "main assignment" (50 percent or more of teaching periods/classes) and "other assignment" (less than 50 percent of teaching periods/classes).

High School Teachers

Table 17 shows the total numbers of high school teachers by state in mathematics, biology, chemistry,

TABLE 17
NUMBER OF MATHEMATICS AND SCIENCE TEACHERS IN GRADES 9—12
(1991-1992)

STATE	Math Teachers	Biology Teachers	Chemistry Teachers	Physics Teachers	Earth Science Teachers
Alabama	1,608	826	378	286	21
Alaska	—	—	—	—	—
Arizona	1,050	934 *	—	—	—
Arkansas	709 **	629	306	238	64
California	9,837	3,887	1,365	922	550
Colorado	1,275	1,131 *	—	—	—
Connecticut	1,545	679	375	263	257
Delaware	192 **	51 **	16 **	30 **	8 **
Dist. of Columbia	—	—	—	—	—
Florida	8,880	2,427	691	401	1,323
Georgia	—	—	—	—	—
Hawaii	578	194	59	44	92
Idaho	747	253	131	91	148
Illinois	3,799	1,369	687	321	204
Indiana	2,270	1,015	507	366	287
Iowa	1,534	746	426	389	225
Kansas	1,224	632	391	274	98
Kentucky	1,568	716	344	219	51
Louisiana	—	—	—	—	—
Maine	825	363	211	177	162
Maryland	—	—	—	—	—
Massachusetts	3,329 *	741	441	261	309
Michigan	3,380	863	438	261	130
Minnesota	1,787	741	501	375	111
Mississippi	1,142	792	548	197	7
Missouri	2,029	1,038	588	378	162
Montana	506	251	167	134	175
Nebraska	—	—	—	—	—
Nevada	474	211	77	50	91
New Hampshire	471	181	67	37	26
New Jersey	3,677	922	448	163	327
New Mexico	716	313	143	98	41
New York	7,555	5,047	1,835	1,089	2,831
North Carolina	3,318	1,368	571	351	328
North Dakota	468	261	176	124	8
Ohio	4,210	1,797	1,014	748	410
Oklahoma	1,701	914	463	243	65
Oregon	1,207	362	—	—	—
Pennsylvania	6,443 *	1,939	1,065	693	778
Puerto Rico	1,582	414	231	119	94
Rhode Island	413	153	88	52	10
South Carolina	1,845	664	346	232	2
South Dakota	467	228	155	123	28
Tennessee	1,892	697	362	237	71
Texas	10,612	4,367	1,682	1,043	334
Utah	1,243	456	124	80	344
Vermont	278	127	80	73	77
Virginia	—	—	—	—	—
Washington	—	—	—	—	—
West Virginia	1019	381	162	108	283
Wisconsin	—	—	—	—	—
Wyoming	275	147	88	71	63
NATION	**116,849**	**46,864**	**21,277**	**13,610**	**12,273**

** Arizona. Colorado Biology total = all science Massachusetts total = K—12 full-time equivalent; Pennsylvania total = 7—12. ** = Main assignment only*
Note Total by subject = All teachers assigned to teach subject 1 or more periods/classes—Data not available
National totals include imputation for nonreporting states
Source: State Departments of Education. Data on Public Schools. Fall 1991. California. Fall 1990
Council of Chief State School Officers State Education Assessment Center. Washington. DC. 1993

physics, and earth science. The 1992 totals for teachers in science and mathematics can be compared with the totals in 1990, to obtain an indication of change (see state data by assignment in Appendix Tables B-1 through B-6).

NUMBER OF HIGH SCHOOL TEACHERS ASSIGNED TO MATHEMATICS AND SCIENCE: 1990 TO 1992

	1992	1990	Change
Mathematics	116,850	109,500	+ 7,350
Biology	46,900	46,300	+ 600
Chemistry	21,300	21,200	+ 100
Physics	13,600	14,100	- 500
Earth Science	12,300	13,400	- 1,100

The enrollment figures for high school mathematics (see Table 4) show that the total student enrollment increased by 3 percent from 1990 to 1992. The total number of teachers in mathematics has increased by over 7,300, or 7 percent. In science, the total enrollments have increased by 3 percent, with most of the increase in advanced/second-year biology and chemistry. The total number of teachers in biology increased by 600, or 1.3 percent; and chemistry teachers increased by 100, or 0.5 percent. The number of teachers assigned to physics declined by 500, or 3 percent; and the number of teachers in earth science declined by 1,100, or 8 percent. Some physics and earth science teachers may have been reassigned to biology or chemistry. Also, a total of 800 teachers were assigned to "integrated science" in 11 states.

Student/Teacher Ratios

Another measure of teacher supply is the student/teacher ratio, as shown in Table 18. The student/teachers ratio is based on the total state student membership and the estimated teacher time assigned to a subject. It provides a standardized statistic for comparing states on the supply of teachers for each subject area; and it also provides an indicator of the opportunity for students in each state to study mathematics and science, particularly in advanced fields.[10]

The average number of high school students as compared to current teachers are:

- 149 students per mathematics teacher,
- 217 students per biology teacher,
- 447 students per chemistry teacher, and
- 971 students per physics teacher.

These national ratios indicate widely differing opportunities to take mathematics and science. If we assume 5 classes per teacher (and current staffing levels), all students could take mathematics in a class of

[10] Student/teacher ratio = student membership divided by number of teachers with main assignment in a subject plus .25 times the number of teachers with other assignment in the subject. This estimate of total assigned teacher time by subject was developed by the Council to standardize state teacher data by subject, which is typically not reported by teacher full-time equivalents (FTEs).

TABLE 18
MATHEMATICS AND SCIENCE STUDENT/TEACHER RATIO IN GRADES 9—12

STATE	Students/Math Teacher (Grades 9—12)	Students/Biology Teacher (Grades 9—10)	Students/Chemistry Teacher (Grades 11—12)	Students/Physics Teacher (Grades 11—12)
Alabama	192	292	720	1143
Alaska	—	—	—	—
Arizona	164	185 *	—	—
Arkansas	135	180	376	813
California	180	287	658	1431
Colorado	132	149 *	—	—
Connecticut	95	138	226	426
Delaware	122	215	447	384
Dist. of Columbia	—	—	—	—
Florida	73	173	447	879
Georgia	—	—	—	—
Hawaii	105	188	455	736
Idaho	159	229	444	965
Illinois	131	201	323	697
Indiana	138	181	314	710
Iowa	—	—	—	—
Kansas	—	—	—	—
Kentucky	126	179	325	1032
Louisiana	—	—	—	—
Maine	—	—	—	—
Maryland	—	—	—	—
Massachusetts	105	163	247	418
Michigan	132	295	536	1127
Minnesota	148	200	373	636
Mississippi	128	121	183	865
Missouri	128	164	308	751
Montana	100	156	240	435
Nebraska	—	—	—	—
Nevada	149	203	466	1059
New Hampshire	—	—	—	—
New Jersey	84	176	330	924
New Mexico	127	197	444	977
New York	119	108	227	439
North Carolina	111	173	327	994
North Dakota	97	141	241	451
Ohio	140	198	328	692
Oklahoma	98	124	317	863
Oregon	127	243	—	—
Pennsylvania	116	145	234	412
Puerto Rico	139	238	346	734
Rhode Island	93	148	226	376
South Carolina	103	195	293	809
South Dakota	98	142	255	419
Tennessee	145	245	388	1184
Texas	104	171	352	879
Utah	136	198	647	1427
Vermont	102	125	209	253
Virginia	—	—	—	—
Washington	—	—	—	—
West Virginia	95	152	352	1024
Wisconsin	—	—	—	—
Wyoming	115	123	200	265
SUM (39 states)	**149**	**217**	**447**	**971**

Note Student/teacher ratio = student membership divided by teacher time assigned to subject (number of main assignment teachers + .25 times number with other assignment)
** Arizona, Colorado = All science for students 9—12 — Data not available*
Source State Departments of Education, Data on Public Schools, Fall 1991. California, Fall 1990 NCES CCD Fall Membership 1991.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

TABLE 19
NUMBER OF MATHEMATICS AND SCIENCE TEACHERS IN GRADES 7—8

STATE	Math Teachers	Students/Math Teacher (Grades 7-8)	Science Teachers	Students/Science Teacher (Grades 7-8)
Alabama	1,359	127	1,261	138
Alaska	—	—	—	—
Arizona	—	—	—	—
Arkansas	—	—	—	—
California	6,908	154	4,821	201
Colorado	1,032	103	974	109
Connecticut	937	92	782	99
Delaware	123	—	122	—
Dist. of Columbia	—	—	—	—
Florida	3,029	135	6,119	62
Georgia	—	—	—	—
Hawaii	360	96	221	162
Idaho	405	144	325	168
Illinois	1,166	229	1,072	249
Indiana	1,601	113	1,470	122
Iowa	—	—	—	—
Kansas	628	—	652	—
Kentucky	1,189	110	980	126
Louisiana	—	—	—	—
Maine	425	—	368	—
Maryland	—	—	—	—
Massachusetts	—	—	—	—
Michigan	1,953	134	1,767	147
Minnesota	963	172	843	188
Mississippi	1,038	99	832	124
Missouri	1,294	125	1,289	126
Montana	401	105	381	105
Nebraska	—	—	—	—
Nevada	300	118	198	193
New Hampshire	89	—	—	—
New Jersey	2,322	89	1,237	143
New Mexico	483	119	456	118
New York	6,092	92	5,382	90
North Carolina	2,774	97	2,173	113
North Dakota	459	87	392	100
Ohio	2,634	129	2,220	145
Oklahoma	922	123	850	135
Oregon	645	145	476	178
Pennsylvania	—	—	—	—
Puerto Rico	1,412	92	748	162
Rhode Island	232	90	217	97
South Carolina	1,637	93	1,168	127
South Dakota	319	106	298	112
Tennessee	—	—	—	—
Texas	6.421	114	5,742	120
Utah	272	316	217	426
Vermont	—	—	—	—
Virginia	—	—	—	—
Washington	—	—	—	—
West Virginia	461	112	276	189
Wisconsin	—	—	—	—
Wyoming	231	79	199	92
SUM (36 states)	**52,516**	**166**	**46,528**	**177**

Note Student/teacher ratio = student membership divided by teacher time assigned to subject (number of main assignment teachers + .25 times number with other assignment) Math total = All teachers assigned to math 1 or more periods/classes — Data not available
Source State Departments of Education Data on Public Schools, Fall 1991, California, Fall 1990
Council of Chief State School Officers. State Education Assessment Center, Washington, DC. 1993

30 students, while only 1 in 7 students could take physics. The student/teacher ratios also differ widely by state.

The students/mathematics teacher ratio shows that 13 states reported more than 135 students per teacher in mathematics with Alabama the highest at 192 students per teacher, and California next at 180 students per teacher, whereas 8 states have less than 100 students per teacher. This ratio means if all grade 9-12 students in Alabama were taking mathematics at one time, the average teacher would be teaching 192 students. The states with high ratios are likely to have less flexibility to respond to increased student interest in mathematics.

In chemistry, four states have more than 500 students per teacher (Alabama, California, Michigan, and Utah), and 8 states have more than 1,000 students per physics teacher. States with very high ratios of students per science teacher would have great difficulty in increasing instruction in chemistry and physics.

Grades 7-8 Teachers

The total numbers of science and mathematics teachers in grades 7-8 by state are shown in Table 19. Some states have all teachers at these grades assigned by subject area only; other states have many teachers with a general assignment that may include science or mathematics in middle schools or self-contained classes. The data on general grade 7-8 assignments are incomplete for many of the states. In 35 reporting states, there are 52,500 mathematics teachers and 46,500 science teachers in grades 7-8. If we use statistical imputation for nonreporting states, we can estimate the national total as 63,100 mathematics and 55,600 science teachers in grades 7-8.

The student/teacher ratios are also reported in Table 19. Most states have mathematics ratios of 70 to 120 students per teacher. Two states have more than 200 students per teacher assigned in mathematics, which probably means that most mathematics teaching is done by teachers with an assignment and certification in elementary or general secondary education. Eleven states report fewer than 100 students per mathematics teacher. The student/science teacher ratios are slightly higher across the states, with 3 states reporting more than 200 students per science teacher and 5 states reporting fewer than 100 students per teacher.

Main vs. Other Assignments

Figure 6 shows the proportion of all high school teachers in mathematics and four science fields—teachers who teach a majority of time in that field ("main assignment"). Nationally, 8 of 10 teachers of mathematics have their main assignment in mathematics, and 2 of 10 teach less than half time in mathematics. In the teaching fields of physics and earth science, a far smaller proportion of teachers are assigned a majority of their teaching time to these fields—3 of 10 physics teachers and 5 of 10 teachers of earth science.

Figure 6 also illustrates the proportion of science and mathematics teachers in grades 7 and 8 that teach a majority of time in the subject (main assignment). The percentages show that 7 of 10 middle grades science teachers primarily teach science, and 6.5 of 10 mathematics teachers at this level primarily teach mathematics. One-third of mathematics teaching is done by teachers from other disciplines. Fifteen states reported data on grade 7-8 teachers with a general elementary or middle school assignment, who teach mathematics or science. In Colorado, Illinois, Kansas, Ohio, and Oregon, teachers with a general assignment teach a third or more of the mathematics and science in grades 7 and 8 (see Appendix Table B-6).

State-by-state data on teaching assignments (see Appendix Tables B-1 through B-6) show that states vary widely in the proportion of teachers with their main assignment in science and mathematics. For example, states with over 90 percent of their high school mathematics teachers spending a majority of time teaching mathematics are Arizona, Colorado, Illinois, Michigan, New Jersey, Oklahoma, Pennsylvania, Rhode Island, and West Virginia. At the other extreme, one-third or more of high school mathematics teaching is done by teachers from other disciplines in California, Hawaii, Idaho, North Dakota, Puerto Rico, South Dakota, and Utah—teachers who have their main assignment in another subject.

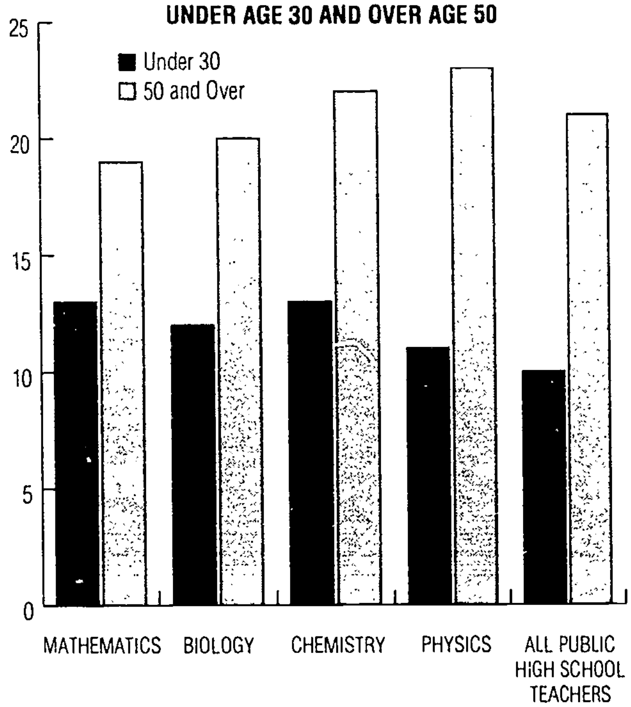
Higher numbers of teachers with "other assignments" in mathematics and science may be due to population growth (such as in California), as well as increases in state course requirements. In science, states with more small, rural districts, such as Arkansas, Oklahoma, and North Dakota, have fewer teachers with primary assignments in any of the science fields; and states with a greater proportion of urban and suburban districts, such as Connecticut, New York, and Pennsylvania, have more teachers with primary assignments in the science fields.

Age of Science and Mathematics Teachers

In 1990, the states reported data on the age distribution of science and mathematics teachers. These data were not repeated in the 1992 data report from states, but data collection will be repeated in the 1993-94 school year.

Data on the age of science and mathematics teachers provide useful information for estimating possible shortage fields as teachers near retirement age. Figure 7 shows summary statistics from the state aggregate data on teacher age by field. Illustrated are the proportion of teachers aged 50 and over and under age

FIGURE 7
PERCENTAGE OF MATHEMATICS AND SCIENCE TEACHERS UNDER AGE 30 AND OVER AGE 50



Source: State Departments of Education. Data on Public Schools. Fall 1989. N. Carolina. Fall 1988
Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1993.

30 in the 36 reporting states. The proportion of teachers over age 50 varies by teaching field from 19 percent of mathematics teachers to 23 percent of physics teachers. The proportion under 30 varies from 13 percent in mathematics and chemistry to 12 percent in biology and 11 percent in physics. The proportion of science and mathematics teachers reaching retirement age varies little from the average of 21 percent over 50 among all high school teachers.

The age distributions of mathematics and science teachers do vary widely by state in all fields. Table 20 shows that shortages of science and mathematics teachers can be anticipated in a few states with much percentages of their teaching force over age 50, including Minnesota, Delaware, California, Michigan, and Wisconsin. States with numbers of teachers over age 50 significantly below the average are Alabama, Kentucky, North Dakota, Ohio, Oklahoma, and South Carolina. According to NCES projections, attrition rates from elementary and secondary teaching will be rising to almost 10 percent per year after 1995 because of increasing retirement (NCES, 1989). States that have flat or declining populations over the past two decades, particularly northeastern and midwestern states, have higher proportions of older science and mathematics teachers. Many of the teachers over 50 years of age in these states were hired in the 1960s when school enrollments were increasing.

TABLE 20
PERCENTAGE OF MATHEMATICS AND SCIENCE TEACHERS OVER AGE 50: HIGH AND LOW STATES

High States	Math	Biology	Chemistry	Physics
California	26 %	21 %	23 %	22 %
Connecticut	20	24	27	29
Delaware	28	23	41	29
Illinois	23	28	30	32
Michigan	24	26	33	29
Minnesota	29	30	45	43
Low States				
Alabama	13 %	12 %	15 %	18 %
Kentucky	10	14	13	12
North Dakota	13	16	13	16
Ohio	13	16	15	14
Oklahoma	11	9	13	18
South Carolina	13	13	17	17
NATION	**19 %**	**20 %**	**22 %**	**23 %**

Source State Departments of Education. Data on Public Schools. Fall 1989. N Carolina. Fall 1988
Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1990

INDICATORS OF EQUITY IN THE TEACHING FORCE

For the 1990 Council report, states reported data on two indicators of equity among current teachers in science and mathematics: gender and race/ethnicity. The distribution of science and mathematics teachers by gender and race/ethnicity provides a basis for states and the nation to compare the characteristics of the current teaching force with goals of improving the match between students and teachers in terms of gender and race/ethnic characteristics.

National survey data show that minority science and mathematics teachers and female science teachers are vastly under represented considering the student population in our schools (Weiss, 1987). Oakes' analysis of teacher characteristics and student participation and opportunities in science and mathematics demonstrated that the rate of participation of minority and female students in science and mathematics is related to the characteristics of their teachers (Oakes, 1990a).

Gender of Science and Mathematics Teachers

Figure 8 provides national summary statistics on the gender of high school science and mathematics teachers in four fields as of 1990, based on data from 40 states. The percentage of female teachers differs by subject: 45 percent in mathematics, 37 in biology, 34 in chemistry, and 22 in physics. By comparison, 50 percent of all high school teachers are female.

State-by-state statistics on the gender of mathematics and science teachers show that the distributions vary widely. For example, in mathematics, Figure 9 shows that the percentage of female teachers varies from 21 percent in Minnesota to 69 percent in both North and South Carolina.

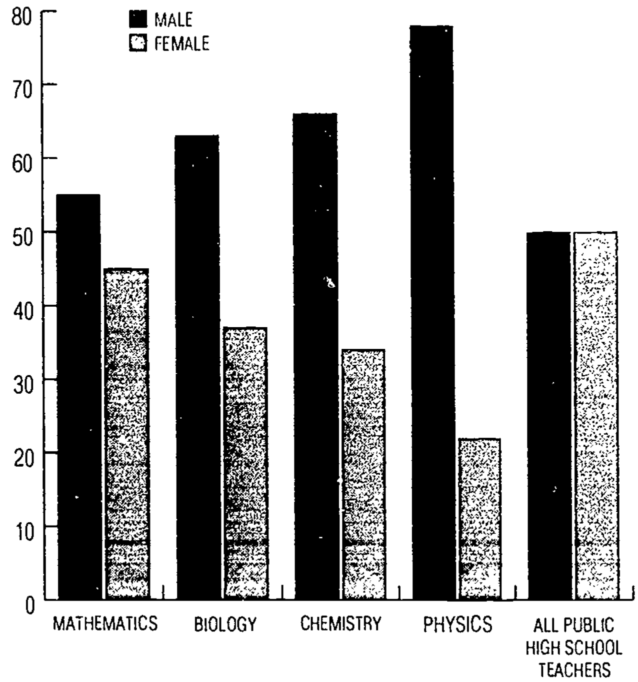
Figure 9 also indicates that in biology the percentage of females varies from 16 percent in Montana and Wisconsin to 63 percent in Alabama. The percentages of female mathematics and science teachers by state shows that geographic region is associated with the gender of science and mathematics teachers. Thirteen states have more female than male mathematics teachers, and eight of these states are in the Southeast. Six states have more female mathematics teachers than female high school teachers in general: Alabama, Kentucky, Mississippi, New Jersey, North Carolina, South Carolina, and Virginia. States in the Southeast have the highest proportion of female high school science and mathematics teachers, and states in the Midwest have the lowest proportion.

New Teachers in Science and Mathematics

A second indicator of equity in teacher supply is the number of new, first-year teachers entering science and mathematics teaching in each state.

Table 21 provides a state-by-state comparison of the proportion of new mathematics and science

FIGURE 8
GENDER OF MATHEMATICS AND SCIENCE TEACHERS
(40 STATES)



Source State Departments of Education. Data on Public Schools. Fall 1989. N Carolina. Fall 1988
Council of Chief State School Officers, State Education Assessment Center. Washington. DC. 1993

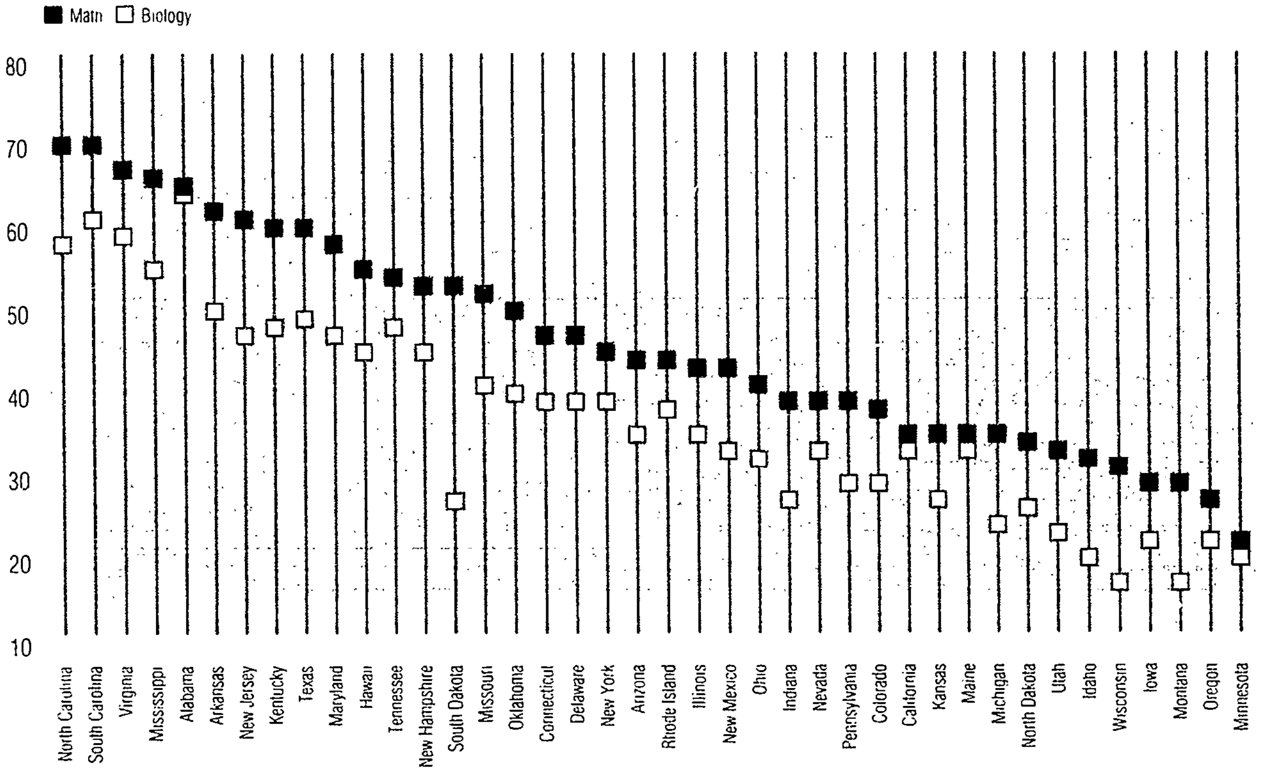
teachers in their first year of teaching. The data on mathematics teachers show that:

- Five states have more than 6 percent new first-year mathematics teachers (Arkansas, 17; Idaho, 10; Mississippi, 37; Montana, 9; and New Mexico, 7 percent).
- Amo g the reporting states, 5 percent of all mathematics teachers were new, first-year teachers in 1991-92.
- Three states have more than 5 percent new, first-year science teachers (Idaho, 6; Delaware, 12; and Mississippi, 31 percent). Four percent of all high school science teachers were new to teaching in 1991-92.
- About 7 percent of all mathematics and science teachers were new hires (new to current district).
- The data show that over one-third of the teachers hired in mathematics and science were experienced teachers who either transferred from another district or state, or returned to teaching. The states with over half of new hires in 1991-92 being experienced teachers were: California, Delaware, Minnesota, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, and Texas.

New Minority and Female Teachers

In 1991-92, the states reported the numbers of new teachers by gender and race/ethnicity. These data provide a current update on the degree of suc-

FIGURE 9
PERCENTAGE OF FEMALE TEACHERS IN MATHEMATICS AND BIOLOGY



Source State Departments of Education. Data on Public Schools, Fall 1989. N Carolina Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

cess that schools are having in each state in recruiting and hiring more minority and female science and mathematics teachers. The summary statistics are as follows.

CHANGE IN COMPOSITION OF SCIENCE AND MATHEMATICS TEACHING (1991-92)

	Percent Minority	Percent Female
All Mathematics teachers	11	45
New, First-Year Mathematics teachers	14	55
All Science teachers	8	34
New, First-Year Science teachers	12	52

The data show that the percentage of new minority teachers in mathematics (14 percent) and science (12 percent) is slightly greater than the current representation of minorities in the teaching force in high schools (11 percent mathematics, 8 percent science). More than half of new science and mathematics teachers are female, and the percentages are significantly higher than the current representation of female teachers. These data on new teachers are consistent with national data from NSF surveys of college graduates which show a recent trend of only small increases in the number of minority graduates in science, mathematics, and engineering, but larger increases in the numbers of female graduates in these fields (National Science Board, 1991).

State-by-state data on new minority and female teachers are shown in Appendix Table B-17. The state figures show that nine states have a larger proportion of new minority mathematics teachers than the current representation of minority teachers (California, Connecticut, Michigan, New Jersey, North Dakota, Pennsylvania, Rhode Island, Texas, Utah). Nine states also have a larger proportion of minority science teachers than the current representation (California, Connecticut, Delaware, Kentucky, New Mexico, Pennsylvania, Rhode Island, Texas, Utah).

Race/Ethnicity of Science and Mathematics Teachers

A third indicator of equity in the science and mathematics teaching force is the race/ethnicity of current teachers. In 1990, state data on the race/ethnicity of science and mathematics teachers (grades 9-12) showed the following percentages of white and minority teachers in 33 reporting states (with percent minority teachers equal to the sum of four race/ethnic groups: African American, Hispanic, Asian American, and American Indian/Pacific Islander).

PERCENTAGE OF NEW TEACHERS IN MATHEMATICS AND SCIENCE (FALL 1991)

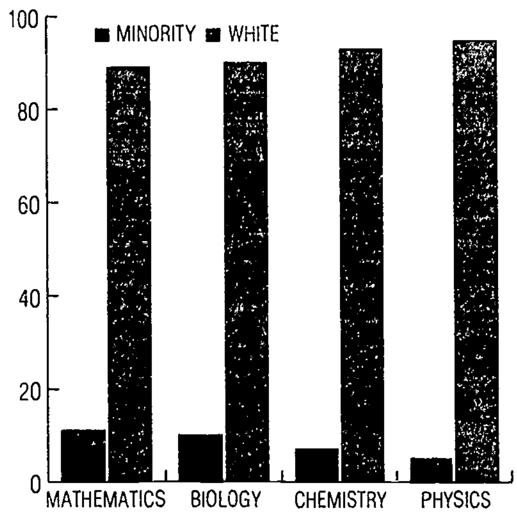


Table 22 shows that the states with the highest proportions of minority teachers in science and mathematics (over 15 percent) are in the Southeast states and Hawaii. There is relatively little variation among mathematics, biology, and chemistry in the percentage of minority teachers, although chemistry and physics have slightly fewer minorities in most states.

Table 22 also provides state-by-state comparisons of the proportion of minority high school science and mathematics teachers with the proportion of minority students. Among the 33 states that reported teacher race/ethnicity by field, only 11 states had over 10 percent minority teachers in any of the three fields. Of the 20 states with more than 20 percent minority students, only 5 states have even half as many minority teachers in mathematics, biology, or chemistry as the proportion of minority students (Virginia, Alabama, South Carolina, Mississippi, Hawaii).

New Teachers in Large Cities

The five states that reported data for the pilot study of science and mathematics in large cities also reported on the number of new teachers in Appendix Table B-7. The data show that large city school districts have about the same percentage of new, first-year teachers as their states as a whole. California has 5 percent new, first-year mathematics and science teachers, and the 11 large cities have about the same percentages. Ohio and Texas have fewer new teachers in large city schools than the state average. New York had slightly more new mathematics teachers in 3 large cities, but both percentages are small (2 vs. 1 percent).

Three of the four states had fewer new hires in large cities than the state as a whole. For example,

TABLE 21
NEW HIGH SCHOOL TEACHERS IN SCIENCE AND MATH (1991-92)

STATE	% New of All Math	% New of All Science	% Newly Hired Math	% Newly Hired Science
Alabama	4 %	3 %	7 %	5 %
Alaska	—	—	—	—
Arizona	—	—	—	—
Arkansas	17	3	17	3
California	5	4	10	7
Colorado	4	5	7	8
Connecticut	1	1	—	—
Delaware	8	12	23	18
Dist. of Columbia	—	—	—	—
Florida	5	5	5	5
Georgia	—	—	—	—
Hawaii	6	3	10	4
Idaho	10	6	14	9
Illinois	3	4	6	6
Indiana	2	2	—	—
Iowa	3	2	4	4
Kansas	4	4	6	5
Kentucky	6	3	9	5
Louisiana	—	—	—	—
Maine	2	1	—	—
Maryland	—	—	—	—
Massachusetts	—	—	—	—
Michigan	6	3	3	2
Minnesota	3	3	7	7
Mississippi	37	31	—	—
Missouri	5	4	9	7
Montana	9	5	—	—
Nebraska	—	—	—	—
Nevada	5	5	7	6
New Hampshire	—	—	—	—
New Jersey	2	2	3	5
New Mexico	7	4	15	10
New York	1	1	4	4
North Carolina	5	5	10	8
North Dakota	5	3	12	10
Ohio	3	2	6	4
Oklahoma	5	4	13	10
Oregon	4	3	9	6
Pennsylvania	2	1	2	2
Puerto Rico	4	4	4	4
Rhode Island	3	1	—	—
South Carolina	4	3	8	6
South Dakota	4	4	11	11
Tennessee	—	—	—	—
Texas	6	5	14	11
Utah	1	1	1	1
Vermont	2	3	4	3
Virginia	—	—	—	—
Washington	—	—	—	—
West Virginia	—	—	—	—
Wisconsin	—	—	—	—
Wyoming	8	3	13	7
SUM (38 states)	**5 %**	**4 %**	**7 %**	**7 %**

Note: New 1st year = 0 year teaching experience. Newly hired - 0 year experience in current district. Science = 1 or more periods assigned in biology, chemistry or physics adjusted for 1/3 of teachers with multiple science assignments. Math = 1 or more period assigned in math. Source: State Departments of Education, Data on Public Schools Fall 1991. California, Fall 1990. — Data not available

Council of Chief State School Officers, State Education Assessment Center, Washington, DC 1993

TABLE 22
MINORITY TEACHERS IN MATHEMATICS AND SCIENCE BY MINORITY STUDENTS IN STATE

STATE	% Minority Students (K—12)	% Minority Teachers (9—12) Math	Biology	Chemistry	Physics	All High School
Maine	3 %	.2 %	0 %	0 %	0 %	.3 %
Idaho	8	2	1	0	1	2
Iowa	8	.4	0	1	1	1
Utah	8	2	2	1	1	3
North Dakota	9	.2	1	1	0	2
Kentucky	10	2	3	1	1	4
Montana	12	1	1	0	0	2
Kansas	14	3	2	4	3	4
Indiana	14	3	3	2	.3	4
Wisconsin	15	2	2	1	1	2
Ohio	16	3	5	2	1	6
Pennsylvania	17	3	3	1	.4	3
Rhode Island	17	2	2	5	0	6
Michigan	22	7	3	1	1	8
Connecticut	23	3	3	2	2	5
Colorado	25	5	6	—	—	7
Nevada	26	9	7	3	0	10
Arkansas	27	10	10	6	4	10
Oklahoma	28	5	5	4	1	6
Delaware	30	8	4	0	10	11
North Carolina	32	14	16	11	6	16
Virginia	32	13	14	10	10	15
New Jersey	32	10	7	5	3	10
Illinois	35	11	12	7	4	12
Maryland	38	17	16	—	—	—
Arizona	39	6	5	—	—	10
Alabama	41	18	19	17	15	21
South Carolina	43	22	21	17	15	20
Texas	48	18	17	11	8	19
Mississippi	48	26	30	27	24	31
California	53	18	16	12	9	18
New Mexico	58	20	19	19	15	25
Hawaii	76	71	61	67	59	78
SUM (33 states)	**31 %**	**11 %**	**10 %**	**7 %**	**4 %**	**11 %**

Note Percent minority teachers = Asian/Pacific Islander, Black, Hispanic, and American Indian Number of teachers in each race/ethnic group available in Blank & Dalkilic, 1990 Minority teachers reported under Biology for Colorado, Arizona Maryland = All science fields
Sources (Teachers) State Departments of Education, Fall 1989, (Students) NCES, Schools and Staffing Survey Washington, DC, U S Department of Education Spring 1991
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

California large cities had 8 percent new mathematics hires, as compared to the state average of 10 percent. Texas' large cities had about half the percentage of new hires as state as a whole. The data on new hires in large cities versus state averages confirm the verbal reports of administrators in urban districts on the difficulty of attracting and hiring science and mathematics teachers. A larger portion of new hires in large cities are first-year teachers. Part of the problem may be due to large city districts having restricted budgets that limit their ability to attract more highly paid, experienced teachers; and it is likely that many experienced teachers are not interested in transferring to large urban school systems.

TEACHER PREPARATION IN SCIENCE AND MATHEMATICS

The Council's priority indicators of science and mathematics education focus on three indicators of teacher preparation: (1) the proportion of teachers with state certification in the assigned teaching field, (2) the percentage of teachers with a major in their assigned teaching field, and (3) the average number of college courses that teachers have completed in science and mathematics.

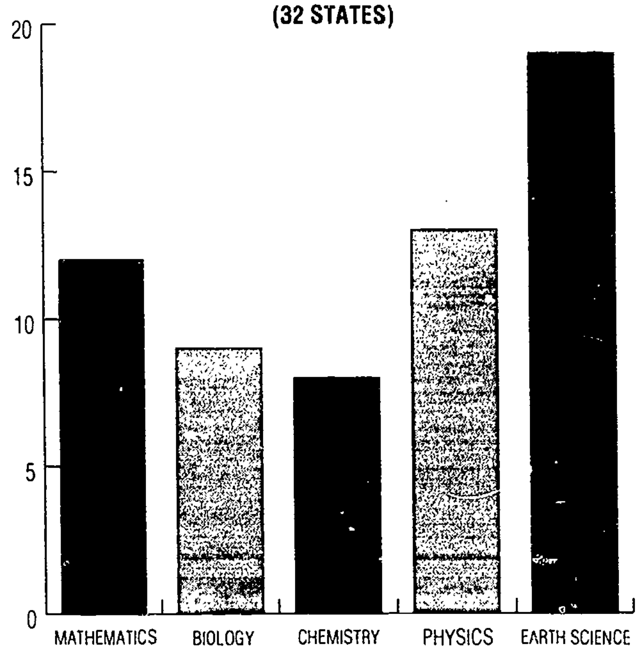
Certification in Teaching Field

State certification in the assigned teaching field indicates that teachers have a basic level of preparation in the subject. Using state personnel files and teacher assignment data, states reported, for example, the percentage of high school biology teachers that are certified in biology. Additionally, the data were disaggregated by teachers who spend a majority of their time teaching biology (main assignment), and those teaching biology as a secondary or third assignment (other assignment). Often, policymakers and educators are interested in the percentage of teachers who are *not* state certified (i.e., the percentage of "out-of-field" teachers). The proportion of teachers who are certified in the fields in which they are teaching is an important policy indicator for state and local educators because state certification is often used as a basic measure of teacher qualification and as an indicator of teacher supply and shortage (Murnane & Raizen, 1988). It is not an adequate measure of quality of teacher preparation, particularly in cross-state comparisons, because of the differing state standards for certification.

For the 1992 science-mathematics indicators, 32 states reported the numbers of teachers certified, or not certified, in their assigned teaching fields. The data are supported by states in Tables 23 (grades 9-12). As shown in Figure 10, among the high school teachers in the reporting states, 12 percent of mathematics teachers were not state certified in mathematics, 9 percent of biology teachers were not certified, 8 percent of chemistry teachers, 13 percent of physics teachers, and 19 percent of earth science teachers. Among the teachers in grades 7-8, 10 percent of mathematics teachers were not certified in mathematics, and 11 percent of science teachers were not certified in science. In addition, 26 percent of grade 7-8 mathematics teachers and 19 percent of science teachers were certified in general elementary, middle grades, or secondary teaching.

The total percentage of teachers certified and not certified can be disaggregated by main assignments versus other assignment by subject.

FIGURE 10
PERCENTAGE OF HIGH SCHOOL MATHEMATICS AND SCIENCE TEACHERS NOT STATE CERTIFIED (32 STATES)



Source: State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990 Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

CERTIFICATION OF HIGH SCHOOL MATHEMATICS AND SCIENCE TEACHERS BY ASSIGNMENT

	Main Assignment		Other Assignment	
	% Certified	% Not Certified	% Certified	% Not Certified
Mathematics	73	6	14	6
Biology	63	4	28	5
Chemistry	56	3	36	5
Physics	33	3	54	10
Earth Science	48	6	32	14

The summary figures show that in the sciences a majority of teachers that are not state certified are assigned to the subject as an "other" (or second) assignment. In high school mathematics, one-half of the 12 percent of teachers not certified have mathematics as their main assignment (6 percent) and one-half teach mathematics as an other assignment. In physics, over two-thirds of teachers are assigned on a part-time basis, and 1 of 6 of these teachers are not certified in physics.

TYPE OF CERTIFICATION OF SCIENCE TEACHERS

	% Certified Specific Field	% Certified Broad-Field	% Not State Certified
Biology	72	19	9
Chemistry	66	26	8
Physics	56	31	13
Earth Science	53	27	20

Two-thirds of the states certify secondary science teachers through "broad field" certification, as well

TABLE 23
CERTIFICATION OF MATH AND SCIENCE TEACHERS: GRADES 9-12

STATE	Math: % Not Certified	Biology: % Not Certified	Chemistry: % Not Certified	Physics: % Not Certified	Earth Science: % Not Certified
Alabama	4 %	2 %	6 %	19 %	10 %
Arkansas	1	2	7	11	9
California	20	18	17	17	12
Connecticut	2	3	2	12	24
Colorado	25	7	—	—	—
Delaware	6	6	0	7	0
Florida	29	19	3	3	28
Idaho	4	4	18	40	11
Illinois	21	22	17	17	8
Indiana	4	4	6	15	35
Kentucky	1	2	2	16	55
Minnesota	2	2	12	11	23
Misssissippi	10	20	25	50	14
Missouri	1	4	7	26	35
Montana	1	4	1	4	5
Nevada	5	1	0	4	8
New Mexico	.4	.3	0	1	2
New York	8	8	7	16	23
North Carolina	7	3	.2	8	8
North Dakota	0	0	0	0	0
Ohio	10	4	2	3	5
Oklahoma	5	3	4	10	29
Oregon	14	4	—	—	—
Pennsylvania	13	9	9	11	8
Puerto Rico	10	1	1	6	5
Rhode Island	0	0	0	0	0
South Carolina	8	8	6	8	50
South Dakota	1	1	2	7	0
Utah	12	13	13	18	36
Vermont	3	—	—	—	—
West Virginia	5	6	10	12	3
Wyoming	8	4	6	7	3
SUM (32 states)	**12 %**	**9 %**	**8 %**	**13 %**	**19 %**

Note % Not Certified = Teachers assigned 1 or more period/class to subject with no state certification in subject Colorado Biology = All science · --Data not available
Source State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington, DC 1993

as in specific fields of biology, chemistry, and so forth. (See Appendix Tables B-8 and B-9 for state certification requirements.) The summary data from states show that almost one-third of science teachers in the reporting states were certified through a broad field certification. About the same proportion of teachers had broad-field certification among teachers with their main assignment in science as among teachers with an other assignment in science. Many schools must hire teachers to teach two or three science subjects, and they tend to hire teachers who have received state certification through a broad-field (or nonspecialist) method of science certification.

In Table 23, the state percentages of noncertified teachers vary widely. States with high percentages of noncertified mathematics teachers are California (20 percent), Colorado (25 percent), Florida (29 percent), Illinois (21 percent), and Pennsylvania (13 percent). States with high percentages of noncertified chemistry teachers are California (17 percent), Idaho (18 percent), Illinois (17 percent), Mississippi (25 percent), and Utah (13 percent). In physics, Alabama (19 percent), Kentucky (16 percent), Missouri (26 percent), New York (16 percent), Oklahoma (10 percent), and West Virginia (12 percent) have shortages of certified teachers; and the states with a shortage of certified chemistry teachers also tend to have physics shortages (e.g., California, Illinois, Mississippi, and Utah). Appendix Tables B-10 and B-11 show state data on certification of teachers in grades 7-8.

State Requirements by Rate of Noncertification

States have different requirements for teacher certification and one possible reason for differing rates of noncertified teachers is differences in the level of state requirements for certification. (See Appendix Tables B-8 and B-9 for state requirements.) For example, a question that can be examined is whether states requiring more subject area course credits have higher rates of noncertified teachers. Among the 5 states with high noncertified mathematics teachers, Florida requires 21 credits; Illinois requires 24 credits; and California, Colorado, and Pennsylvania requirements are set by higher education institutions (with state approval of programs). The average state requires 27 credits in mathematics, and 14 states certify through institutions of higher education. Among the 5 states with high rates of noncertified teachers in chemistry, Mississippi requirements are set by institutions of higher education, Idaho requires 20 credits, Illinois requires 24 credits, and Utah requires 45 quarter credits. The average among states is 30 credits. These requirement levels indicate that among states that currently have a shortage of certified teachers in high school mathematics and science, there is no pattern of higher than average requirements.

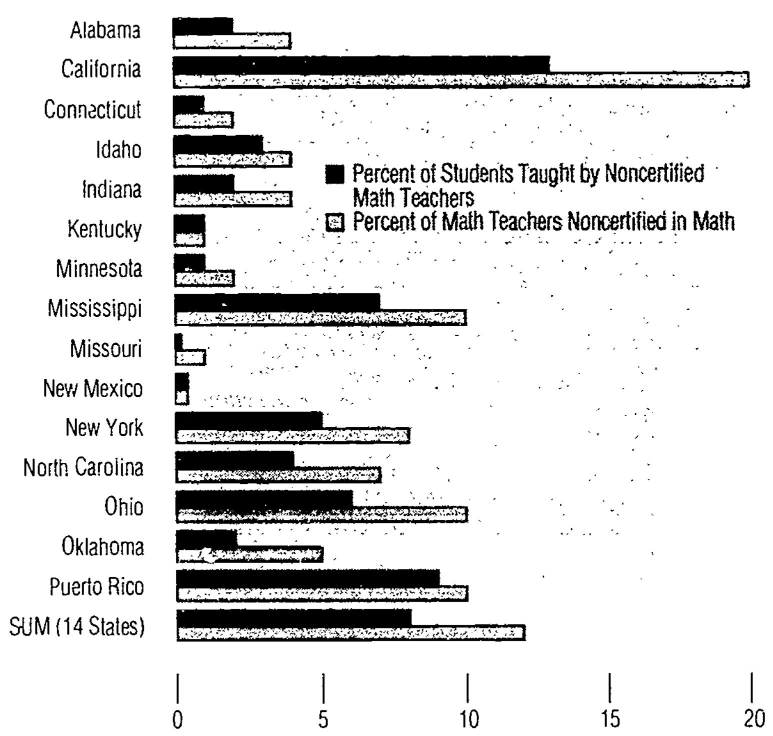
Do states with few noncertified teachers have lower, less stringent requirements? Among five states reporting 0 to 1 percent noncertified in mathematics, Kentucky requires 30 mathematics credits, Missouri 30 credits, Montana 30 credits, Rhode Island 30 credits, South Dakota 18 credits, and North Dakota requirements are set by higher education institutions. Thus, these states do not have less stringent requirements for mathematics certification than other states, and a similar pattern holds in the sciences.

Some states have a policy of recognizing a teacher's "endorsement" to teach courses in a subject that is not their main assignment. The "endorsement" is based on completing a minimum number of credits in a field (often the equivalent of a college minor) to teach courses in the field, and these teachers are typically counted as "certified." This policy reduces the number of noncertified reachers in several states, including Alabama, Maryland, and South Dakota.

Important factors in the rate of noncertified teachers in mathematics and science are related to state demographics. For example, two states with high population growth, California and Florida, have many noncertified mathematics teachers and science teachers. Oakes (1990b) research on equity in science and mathematics shows that schools in inner cities and schools with a high percent minority students have significantly more noncertified teachers (see Figure 12).

Pennsylvania, Illinois, and California have a high percentage of enrollments in schools in large cities that have these characteristics, and these factors raise the state proportion of noncertified teachers. A third factor affecting state noncertified teachers is the number of small rural districts and high schools in the state. Highly rural states, such as Oklahoma, Mississippi, and Utah, experience problems in hiring certified science teachers due to the many small high schools.

FIGURE 11
PERCENTAGE OF STUDENTS IN MATHEMATICS WITH NONCERTIFIED TEACHERS



Source State Departments of Education. Data on Public Schools Fall 1991 California Fall 1990 Council of Chief State School Officers State Education Assessment Center. Washington DC. 1993

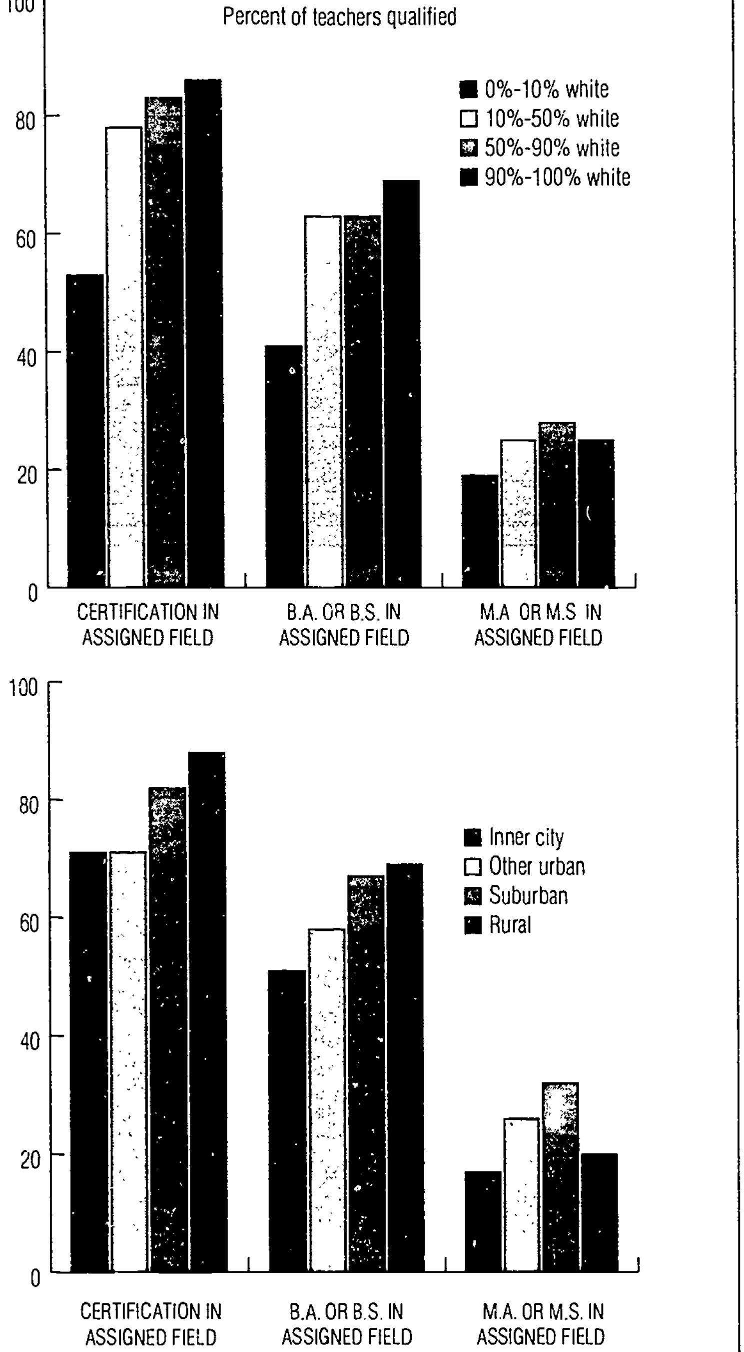
Students Taught by Noncertified Teachers

The percentage of noncertified teachers in a state may not accurately reflect the extent to which mathematics instruction is being provided by poorly prepared teachers. A statistic that gives a clearer picture of the size of the problem is the percentage of *students taught* by noncertified teachers. Figure 11 compares the percentage of noncertified teachers with the percentage of students affected by these teachers. Fourteen states were able to report this level of detail from their state data systems. In sum, 8 percent of high school students are taught by noncertified mathematics teachers as compared to 12 percent of teachers who are not certified in mathematics. Thus, the number of noncertified teachers overrepresents the number of students exposed to these teachers by one-third. California's 20 percent of noncertified teachers in mathematics instruct 13 percent of the students in mathematics (still a large number of students). The 8 percent of noncertified teachers in New York teach 5 percent of the students, and the 10 percent noncertified in Ohio teach 6 percent of the students.

Certified/Noncertified Teachers in Large Cities

The 1992 pilot study of science and mathematics

FIGURE 12
SECONDARY MATHEMATICS AND SCIENCE TEACHERS' QUALIFICATIONS BY SCHOOL RACIAL COMPOSITION AND TYPE OF COMMUNITY



Source Oakes J. Multiplying Inequalities, The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science *Rand Corp. Santa Monica, CA. 1990 p 61*
Council of Chief State School Officers State Education Assessment Center. Washington, DC. 1993

indicators for large cities provides data for three states to compare the proportion of certified teachers in large city schools and state averages. Appendix Table B-18 shows that California has about 10 percent more noncertified mathematics and science teachers in large cities than the state as a whole. New York and Ohio also have more noncertified teachers in their large city districts. In these three states the data show it is more difficult to hire and retain certified mathematics and science teachers in large cities.

College Major in Assigned Teaching Field

A second indicator of teacher preparation in science or mathematics is the percentage of teachers that hold a degree in their assigned field. This indicator sets a higher standard for preparation in science or mathematics than state certification. A teacher's academic knowledge, as measured by the amount of coursework preparation, has been found to be related to student learning, particularly in science and mathematics (Shavelson et al., 1989). Monk's (1993) new analysis of the Longitudinal Study of American Youth, which follows the academic progress of a national sample of students, shows that each additional mathematics course taken by mathematics teachers above the minimum translates into 2 to 4 percent higher student achievement scores (up to 5 additional courses). The National Education Goals Panel uses the percentage of teachers in science and mathematics with an undergraduate or graduate degree, or major, in their teaching field as a measure of progress toward Goal 4 on science and mathematics education (NEGP, 1992). The 1990 Council report on science-mathematics indicators also reported these data as a measure of teachers' coursework preparation.

The 1991 Schools and Staffing Survey (SASS) provides the most recent state-by-state data on college majors of teachers, as reported in Table 24. The state percentages are based on responses from a representative sample of teachers in each state. Small states that had less than 30 math or science teachers in the sample do not have state estimates. The results show that the percentage of high school math teachers with a major in math or math education (undergraduate or graduate degree) varies from 42 percent (Alaska) to 90 percent (Minnesota), for teachers with their *main* assignment in math. For *all* teachers of math, the percentages vary from 25 percent (Alaska) to 87 percent (Alabama) of teachers with a math major. The national average is 69 percent with a math major among teachers with their main assignment in math, and 61 percent with a major among all math teachers. (Standard error estimates for Table 24 are in Appendix Table B-20.)

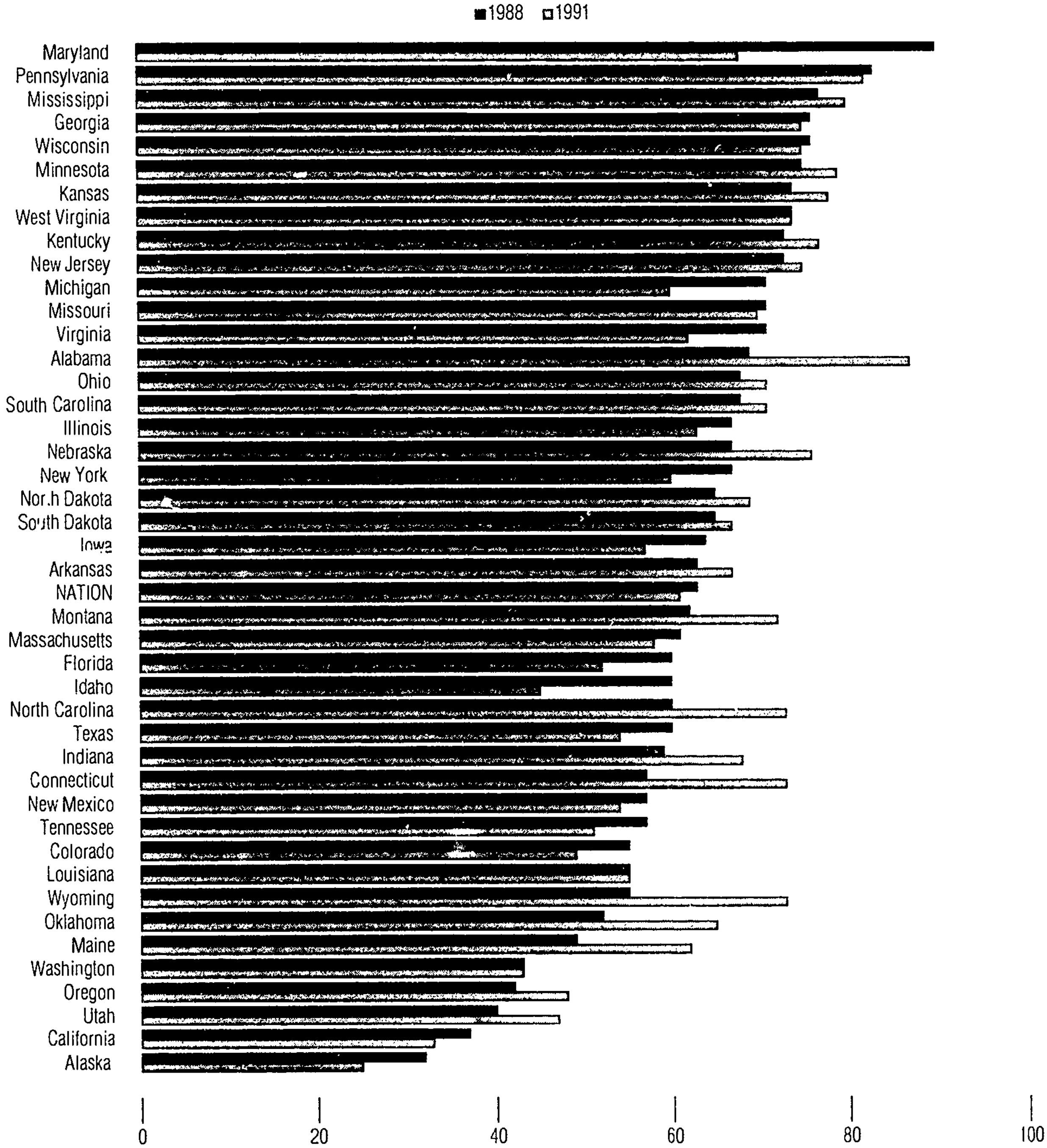
Table 24 also shows the percentage of high school science teachers with a major in a field of science or in science education. The percentage of teachers with a science major varies from 58 percent (Arkansas) to 91 percent (Maryland), for teachers with their main assignment in science. For *all* teachers of high school science, the state percentages vary from 48 percent (Arkansas) to 85 percent (Connecticut). The national average is 79 percent with a science major among

TABLE 24
PERCENTAGE OF MATHEMATICS AND SCIENCE TEACHERS WITH MAJOR IN FIELD (GRADES 9—12, SPRING 1991)

	MATHEMATICS		SCIENCE	
STATE	Main Assignment: % with Major in Math	All Teachers: % with Major in Math	Main Assignment: % with Major in Science	All Teachers: % with Major in Science
Alabama	89 %	87 %	79 %	63 %
Alaska	42	25	86	68
Arizona	68	64	76	69
Arkansas	69	67	58	48
California	44	33	76	62
Colorado	58	49	87	75
Connecticut	80	73	88	85
Delaware	—	—	—	—
Dist. of Columbia	—	—	—	—
Florida	56	52	71	67
Georgia	84	75	87	77
Hawaii	—	—	—	—
Idaho	55	45	77	63
Illinois	69	63	83	77
Indiana	79	68	82	79
Iowa	69	57	82	72
Kansas	82	78	72	66
Kentucky	86	77	85	72
Louisiana	60	55	66	50
Maine	69	62	83	73
Maryland	74	68	91	82
Massachusetts	68	58	86	84
Michigan	76	60	82	70
Minnesota	90	79	87	80
Mississippi	84	80	77	71
Missouri	73	70	79	65
Montana	73	72	75	71
Nebraska	87	76	83	72
Nevada	—	67	—	—
New Hampshire	—	—	—	—
New Jersey	84	75	76	73
New Mexico	55	54	48	41
New York	70	60	89	84
North Carolina	77	73	89	84
North Dakota	79	69	83	63
Ohio	78	71	73	66
Oklahoma	68	65	66	58
Oregon	59	48	90	78
Pennsylvania	84	82	83	78
Rhode Island	—	—	—	—
South Carolina	80	71	79	64
South Dakota	84	67	68	57
Tennessee	56	51	59	52
Texas	59	54	64	56
Utah	65	47	76	66
Vermont	—	—	—	—
Virginia	67	62	78	69
Washington	60	43	76	64
West Virginia	78	74	75	70
Wisconsin	87	75	83	74
Wyoming	85	73	82	77
NATION	**69 %**	**61 %**	**79 %**	**70 %**

Notes Percent with major = Percent of assigned teachers with an undergraduate or graduate degree with a major in math (science field) or math education (science education). see standard errors for estimates in Appendix Table B-18 — Respondents too few for a reliable state estimate
Source NCES. Schools and Staffing Survey Public School Teachers. Washington. DC. U S Department of Education Spring 1991
Council of Chief State School Officers. State Education Assessment Center. Washington. DC 1993

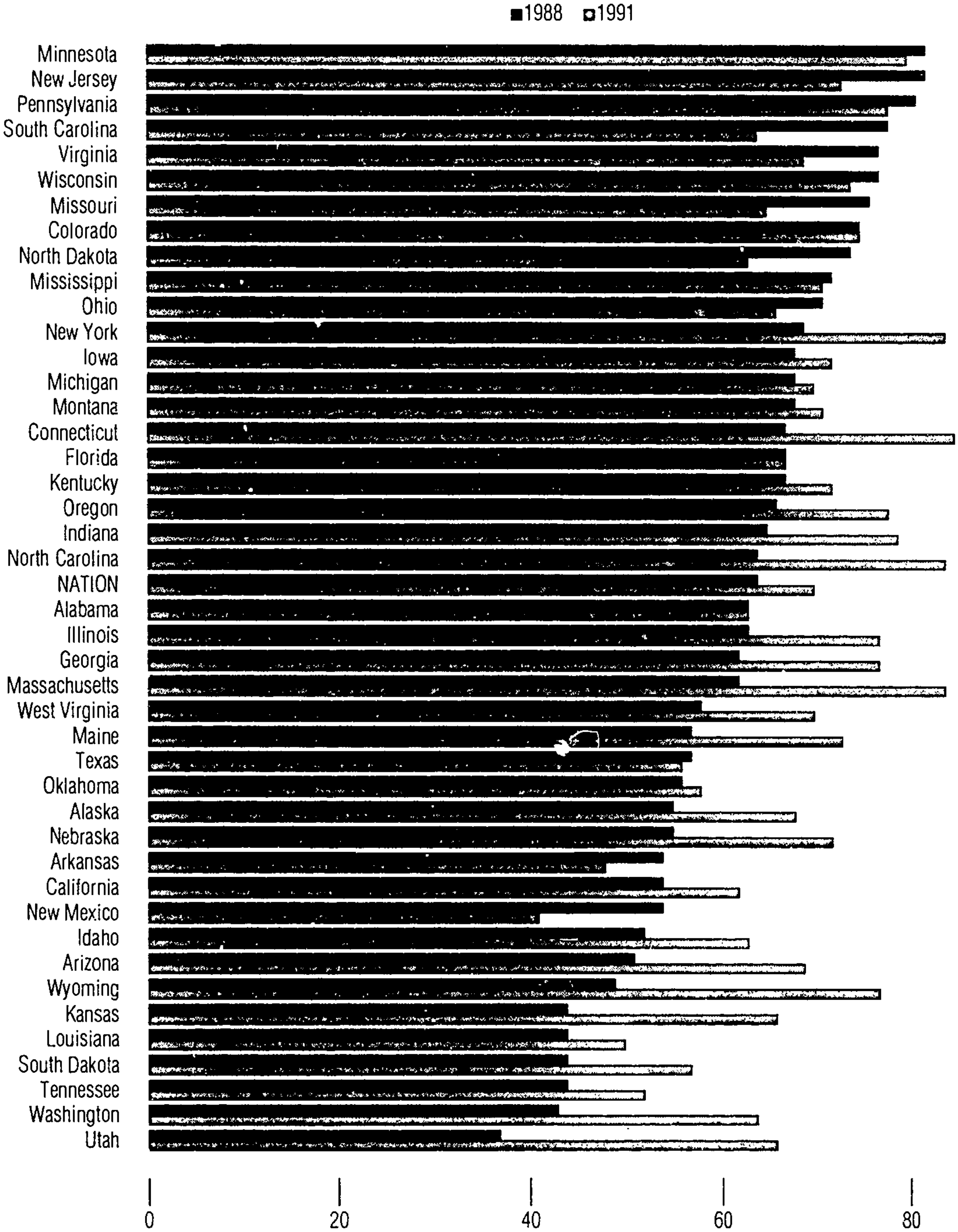
FIGURE 13
CHANGE IN PERCENTAGE OF TEACHERS WITH MAJORS IN MATHEMATICS: 1988 TO 1991



Notes Percent with major = Percent of assigned teachers with an undergraduate or graduate degree with a major in math or math education. see standard errors for estimates in Appendix Table B-20. Interpret 1988 to '91 change by state with caution considering standard errors

Source NCES. Schools and Staffing Survey. Public School Teachers. Washington. DC. U S Department of Education Spring 1988. Spring 1991 Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

FIGURE 14
CHANGE IN PERCENTAGE OF TEACHERS WITH MAJORS IN SCIENCE: 1988 TO 1991



Notes Percent with major = Percent of assigned teachers with an undergraduate or graduate degree with a major in science field or science education. see standard errors for estimates in Appendix Table B-20 Interpret 1988 to '91 change by state with caution considering standard errors

Source NCES. Schools and Staffing Survey. Public School Teachers. Washington. DC. U S Department of Education. Spring 1988. Spring 1991 Council of Chief State School Officers. State Education Assessment Center Washington. DC. 1993 teachers with their main assignment in science, and 70 percent for all science teachers.

The bar graph in Figure 13 illustrates the state-to-state variation in percentages of high school math teachers with a major in their field, and the percent change from 1988 to 1991. Nationally, the percentage of high school mathematics teachers with a mathematics major decreased by 2 percent from 1988 to 1991, from 63 to 61 percent. Figure 14 shows the variation in science majors by state and the percent change from 1988 to 1991. Nationally, the percentage of science teachers with a science major increased by 6 percent, from 64 to 70 percent. Thus, only slight improvement has been made toward one objective for National Goal 4 to "increase by 50 percent the number of teachers with a substantive background in science and math" (NEGP, 1992).

In addition to comparison of state averages, many educators are interested in the variation in preparation of teachers within their state. One approach is to examine the differences in teacher preparation by characteristics of the schools. The results of Oakes' (1990b) analysis of teacher preparation from a national survey of teachers and schools in 1986 are illustrated in Figure 12. The data show clearly that teachers qualifications vary significantly by the characteristics of schools. Students in inner city and urban schools had approximately 70 percent of science and mathematics teachers who were certified in their assigned field and about half of the teachers had a degree in their assigned field. Students in schools with more than 90 percent minority teachers had even less chance of having a well-qualified teacher in science or mathematics.

The results of the National Education Longitudinal Study of the eighth grade class of 1988 showed that 50 percent of math teachers of high-SES students had a degree in math or math education, while 38 percent of teachers of low-SES students had a math degree (Horn & Hafner, 1992).

Amount of Teacher Coursework

The preparation of teachers in their teaching field can also be measured by the number of undergraduate and graduate courses in science and mathematics that teachers have completed. This indicator can provide a more current picture of the preparation of teachers in their field, since the college major could have been completed from 1 to 40 years previously. Also, the number of science and mathematics courses can indicate the preparation of teachers at the level of elementary, middle grades, and high schools. The number of teachers with a degree in science and mathematics may not be a useful indicator in many states for elementary and middle grades teachers.

Two sources of state-level data are available on the number of courses teachers have completed: NAEP and SASS. Both sources are from teachers self-reports. This report includes data from the 1990 NAEP Mathematics teacher questionnaire.

On the NAEP questionnaire teachers reported the number of college courses in completed in the seven areas of mathematics content recommended by the NCTM Professional Standards for the Teaching of Mathematics. As a national average, 52 percent of 8th grade students had mathematics teachers one or more mathematics courses in each of six or seven of the recommended content areas. Forty-eight percent of teachers had one or more courses in five or fewer of the areas. The NAEP results for 1990 demonstrated that the amount of mathematics coursework completed by teachers has a positive relationship to student mathematics proficiency (Mullis et al., 1991). Students who have teachers with coursework in six or seven of the mathematics areas have a significantly higher mathematics proficiency (271) than students who have teachers with coursework in four or five areas (263) or zero to three areas (262).[11]

The state level data on mathematics coursework of teachers shows that seven of the ten states with the highest average mathematics proficiency had rates of teacher coursework in six or seven areas that were above the national average. Three of the high scoring states, North Dakota, Minnesota, and Nebraska, had over 70 percent of their students being taught by teachers with coursework in six or seven areas (see Table B-19 in the Appendix). Conversely, seven of the ten states with the lowest average mathematics proficiency had less than 50 percent of students being taught by teachers with coursework in six or seven areas.

The NAEP assessment also asked teachers to report the number of courses in methods of teaching mathematics that they had completed. The 1990 results indicate that nationally 28 percent of 8th grade students had teachers who had no coursework in the teaching of mathematics, while at the other extreme 20 percent of 8th grade students had teachers with three or more methods courses. However, these differences among teachers in mathematics methods courses were not related to higher or lower average student mathematics proficiency on NAEP. It is possible that the *quality* of preparation and teachers' knowledge of how to teach 8th grade mathematics does make a difference, but the current NAEP questionnaire does not collect this information.

[11]Difference of means significant at the .001 level of statistical significance. This finding indicates a correlation between teachers' coursework in math and students' math proficiency, but there may be other factors that account for the relationship. For example, students with higher achievement entering eighth grade may be assigned to teachers with more coursework in mathematics.

INDICATORS OF SCHOOL CONDITIONS

The conditions for teaching and learning are important factors in the effectiveness of science and mathematics education. Since the initial development of a system of science-mathematics indicators, the Council has sought useful, meaningful indicators of differences in school conditions across states. This report focuses on three kinds of indicators: (1) size of science and mathematics classes, (2) availability of instructional materials and resources, and (3) use of calculators in the classroom.

Class Size

Data from the 1991 Schools and Staffing Survey in Table 25 show that the average class in high school mathematics varies by state from 26 students (California, Florida) to 17 students (Maine, New Jersey, North Dakota, Oklahoma, Wyoming). The national average is 21 students per mathematics class. From 1988 to 1991, the average mathematics class maintained the same number of students, while the average science class increased from 22 to 23. In advanced mathematics classes (algebra 2, trigonometry, or calculus), the average class size is also 22 students. Class size in advanced mathematics varies by state from 30 students per class to 15 students per class. The variation in class size by state is illustrated in Figure 15.

The percent of classes over 30 students provides information on class size distribution by showing the proportion of very large classes in a state. National sample data from SASS show that 9 percent of all math classes have over 30 students. The national results also show that 14 percent of algebra 1 classes have more than 30 students and 11 percent of advanced mathematics classes have over 30 students.

AVERAGE CLASS SIZE AND PERCENT OF CLASSES OVER 30 STUDENTS (GRADES 9-12)

	Average Size	Percent Classes Over 30
All Mathematics	21	9
Algebra '	23	14
Advanced Math (algebra 2, trigonometry, calculus)	22	11
All Science	23	11
Biology	23	10
Physics	18	5

Five states have over 20 percent of classes in advanced mathematics with more than 30 students—Florida (50 percent), California (37 percent), Utah (35 percent), New Mexico (24 percent), Minnesota (22 percent). Twelve states have less than 1 percent of mathematics classes with more than 30 students.

Table 25 shows science class size differs considerably by state. Utah has an average of 28 students per science class and California has an average of 27 per class, while Wyoming averages 16 students in a science class. The national average is 23 students per class. In biology classes, the average size is also 23 students and state averages vary from 17 to 26 students per class.

Nationally, 11 percent of all science classes are over 30 students. The national results also show that 10 percent of biology classes have more than 30 students and 5 percent of physics classes are larger than 30.

Five states have over 20 percent of biology classes with more than 30 students—California, Florida, New York, Tennessee, and Utah. Fifteen states have less than 1 percent of science classes with more than 30 students.

Standard errors for class size by state are shown in Appendix Table B-21.

Teachers' Perceptions of the Availability of Materials

A second indicator of school conditions by state focuses on mathematics education. The 1990 NAEP teacher questionnaire asked eighth grade mathematics teachers: "How well supplied are you by your school system with the instructional materials and other resources you need to teach your class?" The state indicator from the compiled results, as shown in Figure 16, is subjective because it is based on teacher attitudes or opinions, but it does generate data directly from the classroom-level on the availability of materials and resources.

Nationally, teachers of 31 percent of eighth grade students reported they "get some or none" of the materials and resources they need, while 13 percent said they received "all" the materials and resources they need and 56 percent said they received "most" of what they need. The level of agreement with a shortage of materials and resources varied by the socioeconomic level of the school community—only 10 percent in advantaged urban schools, but 40 percent in disadvantaged urban schools and 31 percent in rural schools (29 percent in schools in other areas).

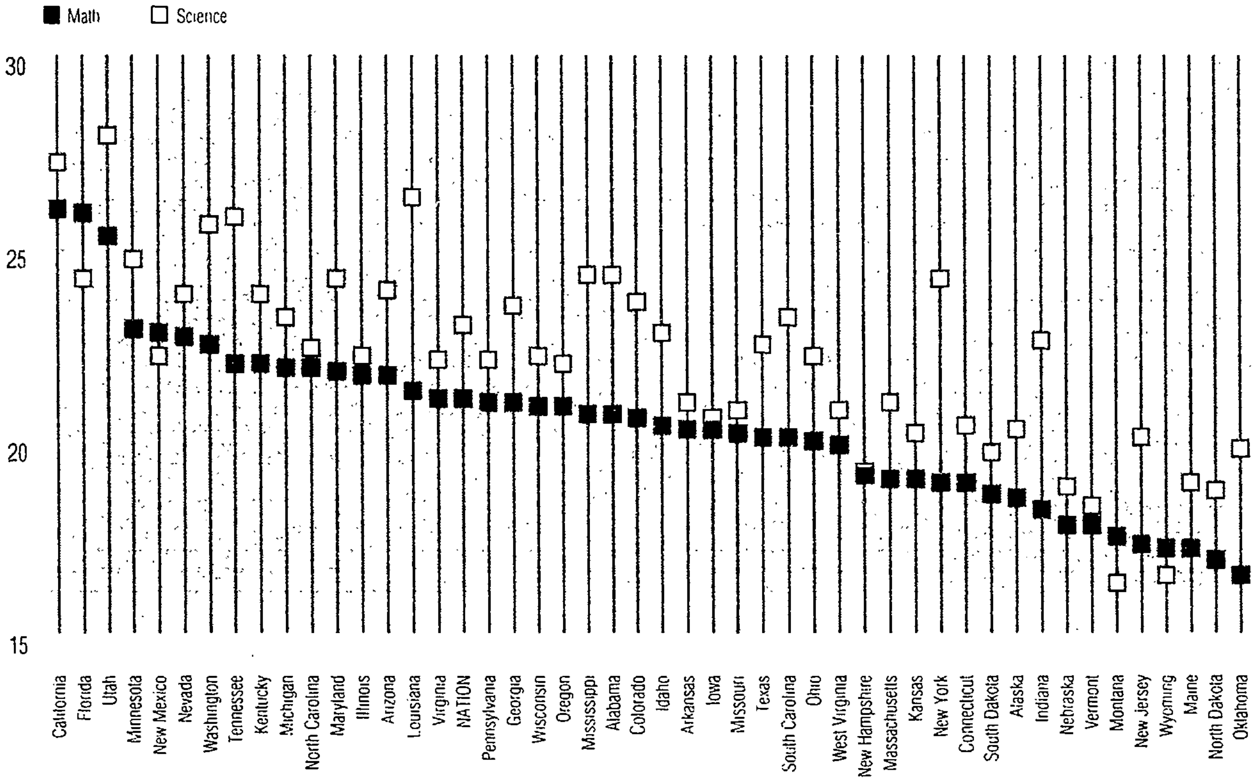
The state percentage of eighth grade teachers that reported having "some or none" of needed materials varied from over 45 percent (Louisiana, West Virginia, District of Columbia, Guam, and Virgin Islands) to less than 20 percent (Iowa and Wyoming). The state NAEP analysis conducted by CCSSO examined the relationship of average state mathematics proficiency to teachers' perceptions of the availability of mathematics materials and resources. There is a strong correlation ($r = -.861$) between average state mathematics proficiency and the state's percentage of students with teachers who receive some or none of the instructional materials and resources they need. As illustrated in Figure 16, the states in the top quintile of mathematics proficiency had an average

TABLE 25
AVERAGE CLASS SIZE IN MATHEMATICS AND SCIENCE AND PERCENT CLASSES OVER 30 STUDENTS (GRADES 9—12)

STATE	All Math Average Class	Percent All Classes Over 30	Advanced Math Average Class	Percent Advanced Over 30	All Science Average Class	Percent All Classes Over 30	Biology Average Class	Percent Biology Over 30
Alabama	20.7	7 8 %	18.9	2.5 %	24.3	17.4 %	22.8	7.8 %
Alaska	18.5	10.0	—	—	20.3	13.4	17.7	15.6
Arizona	21.7	12.2	24.9	23.4	23.9	13.4	24.6	17.8
Arkansas	20.3	<1.0	—	—	21.0	1.6	20.4	<1.0
California	26.0	29.2	29.0	36.9	27.2	27.4	26.3	21.8
Colorado	20.6	5.0	21.2	7.7	23.6	8.0	23.3	6.5
Connecticut	18.9	<1.0	18.5	0.0	20.4	2.9	—	—
Delaware	—	—	—	—	—	—	—	—
Dist. of Columbia	—	—	—	—	—	—	—	—
Florida	25.9	29.8	30.4	50.2	24.2	22.1	25.3	22.2
Georgia	21.0	10.0	23.7	14.7	23.5	11.7	21.8	<1.0
Hawaii	18.8	7.7	—	—	—	—	—	—
Idaho	20.4	7.9	20.1	11.6	22.8	5.1	23.5	2.5
Illinois	21.7	8.2	20.8	6.8	22.2	10.6	20 6	<1.0
Indiana	18.2	3 0	20.2	3.5	22.6	4.3	21.4	<1.0
Iowa	20.3	0.8	17.8	<1.0	20.6	1.0	20.5	<1.0
Kansas	19.0	8.6	14.3	<1.0	20.2	4.8	21.5	<1.0
Kentucky	22.0	11.8	22.6	11.8	23.8	10.6	22.7	9.3
Louisiana	21.3	7.3	21.0	7.3	26.3	17.8	24 8	15.7
Maine	17.2	<1.0	16.0	0.0	18.9	<1.0	—	—
Maryland	21.8	12.9	22.5	10.2	24.2	21.5	23.1	17.3
Massachusetts	19.0	1.9	20.6	<1.0	21.0	3.2	22.1	<1.0
Michigan	21.9	12.0	23.7	7.7	23.2	11.4	22.7	10.7
Minnesota	22.9	12.5	25.0	21.9	24.7	8.4	24.5	7.8
Mississippi	20.7	5.7	19.9	<1.0	24.3	13.6	24.3	12.8
Missouri	20.2	1.6	19 0	3.2	20.8	3.2	19.9	<1.0
Montana	17.5	1.3	18.7	<1.0	16.3	<1.0	17.0	<1.0
Nebraska	17.8	1.4	17.7	<1.0	18.8	3.8	18.7	<1.0
Nevada	22.7	16.2	—	—	23.8	16.2	—	—
New Hampshire	19.1	<1.0	—	—	19.2	0.0	—	—
New Jersey	17.3	<1.0	20.4	0.0	20.1	1.1	19.2	<1.0
New Mexico	22.8	12.2	26.9	24.2	22.2	7.8	22.0	7.1
New York	18.9	7.6	20.6	15.0	24.2	21.3	27.6	20.1
North Carolina	21.9	4.4	23.3	6.1	22.4	3 0	—	—
North Dakota	16.9	1.0	15.1	<1.0	18.7	4 8	17.5	<1.0
Ohio	20.0	1.6	20 6	<1.0	22.2	4.9	22.3	5.6
Oklahoma	16.5	2.4	16.1	<1.0	19.8	5.9	19.4	2.9
Oregon	20.9	5.8	21.6	6.1	22.0	6.0	21.8	5.8
Pennsylvania	21.0	2.9	21.2	<1.0	22.1	9.2	—	—
Rhode Island	—	—	—	—	—	—	—	—
South Carolina	20 1	1.7	19.0	<1.0	23.2	7.7	22.7	3.8
South Dakota	18.6	4.0	16.2	3.7	19.7	3.6	19.3	3.1
Tennessee	22.0	14.2	23.1	15.0	25.8	19.4	26.5	28.4
Texas	20.1	2 9	18.2	1.8	22.5	5.2	23.1	6.4
Utah	25.3	29.1	27.2	35.1	27.9	41.7	25.7	23.2
Vermont	17.8	2.6	—	—	18.3	<1.0	—	—
Virginia	21.1	3.6	22.1	5.8	22.1	0 7	—	—
Washington	22.5	8.2	22.8	16.9	25.6	17.1	26.6	19.1
West Virginia	19.9	1.8	20.3	2.3	20.8	2 9	20.4	0.9
Wisconsin	20.9	4.8	19.3	6.0	22.2	4.5	23.2	<1.0
Wyoming	17.2	<1.0	—	—	16.5	<1.0	16 6	<1.0
NATION	**21.1**	**8.8%**	**21.7**	**10.9%**	**23.0**	**11.0%**	**23.1**	**9.7%**

Notes <1 Less than 1 percent of classes. — Respondents too few for a reliable state estimate. see standard errors in Appendix Table B-21
Source NCES. Schools and Staffing Survey. Public School Teachers. Spring 1991
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

FIGURE 15
AVERAGE CLASS SIZE IN HIGH SCHOOL MATHEMATICS AND SCIENCE



Source NCES, Schools and Staffing Survey, Public School Teachers Spring 1991
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

of 24 percent of students with teachers reporting some or no materials and resources, while the states in the bottom quartile of mathematics proficiency had an average of 52 percent of students with teachers reporting this problem.[12]

Use of Calculators

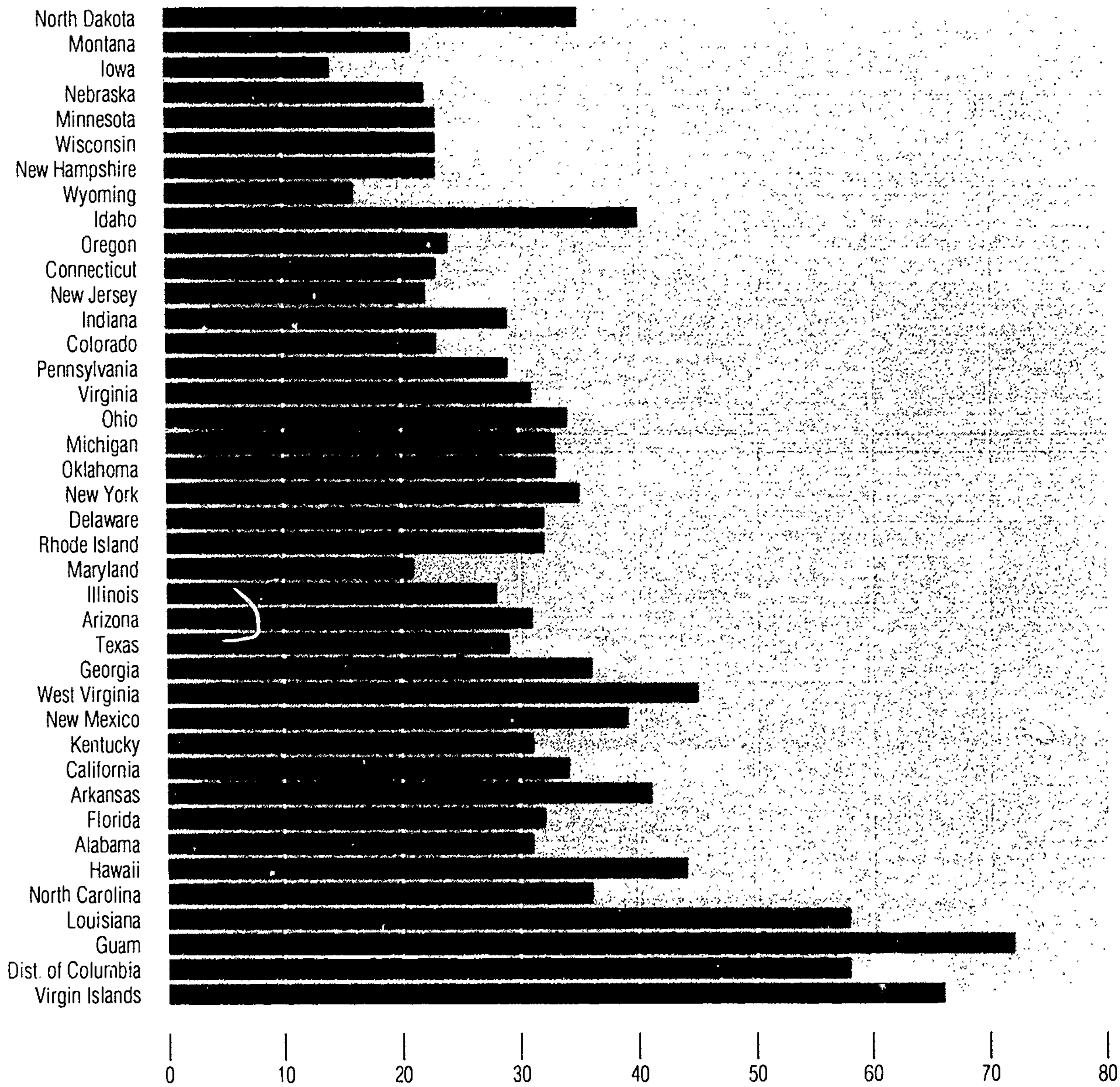
The 1990 NAEP mathematics assessment provided state-level data on students' use of calculators. Nationwide, 19 percent of the eighth grade students in 1990 had unrestricted use of hand calculators in their mathematics classrooms, and 24 percent were permitted use of calculators on tests. The mean NAEP score of students having access to calculators (280) was significantly higher than the score for students with restrictions (263).

The results indicate that students who have access to calculators as part of their daily learning of mathematics are learning more and are not disadvantaged when asked on tests to compete with students who have only used paper and pencil. A large portion of the assessment required these calculator-friendly students to work without their calculators during the NAEP tests.

Figure 17 shows the relationship of overall state mathematics proficiency and the percentage of students allowed unrestricted use of the calculator in mathematics class at the eighth grade level. There is a significant positive relationship. Eleven of the 12 states with highest overall student mathematics proficiency had at least 20 percent of their students reporting unrestricted use of calculators in their mathematics classes, with a mean of 26 percent. Nine of the 12 states with the lowest overall mathematics proficiency had less than 15 percent of their students with unrestricted use of calculators, with a mean of 16 percent.[13]

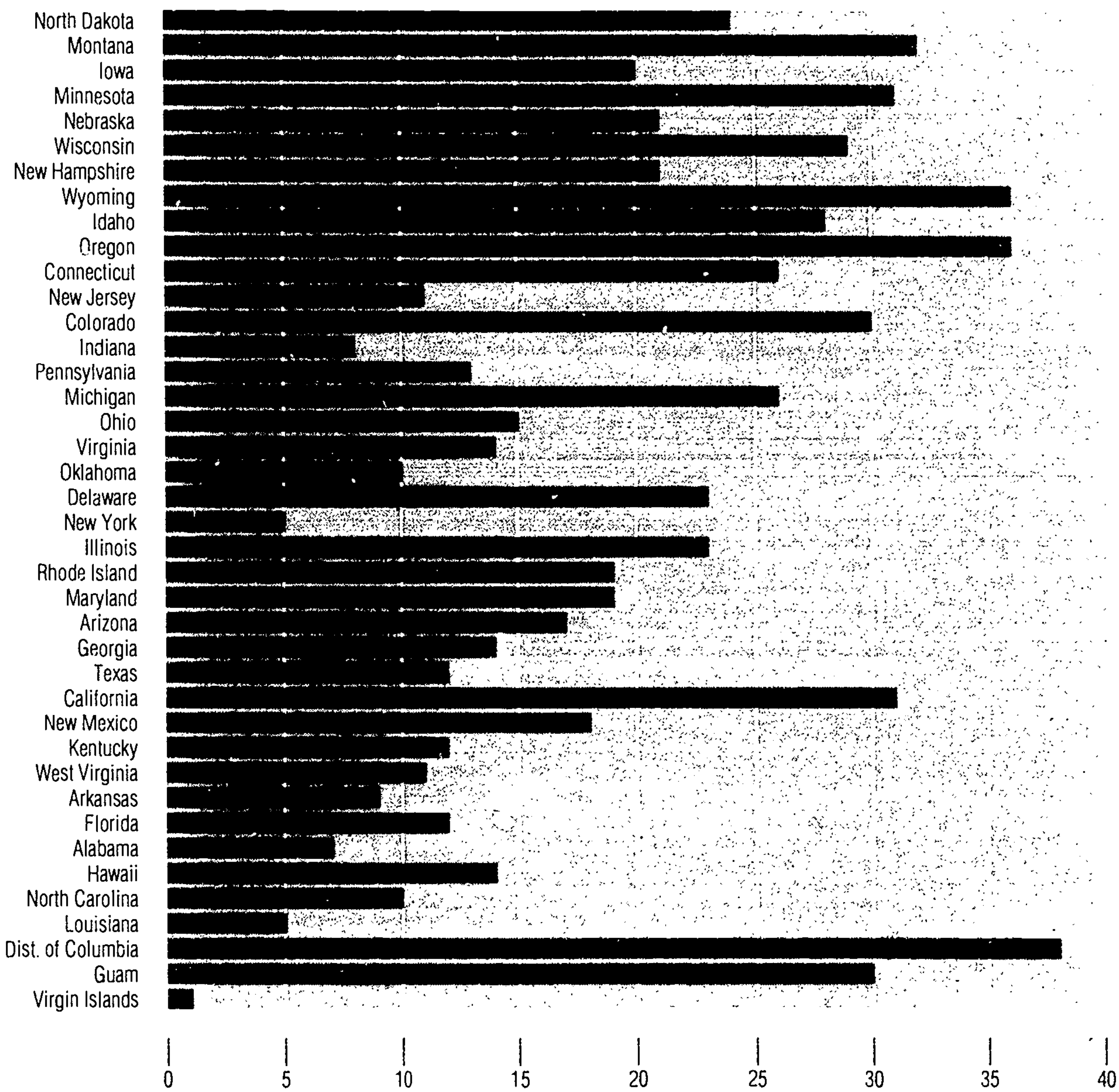
[12] Other analyses show that the state percent of teachers reporting a shortage of materials and resources is correlated with the state SLS.
[13] Difference of means significant at the .02 level of statistical significance.

FIGURE 16
PERCENTAGE OF STUDENTS TAUGHT BY TEACHERS REPORTING THEY GET SOME OR NONE OF THE MATERIALS AND RESOURCES THEY NEED, BY STATE RANK ON MATH PROFICIENCY



Source: Mullis et al., The State of Mathematics Achievement. NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States, U.S. Department of Education, 1991. Council of Chief State School Officers State Education Assessment Center, Washington, DC, 1993

FIGURE 17
PERCENTAGE OF STUDENTS ALLOWED UNRESTRICTED USE OF CALCULATORS IN MATH CLASS, BY STATE RANK ON MATH PROFICIENCY



Source. Mullis et al. The State of Mathematics Achievement NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States U S Department of Education 1991 Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

SUMMARY: STATE AND NATIONAL POLICY ISSUES AND SCIENCE-MATHEMATICS INDICATORS

A major issue in the 1990s for science and mathematics education—and education in general—is the effects of policy reforms and initiatives on improving student learning. The national education goals set a high standard by assessing progress on student learning against achievement levels that reflect the consensus of subject area experts and teachers about what students should know and be able to do. The 1992 NAEP mathematics results show policymakers and mathematics educators that only a quarter of grade 8 students are at or above the Proficient level, and just over 60 percent are at or above the Basic level of achievement.

From 1990 to 1992, 18 states made significant improvement in average student proficiency. In the content areas of the grade 8 mathematics NAEP, 9 states improved student proficiency in Numbers and Operations, 14 states improved in Measurement, 10 states improved in Algebra and Functions, and 4 states improved in Geometry. Only 2 states had significant improvement in the average proficiency of African American students, and 4 states had significant improvement in the proficiency of Hispanic students.

The state results on AP examinations indicate student opportunities and performance at the advanced level of science and mathematics. In 1992, 4 percent of 12th grade students took the AP calculus examination, and 4.4 percent took an AP examination in a science subject. States varied in AP participation from less than 1 percent to over 6 percent of students. Nationally, over 60 percent of students received a qualified score. Minority students comprised one-fourth of all students taking science and mathematics AP examinations, and almost one half were females.

In 1990, states began reporting data to CCSSO on student enrollments in all secondary science and mathematics courses. Course enrollment indicators by state show how far students are proceeding in science and mathematics, the rate of progress in improving science and mathematics opportunities, and the extent of equity in science and mathematics education.

With the 1992 state data, we can begin to analyze trends at the state and national level. In 1992, 87 percent of public high school students were taking mathematics, which was a 3-percent increase since 1990. This overall rise in mathematics enrollments is important because higher level mathematics courses (above first-year algebra) accounted for most of the increase. For example, the percentage of students taking algebra 2 by graduation is up to 55 percent, a 6-percent increase from 1990 to 1992. The data indicate that, as of 1992, slightly more than half of graduates take 3 years of high school mathematics. States vary from 31 to 73 percent of students taking three years of mathematics.

In science, 75 percent of public high school students were taking a course as of 1991-92, which represents a 3-percent increase since 1990. As of 1992, 49 percent of students took chemistry by graduation, which indicates that half of graduates take three high school science courses. The percentage taking three science courses increased 4 percent since 1990. States vary from 33 to 67 percent of students taking three years of science.

Indicators also show the relationship of state graduation requirements and state policies to student enrollments in science and mathematics. In 1992, the states with higher graduation requirements (2.5 to 3 credits) had significantly greater overall enrollments in mathematics and science than did states with lower requirements, and these states also had greater average enrollments in algebra 2, chemistry, and physics. The rate of increase in course enrollments from 1990 to 1992 was slightly greater for the high-requirement states. Almost all states had increased student participation in secondary science and mathematics. The role of states in implementing state curriculum frameworks and state assessment programs are also likely factors in increased enrollments.

Gender differences in science and mathematics continued to decline from 1990 to 1992. In most states, female and male participation is the same except in the most advanced mathematics and physical science courses, where more males continue to enroll. A majority of states have higher enrollments of girls in chemistry and advanced biology courses. Equity in science and mathematics for minority students has improved more slowly. National course enrollment trends from 1982 to 1990 show that students in all race/ethnic groups have significantly higher enrollments. At advanced levels of science and mathematics, Asian Americans have the greatest enrollments, and Hispanic students have the greatest increase in enrollments. Enrollments increased at about the same rate for African Americans and whites. In 1990, the national rates of students taking chemistry by graduation were about 4 of 10 African Americans, 6 of 10 Asian Americans, 4 of 10 Hispanics, and 5 of 10 whites.

Education policymakers have been concerned about our supply of well qualified teachers in science and mathematics. One of the objectives of National Goal 4 on science and mathematics is to "increase the number of teachers with a substantive background in science and mathematics by 50 percent."

The science-math indicators show that our schools have increased the number of mathematics teachers by 7 percent since 1990. This compares to a total enrollment increase of 3 percent in mathematics, indicating that the average student/teacher ratio has improved in mathematics. The total number of science teachers remained relatively constant over the two-year period, while enrollments increased three percent. The number of biology and chemistry teachers increased about 1 percent, while the number of teachers declined in physics (3 percent) and earth science (8 percent). The science changes may reflect shifts between subjects. Student/teacher ratios show there are wide variations across states in student opportunity to study mathematics and science. There are also wide differences in opportunities by subject, differing from almost all students having a mathematics teacher to 1 in 6 students having access to a physics teacher.

From 1990 to 1992, the number of noncertified teachers in high school mathematics went up by 3 percent (to 12 percent), possibly related to the increased number of mathematics teachers. The number of noncertified teachers in science remained at about 10 percent. About one-third of states reported more than 5 percent noncertified teachers in math or science, and one-fifth of states have over 10 percent noncertified teachers in mathematics or science.

The percentage of U.S. high school mathematics teachers with a math major decreased by 2 percent over the 3-year period, from 63 to 61 percent. The percentage of science teachers with a science major increased by 6 percent, from 64 to 70 percent. Thus, only slight improvement has been made toward one objective for National Goal 4.

In 1992, 5 percent of high school mathematics teachers and 4 percent of science teachers were new, first-year teachers. These numbers can be compared to 7 percent of mathematics and science teachers who were newly hired teachers, experienced or first-year. Only five states had more than 6 percent new, first-year teachers. In nine states, over half of new hires were experienced teachers. These data show that some states have had more success in filling science and math teaching positions with experienced teachers, and only a few states have hired large numbers of new graduates.

The percentage of new minority teachers is slightly greater than the current minority representation in the science-mathematics teaching force. The percentage of new female teachers is substantially greater than the current proportion of female teachers. Thus, science and mathematics are areas of growth for female teachers, attracting many more than in previous years. Many more minority teachers will be needed to begin to match the proportion of minority students in our schools.

The Council incorporated a small study of science and mathematics indicators for large cities in this report. The indicators for large cities in five states confirmed that large city schools have difficulty attracting and hiring science and mathematics teachers. Large city schools have the same percent of new, first-year teachers as compared to their state averages (about 5 percent), but they have fewer experienced teachers among new hires.

The indicators of school conditions by state show widely different conditions for science and mathematics teaching. The average class size in science and mathematics varies from 16 to 27. Some states have a high percentage of classes with over 30 students in lower and upper level courses. The data from the 1990 NAEP on two resource indicators—use of calculators in the classroom and mathematics teachers' perceptions of instructional materials—show that states differ greatly in the conditions for science and mathematics teaching. The states with highest use of calculators have more than twice as many students with unrestricted use as compared to states with the lowest rates. In a few states, almost half of mathematics teachers say they have a problem with teaching materials, whereas in other states fewer than 1 in 5 teachers report a problem with materials. These data reveal large state-level differences in school conditions, and the NAEP data do show a strong association with student mathematics proficiency.

The science and mathematics indicators presented in this report provide state-by-state comparisons and national indicators as of the 1991-92 school year. Trends analysis of science and mathematics indicators was initiated with this report, and the Council expects to continue to analyze trends with data for the 1993-94 school year. The science and mathematics indicators are intended for use by policymakers, educators, and researchers. This report focuses on uses of the indicators at state and national levels. However, we hope our efforts in identifying and developing indicators will be pursued further within states and school districts to analyze and report data that will be useful to educators and decision makers at all levels.

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APPENDIX A

APPENDIX TABLE A-1
AVERAGE 8TH GRADE PROFICIENCY IN MATHEMATICS CONTENT AREAS ON 1992 NAEP ASSESSMENT

Grade 8 Public Schools	Numbers and Operations	Measurement	Geometry	Data Analysis, Statistics, and Probability	Algebra and Functions	Estimation
STATES						
Alabama	258	245	245	250	253	260
Arizona	269	264	260	265	264 >	269
Arkansas	262	251	250	254	255	263
California	263	258 >	259	258	258	263
Colorado	273 >	273 >	269	274	270 >	273
Connecticut	277	275 >	268	274	270	275
Delaware	267	258	257	262	263	264
Dist. of Columbia	243 >	221	231	229 >	237	241
Florida	264	254	255	259	260	264
Georgia	265	253	253	259	259	263
Hawaii	261 >	254 >	257 >	249 >	256 >	260
Idaho	277	276 >	271	274	274 >	274
Indiana	272	269	266	273	267	271
Iowa	285	287 >	278	285	280 >	282
Kentucky	266 >	259 >	256	262	260	266
Louisiana	256	242	244	248	249	258
Maine	280	282	274	282	274	275
Maryland	269	261	259	266	264	264
Massachusetts	276	270	267	274	271	275
Michigan	270	266	261	268	267	268
Minnesota	282	285 >	278 >	284 >	281 >	284
Mississippi	256	236	239	243	245	259
Missouri	272	271	266	272	270	271
Nebraska	279	278	274	278	275	277
New Hampshire	280 >	280 >	273	281 >	274	277
New Jersey	276	268	265	271	272	274
New Mexico	263 >	257	256	258	257	265
New York	270 >	262	261	268	265	266
North Carolina	261 >	253 >	254 >	258 >	259 >	263
North Dakota	286	285	277	286	279	283
Ohio	272	266	262	270	267	269
Oklahoma	271	266 >	262	269	267	271
Pennsylvania	274	271	265	273	270	272
Rhode Island	269 >	263 >	259 >	266 >	266 >	269
South Carolina	265	257	256	258	259	264
Tennessee	264	253	252	259	257	264
Texas	267	260 >	262	263	266 >	267
Utah	276	275	269	275	272	274
Virginia	272	265	261	268	267	271
West Virginia	263	256	254	260	257	263
Wisconsin	280	279	272	280	275	278
Wyoming	276	278 >	272	275	271	276
TERRITORIES						
Guam	240	228	239	221 >	235 >	244
Virgin Islands	231	211	222	214 >	221	231
NATION	**272 >**	**266 >**	**263 >**	**268 >**	**267 >**	**271**

Note > Significantly higher than 1990 NAEP mathematics proficiency at about the 95% confidence level

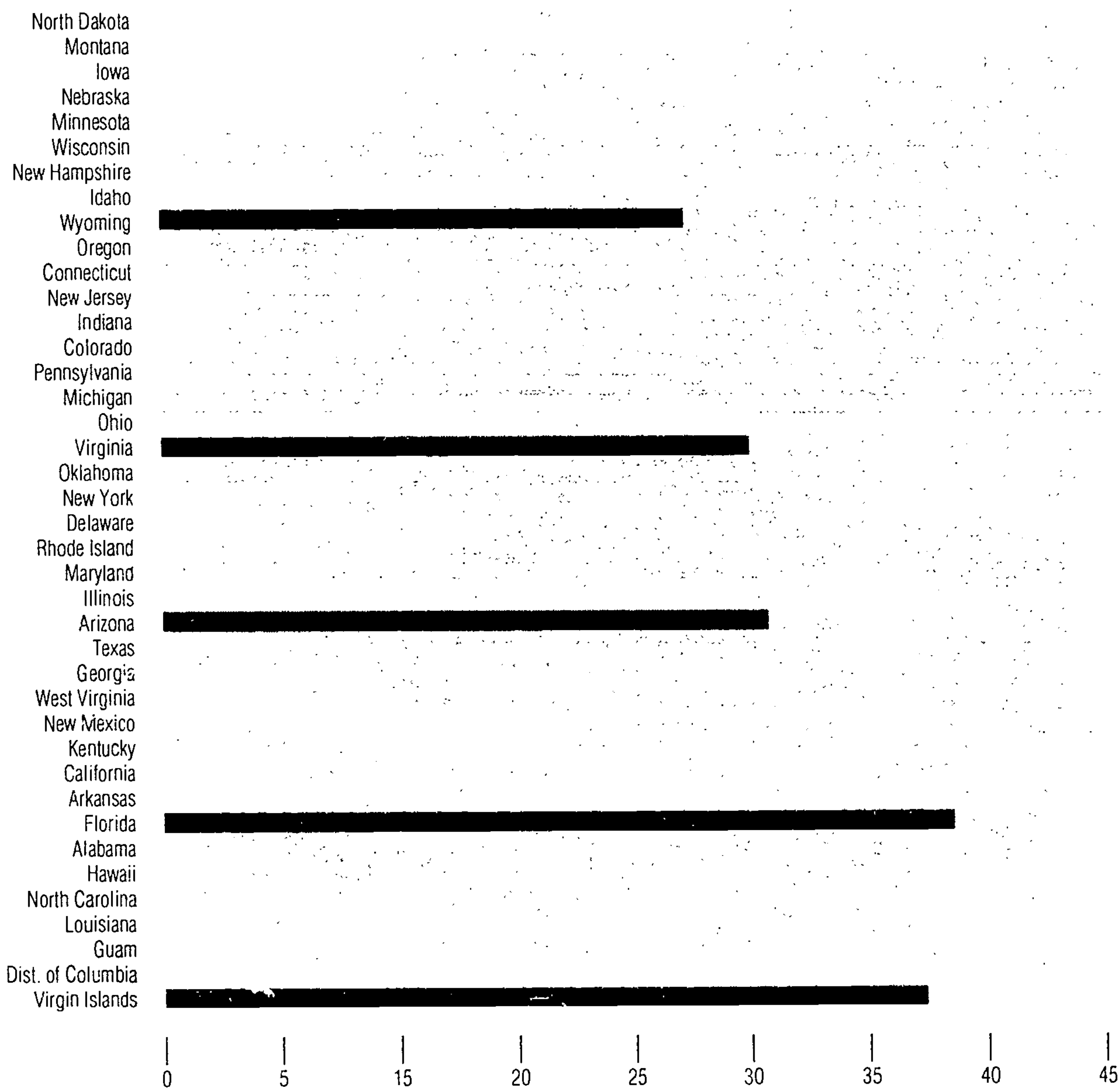
Source Mullis et al., NAEP 1992 Mathematics Report Card for the Nation and the States. *U S Department of Education, 1993 (see for standard errors of estimates) Council of Chief State School Officers, State Education Assessment Center Washington, DC, 1993*

APPENDIX TABLE A-2
STUDENTS TAKING BIOLOGY AND CALCULUS ADVANCED PLACEMENT (AP) EXAMINATION BY RACE/ETHNICITY; STUDENTS TAKING CHEMISTRY, PHYSICS AND COMPUTER SCIENCE AP EXAMINATION

	Biology					Calculus					Chemistry	Physics	Computer Science	All Fields
STATE	Total Taking Exam	% American Indian	% Black	% Hispanic	% Asian	Total Taking Exam	% American Indian	% Black	% Hispanic	% Asian	Total Taking Exam	Total Taking Exam	Total Taking Exam	% Public Schools of Total
Alabama	416	1%	10%	1%	6%	924	1%	11%	1%	6%	210	200	101	85%
Alaska	54	0	2	0	6	208	4	1	2	9	75	61	16	100
Arizona	244	0	2	7	10	1,066	3	2	8	10	360	322	62	91
Arkansas	118	2	4	0	8	282	1	3	0.4	11	83	56	6	96
California	6,574	1	2	6	39	14,034	0.5	2	9	42	3,684	3,551	1,095	82
Colorado	627	1	1	5	7	527	1	2	11	20	427	253	113	94
Connecticut	716	0.3	3	2	10	1,535	0.2	2	2	12	569	588	120	55
Delaware	143	0	0	2	10	378	0.3	3	1	13	106	77	49	53
Dist. of Columbia	233	0	24	6	7	267	0.4	17	3	9	97	172	46	34
Florida	2,368	0.3	7	13	9	4,898	0.3	6	12	11	1,592	1,659	828	87
Georgia	794	0	15	1	10	1,952	0.2	8	2	10	572	268	174	73
Hawaii	228	0	0	1	70	585	1	0	1	74	170	261	103	34
Idaho	143	1	0	0	3	245	1	0.4	1	3	76	29	15	100
Illinois	1,862	0.3	4	5	20	4,798	0.2	3	3	20	1,568	1,627	519	84
Indiana	1,004	0.2	4	2	5	2,434	0.4	2	1	7	1,206	697	32	90
Iowa	149	0	1	1	5	355	0.3	0	1	6	81	97	34	85
Kansas	41	0	2	0	2	307	0.3	1	1	13	104	33	36	93
Kentucky	501	0.2	1	0.4	0.2	858	0.1	1	0.3	5	223	103	54	85
Louisiana	167	0	5	3	21	466	0	7	2	15	118	110	60	57
Maine	115	0	1	0	2	372	1	0.3	1	3	56	97	23	82
Maryland	1,034	0.5	8	3	21	2,413	0 1	3	2	20	799	787	315	72
Massachusetts	1,390	0.2	2	1	12	3,216	0.2	1	2	15	770	945	371	62
Michigan	1,171	0.4	2	0.1	15	2,945	0.4	3	1	12	974	559	244	82
Minnesota	243	0	1	0.4	7	891	0.1	1	1	8	137	66	39	83
Mississippi	164	0	9	1	2	318	0	4	1	7	62	74	5	78
Missouri	351	0.3	5	1	11	679	0.3	2	1	12	270	207	44	52
Montana	69	1	0	0	1	56	2	0	0	5	27	17	10	95
Nebraska	94	0	2	1	4	199	0	1	3	4	39	21	19	76
Nevada	93	0	0	2	14	257	1	2	5	16	127	82	53	90
New Hampshire	164	0	1	1	9	568	0.4	1	1	12	80	99	46	51
New Jersey	1,992	0.1	3	4	19	4,230	0.2	3	3	22	1,273	1,166	546	72
New Mexico	168	4	1	13	8	556	2	1	15	7	129	154	72	77
New York	6,206	0.2	5	4	15	10,908	0.2	4	3	19	2,618	3,230	1,292	81
North Carolina	1,073	0.5	7	1	6	2315	0.5	5	1	7	·584	430	204	90
North Dakota	28	0	0	0	0	66	0	0	2	8	17	16	0	89
Ohio	968	0.1	3	1	15	3,076	0.2	3	1	11	998	689	247	74
Oklahoma	139	1	8	3	8	542	3	3	2	11	210	126	48	77
Oregon	287	0.3	0	2	10	596	0	0.3	1	11	120	154	62	90
Pennsylvania	1,350	0.2	2	1	8	3,610	0.1	2	1	12	950	801	410	67
Rhode Island	223	0	1	0	7	302	1	1	2	14	47	85	24	48
South Carolina	978	0	10	1	5	2,183	0.3	13	1	5	422	210	189	92
South Dakota	25	0	4	0	8	36	0	0	3	0	48	8	1	86
Tennessee	648	0	9	1	10	1,299	0.2	8	1	9	290	232	67	69
Texas	1,360	1	2	9	22	3,472	0.2	2	9	20	805	860	561	86
Utah	1,331	0.2	0.3	1	5	1,787	0.2	0.2	1	5	629	379	168	96
Vermont	147	0	0	1	3	230	0	0	2	6	48	16	22	80
Virginia	1,381	0.4	5	2	14	3,399	0.1	4	2	14	922	486	605	86
Washington	340	1	1	3	11	1,267	1	1	2	17	168	140	92	82
West Virginia	210	0	2	0.5	7	368	0	3	1	7	146	38	55	92
Wisconsin	316	0	1	2	4	1,140	0.2	1	1	5	335	143	136	82
Wyoming	18	0	0	0	6	144	0	0	3	1	25	9	6	100
NATION	**40,458**	**0.3%**	**4%**	**4%**	**17%**	**89,559**	**0.4%**	**3%**	**4%**	**18%**	**25,446**	**22,490**	**9,439**	**80%**

Source. The College Board, Advanced Placement Program. *National and 50 State Summary Reports. New York 1992*
Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1993

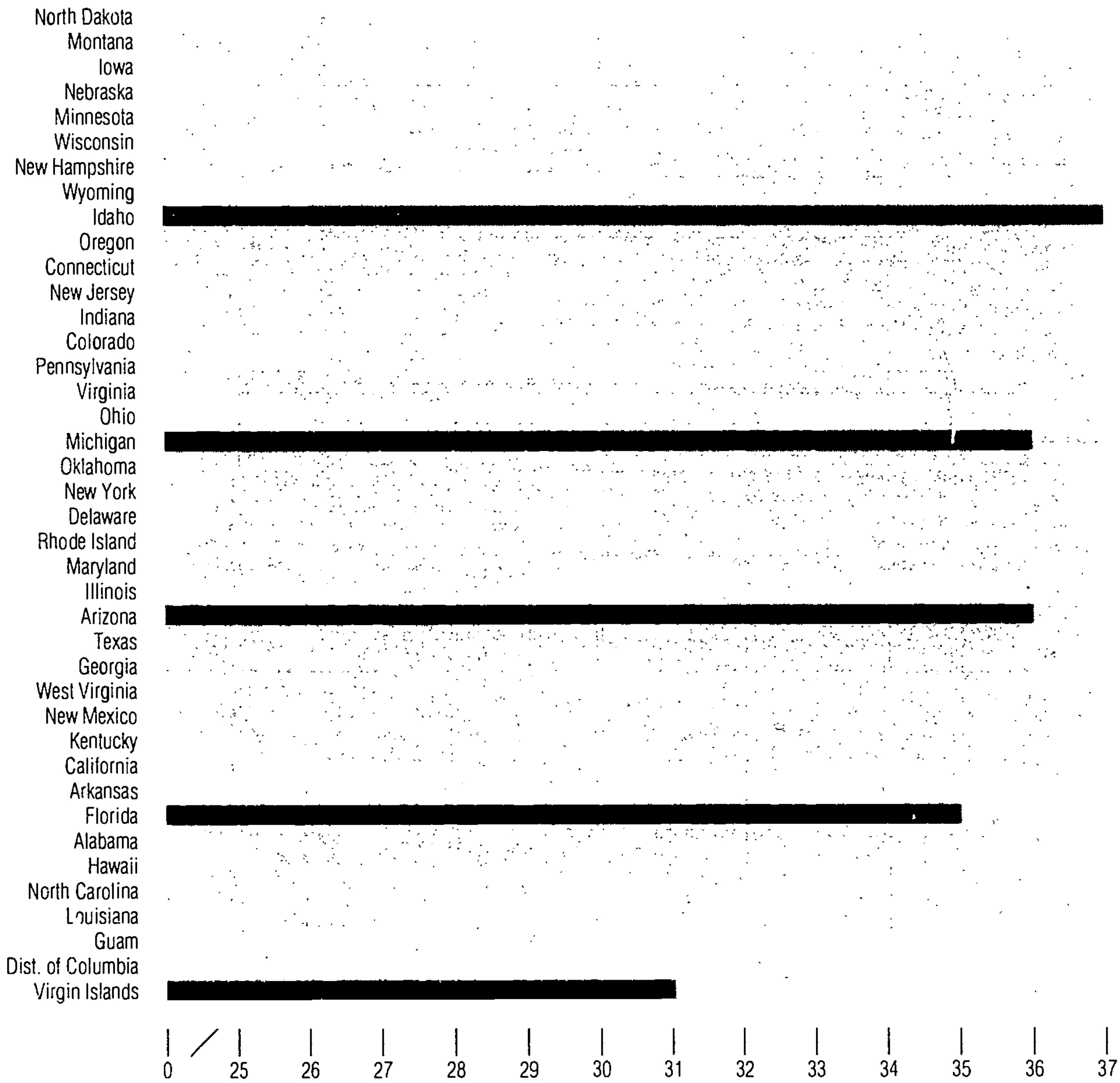
APPENDIX TABLE A-3
PERCENTAGE OF STUDENTS WITH TEACHERS EMPHASIZING NUMBERS/OPERATIONS AND MEASUREMENT BY STATE RANK ON OVERALL MATH PROFICIENCY (QUINTILE AVERAGE)



Note r = -.632 p < .05

Source Mullis et al. The State of Mathematics Achievement NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States. U.S Department of Education. 1991
Council of Chief State School Officers State Education Assessment Center. Washington, DC 1993

APPENDIX TABLE A-4
PERCENTAGE OF STUDENTS WITH TEACHERS EMPHASIZING GEOMETRY AND ALGEBRA/FUNCTIONS BY STATE RANK ON OVERALL MATH PROFICIENCY (QUINTILE AVERAGE)



Note r = 335 p < 05

Source Mullis et al. The State of Mathematics Achievement NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States U S Department of Education, 1991
Council of Chief State School Officers. State Education Assessment Center, Washington, DC 1993

APPENDIX TABLE A-5
OVERALL MATHEMATICS PROFICIENCY AND PERCENTAGE OF STUDENTS RECEIVING HEAVY TEACHER EMPHASIS IN CONTENT AREAS ON 1990 NAEP

	Mathematics Proficiency Score	% Numbers/ Operations	% Measurement	% Geometry	% Data, Prob., Statistics	% Algebra/ Functions
Alabama	252	58%	24%	26%	11%	41%
Arizona	259	52	10	14	7	51
Arkansas	256	60	17	16	9	33
California	256	40	21	25	17	46
Colorado	267	37	7	20	14	51
Connecticut	270	41	28	27	16	48
Delaware	261	43	20	17	17	39
District of Columbia	231	47	25	25	31	46
Florida	255	56	19	18	16	42
Georgia	258	57	33	30	24	47
Guam	231	55	24	22	12	37
Hawaii	251	46	15	17	9	29
Idaho	272	48	10	14	9	56
Illinois	260	41	17	29	14	55
Indiana	267	55	14	15	4	45
Iowa	278	48	14	25	4	49
Kentucky	256	58	13	25	15	46
Louisiana	246	57	21	14	11	59
Maryland	260	35	12	22	14	51
Michigan	264	44	12	20	10	47
Minnesota	276	36	9	19	8	50
Montana	280	40	12	31	13	58
Nebraska	276	41	15	19	8	51
New Hampshire	273	36	24	27	16	47
New Jersey	269	50	16	37	14	55
New Mexico	256	54	13	25	14	53
New York	261	44	17	40	24	49
North Carolina	250	49	13	17	13	44
North Dakota	281	49	17	23	9	56
Ohio	264	48	17	23	13	50
Oklahoma	263	58	11	17	5	55
Oregon	271	34	13	19	17	43
Pennsylvannia	266	47	15	17	6	48
Rhode Island	260	52	13	17	10	43
Texas	258	61	29	37	20	52
Virgin Islands	218	53	35	11	11	47
Virginia	264	46	12	18	10	52
West Virginia	256	48	13	14	8	41
Wisconsin	274	37	11	17	8	48
Wyoming	272	42	7	15	6	48
NATION	**261**	**49%**	**17%**	**28%**	**14%**	**46%**

Source *Mullis et al*. The State of Mathematics Achievement NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States. *U S Department of Education. 1991 (see for standard errors of estimates)*
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

APPENDIX TABLE A-6
ELEMENTARY CLASS TIME ON MATHEMATICS AND SCIENCE

STATE	Mathematics Grades 1—3 Hours/Week	Science Grades 1—3 Hours/Week	Mathematics Grades 4—6 Hours/Week	Science Grades 4—6 Hours/Week
Alabama	5.1	2.8	5.3	3.9
Alaska	4.7	2.9	4.9	2.8
Arizona	4.4	2.2	4.9	2.7
Arkansas	4.4	2.9	4.6	3.7
California	4.7	2.6	5.4	2.6
Colorado	4.7	2.1	4.7	2.8
Connecticut	5.0	2.5	4.3	2.3
Delaware	4.8	2.1	—	—
Dist. of Columbia	5.3	2.7	—	—
Florida	4.9	2.7	4.8	3.1
Georgia	4.9	2.4	4.4	3.5
Hawaii	4.7	2.0	4.5	2.5
Idaho	4.7	2.4	5.5	3.9
Illinois	5.6	2.6	5.4	3.2
Indiana	5.4	2.4	4.5	3.4
Iowa	4.3	2.7	4.6	2.4
Kansas	4.8	2.3	4.9	3.2
Kentucky	4.8	3.1	5.0	3.3
Louisiana	4.8	2.7	4.5	3.1
Maine	4.5	2.6	4.7	3.4
Maryland	4.9	3.2	4.6	3.4
Massachusetts	5.1	2.0	4.5	2.5
Michigan	4.7	2.8	4.9	3.0
Minnesota	4.5	2.5	5.0	3.1
Mississippi	4.4	2.9	3.8	3.8
Missouri	4.7	2.4	4.7	3.7
Montana	5.3	2.2	4.8	3.7
Nebraska	5.1	2.9	5.0	3.4
Nevada	5.5	2.3	5.2	4.0
New Hampshire	4.8	2.9	5.1	3.7
New Jersey	4.7	2.4	4.3	2.9
New Mexico	5.6	2.7	4.5	4.1
New York	4.7	2.6	5.2	2.7
North Carolina	5.2	3.1	4.5	3.2
North Dakota	5.4	2.5	5.2	4.3
Ohio	4.8	2.1	5.2	3.0
Oklahoma	4.6	2.4	4 7	3.5
Oregon	4.5	2.2	4.5	2.8
Pennsylvania	4.8	2.5	4.9	3.2
Rhode Island	4.9	2.5	5.2	2.7
South Carolina	4.8	4.2	4.3	3.3
South Dakota	5.4	2.5	4.9	3.8
Tennessee	5.7	2.1	5.4	3.5
Texas	5.1	2.6	4.1	3 8
Utah	4.7	2.4	4.5	2.8
Vermont	4.7	2.8	4.8	3.9
Virginia	4.7	2.6	4.9	3.1
Washington	4.8	2.5	4.1	2.6
West Virginia	5.5	2.6	4.7	3.2
Wisconsin	4.3	2.7	5.2	3.5
Wyoming	4.5	2 5	4.8	3.7
NATION	**4.9**	**2.6**	**4.8**	**3.1**

Note Class time = State average of teacher-reported hours spent teaching subject "last week" (self-contained elementary classes) Standard errors for national average are 05 math. 05 science State standard errors vary for math from .14 (Alaska) to 61 (Illinois), and for science from 10 (California) to 61 (South Carolina) — Respondents too few for a reliable state estimate

Source NCES. Schools and Staffing Survey. Public School Teachers. Spring 1991

Council of Chief State School Officers State Education Assessment Center, Washington. DC. 1993

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APPENDIX TABLE A-7
STUDENTS TAKING SCIENCE COURSES IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRADES 7—8

STATE	Student Membership (Grades 7—8)	% General Science	% Life Science	% Earth Science	% Physical Science	% Integrated Science	Sum Science
Alabama	117,522	47%	10%	37%	1%	—%	95%
Alaska	17,322	—	—	—	—	—	—
Arizona	97,728	—	—	—	—	—	—
Arkansas	70,324	11	40	39	1	—	91
California	726,132	47	14	5	10	—	76 *
Colorado	87,157	28	30	12	19	—	90 *
Connecticut	67,492	30	30	9	21	3	95
Delaware	15,678	16	38	18	12	0.5	86 *
Dist. of Columbia	10,380	52	—	—	48	—	100
Florida	280,082	0.2	32	10	21	28	91
Georgia	180,220	—	—	—	—	—	—
Hawaii	23,078	11	43	15	—	0.1	68 *
Idaho	36,353	5	37	13	22	—	78 *
Illinois	263,610	—	—	—	—	—	—
Indiana	149,841	83	6	5	4	1	100
Iowa	72,204	—	—	—	—	—	—
Kansas	65 333	19	32	23	13	—	100
Kentucky	59,704	1	30	28	0.1	41	99
Louisiana	—	—	—	—	—	—	—
Maine	31,765	—	—	—	—	—	—
Maryland	104,747	—	—	—	—	—	—
Massachusetts	120,617	—	—	—	—	—	—
Michigan	228,748	—	—	—	—	—	—
Minnesota	116,022	—	33	24	8	—	65 *
Mississippi	78,434	97	—	—	—	—	97
Missouri	127,739	34	31	26	4	—	94
Montana	23,792	6	45	4	42	—	100
Nebraska	42,011	10	13	7	8	—	41 *
Nevada	31,179	21	24	5	15	1	65 *
New Hampshire	26,448	—	—	—	—	—	—
New Jersey	154,752	—	—	—	—	—	—
New Mexico	43,204	33	29	27	10	—	99
New York	369,304	14	40	14	23	—	90 *
North Carolina	166,638	—	0	.1	0.3	98	98
North Dakota	18,057	—	51	49	—	—	100
Ohio	272,181	47	12	13	7	—	81 *
Oklahoma	87,968	7	—	16	2	54	84 *
Oregon	77,102	25	22	23	13	—	86 *
Pennsylvania	248,850	31	34	23	12	—	100
Puerto Rico	107,556	100	0	—	—	—	100
Rhode Island	20,584	—	—	—	—	—	—
South Carolina	98,776	1	50	47	1	—	99
South Dakota	20,195	—	—	—	—	—	—
Tennessee	127,584	93	—	—	—	—	93
Texas	517,811	3	48	46	—	3	99
Utah	69,781	—	31	28	18	0.1	77 *
Vermont	14,342	—	—	—	—	—	—
Virginia	147,384	—	45	—	48	—	93
Washington	130,054	—	—	—	—	—	—
West Virginia	51,314	8	16	21	2	—	47 *
Wisconsin	118,193	30	19	12	9	—	76 *
Wyoming	15,630	30	26	6	14	0.4	77 *
SUM (36 states)		**28%**	**25%**	**17%**	**10%**	**7%**	**88%**

**Science taught in self-contained classrooms not included*

Note Enrollments in SS & C courses in California, Iowa and Puerto Rico not counted in 1991-92 — Data not available

Source State Departments of Education. Data on Public Schools Fall 1991. California Fall 1990 NCES CCD Fall Membership 1991

Council of Chief State School Officers, State Education Assessment Center, Washington DC, 1993

APPENDIX TABLE A-8
STUDENTS TAKING MATHEMATICS COURSES IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRADES 7—8

STATE	Grade 7					Grade 8					
	Student Membership Grade 7	% Remedial Math 7	% Regular Math 7	% Accelerated Math 7	Sum Math % Grade 7	Student Membership Grade 8	% Remedial Math 8	% Regular Math 8	% Enriched Math 8	% Algebra 1 Math 8	Sum Math % Grade 8
Alabama	60,915	2%	76%	15%	93%	56,607	2%	77%	6%	10%	94%
Alaska	8,892	—	—	—	—	8,430	—	—	—	—	—
Arizona	50,528	—	—	—	—	47,200	—	—	—	—	—
Arkansas	35,797	—	49	16	65 *	34,527	—	77	—	4	81 *
California	370,964	4	72	7	83 *	355,168	3	66	3	14	86 *
Colorado	44,823	—	75	19	94	42,334	—	66	13	13	92
Connecticut	34,524	10	67	22	99	32,968	8	47	21	17	93
Delaware	8,175	6	59	18	83 *	7,503	8	43	22	16	89 *
Dist. of Columbia	5,404	6	71	12	89 *	4,976	6	52	2	29	88 *
Florida	144,717	8	62	25	95	135,365	9	53	20	9	90
Georgia	92,686	—	—	—	—	87,534	—	—	—	—	—
Hawaii	11,808	13	88	2	103	11,270	13	83	0.3	7	103
Idaho	18,550	2	71	18	91	17,803	2	49	16	14	82 *
Illinois	135,954	—	—	—	—	127,656	—	—	—	—	—
Indiana	76,002	—	85	5	90	73,839	—	78	7	9	94
Iowa	36,755	—	—	—	—	35,449	—	—	—	—	—
Kansas	33,390	—	78	20	98	31,943	—	65	13	21	99
Kentucky	50,568	0.2	92	8	100	49,136	0.1	75	13	12	100
Louisiana	—	—	—	—	—	—	—	—	—	—	—
Maine	16,086	—	—	—	—	15,679	—	—	—	—	—
Maryland	54,300	—	—	—	—	50,447	—	—	—	—	—
Massachusetts	61,354	—	—	—	—	59,263	—	—	—	—	—
Michigan	116,810	—	—	—	—	111,938	—	—	—	—	—
Minnesota	59,216	—	52	—	52 *	56,806	—	40	—	9	49 *
Mississippi	40,920	5	89	16	110	37,514	6	73	—	9	88 *
Missouri	65,388	1	78	6	85 *	62,351	1	64	—	12	76 *
Montana	11,977	0.4	79	8	87 *	11,815	0.4	76	5	10	92
Nebraska	21,394	—	28	—	28 *	20,617	—	29	18	10	57 *
Nevada	15,974	7	64	21	92	15,205	7	53	22	13	96
New Hampshire	13,567	—	—	—	—	12,881	—	—	—	—	—
New Jersey	79,196	—	—	—	—	75,556	—	—	—	—	—
New Mexico	22,007	6	88	5	100	21,197	7	56	17	21	100
New York	188,586	6	82	13	101	180,718	7	79	0.1	11	96
North Carolina	84,743	6	76	14	96	81,895	5	60	13	18	96
North Dakota	9,128	2	96	5	103	8,929	2	75	—	20	97
Ohio	140,577	5	62	12	78 *	131,604	4	54	10	13	81 *
Oklahoma	44,792	—	78	8	85 *	43,176	—	73	—	8	81 *
Oregon	39,230	—	68	21	90	37,872	—	51	21	16	89 *
Pennsylvania	127,014	1	79	—	81 *	121,836	—	58	—	—	58 *
Puerto Rico	56,879	—	100	—	100	50,677	—	100	—	—	100
Rhode Island	10,531	—	—	—	—	10,053	—	—	—	—	—
South Carolina	51,424	14	91	—	106	47,352	13	78	—	14	106
South Dakota	10,433	—	—	—	—	9,762	—	—	—	—	—
Tennessee	65,961	—	90	18	108	61,623	—	82	18	—	100
Texas	266,704	—	98	—	98	251,107	—	85	—	—	85 *
Utah	36,667	3	58	41	102	33,114	2	32	30	35	99
Vermont	7,313	—	—	—	—	7,029	—	—	—	—	—
Virginia	73,981	6	84	10	100	73,403	—	52	19	29	100
Washington	66,904	—	—	—	—	63,150	—	—	—	—	—
West Virginia	25,574	1	45	9	56 *	25,740	1	31	11	12	55 *
Wisconsin	60,436	1	81	10	93	57,757	1	75	7	12	96
Wyoming	8,119	4	72	13	90	7,511	7	56	—	24	88 *
SUM (36 states)		**5%**	**77%**	**13%**	**95%**		**5%**	**67%**	**10%**	**13%**	**95%**

**Math taught in self-contained classrooms not included - Data not available*
Source State Departments of Education, Data on Public Schools, Fall 1991 California Fall 1990 NCES CCD Fall Membership 1991
Council of Chief State School Officers State Education Assessment Center Washington DC 1993

APPENDIX TABLE A-9
STATE REQUIREMENTS IN MATHEMATICS AND SCIENCE FOR HIGH SCHOOL GRADUATION (1992)

STATE	Credits for a Regular Diploma: Math		Credits for a Regular Diploma: Science	Credits for Advanced/Honors Diploma: Math		Credits for Advanced/Honors Diploma: Science
Alabama	2		2	3		3
Alaska	2		2	—		—
Arizona	2		2	—		—
Arkansas		5 combined		—		—
California	2		2	—		—
Colorado		Local board		—		—
Connecticut	3		2	—		—
Delaware	2		2	—		—
Dist. of Columbia	2		2	—		—
Florida	3		3	4		4
Georgia	2		2	3		3
Hawaii	2 (3, '97)		2 (3, '97)	3		3
Idaho	2		2	—		—
Illinois	2		1	—		—
Indiana	2		2	4		3
Iowa		Local board		—		—
Kansas	2		2	—		—
Kentucky	3		2	4		3
Louisiana	3		3	—		—
Maine	2		2	—		—
Maryland	3		2	3		3
Massachusetts		Local board		—		—
Michigan		Local board		—		—
Minnesota	1	Local board	1	—		—
Mississippi	2 (3, '95)		2	—		—
Missouri	2		2	3		3
Montana	2		2	—		—
Nebraska		Local board		—		—
Nevada	2		2	—		—
New Hampshire	2		2	—		—
New Jersey	3		2	—		—
New Mexico	3		2	—		—
New York	2		2	2	Regents Courses	2
North Carolina	2		2	4		4
North Dakota	2		2	—		—
Ohio	2		1	—		—
Oklahoma	2		2	3		2
Oregon	2		2	—		—
Pennsylvania	3		3	—		—
Rhode Island	2		2	3		2
South Carolina	3		2	—		—
South Dakota	2		2	4		4
Tennessee	2		2	3		3
Texas	3		2	3		3
Utah	2		2	—		—
Vermont		5 combined		—		—
Virginia		5 combined		3		3
Washington	2		2	—		—
West Virginia	2		2	2	Advanced Courses	—
Wisconsin	2		2	—		—
Wyoming		Local board		—		—
TOTAL	**2.5—3 credits = 13 states 2 credits = 31 Local = 7**		**2.5—3 credits = 6 states 2 credits = 36 1 credit = 2 Local = 7**	**17 states**		**16 states**

Note — No State Requirement
Source State Departments of Education, Mathematics and Science Supervisors. Winter, 1992
Council of Chief State School Officers. State Education Assessment Center. Washington DC, 1993

APPENDIX TABLE A-10
PERCENTAGE OF STUDENTS IN EACH GRADE TAKING FIRST-YEAR BIOLOGY
(October 1991)

Biology, 1st Year (General)

STATE	% of Grade 9	% of Grade 10	% of Grade 11	% of Grade 12
Alabama	22	47	6	2
California	6	48	5	1
Connecticut	14	41	2	1
Dist. of Columbia	22	44	17	7
Florida	19	57	4	1
Idaho	6	75	2	1
Kentucky	24	44	23	13
New York	7	88	3	2
North Carolina	15	79	7	3
North Dakota	3	96	5	3
Ohio	26	51	11	6
Puerto Rico	.1	67	16	3
South Carolina	13	79	1	.1
Utah	13	42	15	7
West Virginia	7	83	11	6

Biology, 1st Year, Applied

STATE	% of Grade 9	% of Grade 10	% of Grade 11	% of Grade 12
Alabama	8	17	3	1
California	6	17	4	1
Connecticut	6	24	5	4
Dist. of Columbia	0	.2	.1	.1
Florida	3	10	2	1
Idaho	1	1	.1	.3
North Carolina	.1	.4	.1	.1
North Dakota	0	0	.1	.2
South Carolina	.1	3	3	.1
Utah	1	1	2	2
West Virginia	.1	1	.1	1

Source State Departments of Education. Data on Public Schools. Fall 1991. California. Fall 1990. NCES. CCD Fall Membership 1991 Council of Chief State School Officers. State Education Assessment Center Washington. DC. 1993

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APPENDIX TABLE A-11
ESTIMATED PROPORTION OF STUDENTS ENTERING 9TH GRADE IN 1988
TAKING SELECTED MATH AND SCIENCE COURSES

STATE	Student Membership 1988 (Grade 9)	Algebra 1 %	Algebra 2 %	Biology 1st Year %	Chemistry 1st Year %
Alabama	58,543	68%	39%	91%	33%
Alaska	7,468	—	—	—	—
Arizona	43,002	—	—	—	—
Arkansas	33,009	89	49	93	38
California	356,732	78	38	90	29
Colorado	41,346	68	44	80	39
Connecticut	33,688	64	53	93	56
Delaware	7,651	52	36	89	35
Dist. of Columbia	5,390	73	33	82	48
Florida	144,216	67	38	92	38
Georgia	90,716	—	—	—	—
Hawaii	11,727	51	28	92	36
Idaho	15,710	64	65	91	42
Illinois	130,730	—	—	—	—
Indiana	74,505	76	47	95	41
Iowa	33,373	100	67	100	63
Kansas	29,962	91	59	100	46
Kentucky	48,563	78	53	97	43
Louisiana	60,966	—	—	—	—
Maine	16,255	78	62	83	59
Maryland	52,169	—	—	—	—
Massachusetts	63,606	—	—	—	—
Michigan	123,745	—	—	—	—
Minnesota	51,806	94	64	100	54
Mississippi	36,909	83	51	100	45
Missouri	63,567	87	54	86	39
Montana	10,585	85	57	100	53
Nebraska	19,567	94	56	100	49
Nevada	12,463	78	46	100	45
New Hampshire	13,230	—	—	—	—
New Jersey	79,268	—	—	—	—
New Mexico	21,872	95	43	100	34
New York	202,098	73	37	95	48
North Carolina	89,256	65	43	91	42
North Dakota	8,505	100	73	100	64
Ohio	144,343	69	42	85	44
Oklahoma	42,824	89	54	90	33
Oregon	34,447	68	45	87	39
Pennsylvania	127,405	89	54	88	53
Puerto Rico	46,330	94	47	81	52
Rhode Island	10,228	—	—	—	—
South Carolina	52,835	57	40	84	40
South Dakota	8,517	—	—	—	—
Tennessee	65,659	78	47	90	37
Texas	264,600	84	52	92	35
Utah	28,995	86	70	100	39
Vermont	6,350	63	49	79	47
Virginia	77,510	57	49	89	48
Washington	58,313	—	—	—	—
West Virginia	26,038	65	44	100	42
Wisconsin	59,077	100	56	100	56
Wyoming	6,941	87	58	85	35
SUM (38 states)		**78%**	**47%**	**93%**	**42%**

Note — Data not available
Source State Departments of Education. Data on Public Schools Fall 1991. California, Fall 1990. NCES Digest of Education Statistics, 1991
Council of Chief State School Officers State Education Assessment Center. Washington, DC. 1993

APPENDIX TABLE A-12
STUDENTS TAKING BIOLOGY AND CHEMISTRY COURSES IN OCTOBER 1991
AS A PERCENT OF STUDENTS IN GRADES 9—12

STATE	Student Membership (Grades 9—12)	Biology 1st Year % 9—12	Biology 1st Year Applied % 9—12	Biology 2nd Year AP % 9—12	Biology 2nd Year Advanced % 9—12	Biology 2nd Year Other % 9—12	Chemistry 1st Year % 9—12	Chemistry 1st Year Applied % 9—12	Chemistry 2nd Year AP % 9—12	Chemistry 2nd Year Advanced % 9—12
Alabama	195,531	20 %	7 %	1 %	3 %	2 %	2 %	8 %	1 %	— %
Alaska	29,556	—	—	—	—	—	—	—	—	—
Arizona	166,311	—	—	—	—	—	—	—	—	—
Arkansas	122,209	25	0	—	2	3	10	—	—	—
California	1,354,457	16	7	—	3	0.5	8	—	—	1
Colorado	156,273	21	—	—	5	—	10	—	—	2
Connecticut	125,575	15	0	0.5	3	3	11	4	0.3	0.4
Delaware	27,641	18	6	1	2	0.2	8	2	0.3	0.5
Dist. of Columbia	17,922	25	0.1	1	0	—	14	0.5	0	1
Florida	504,518	22	4	0.4	1	12	11	0.4	0.3	0.3
Georgia	309,439	—	—	—	—	—	—	—	—	—
Hawaii	43,495	21	4	0.2	1	0.4	10	—	0.5	—
Idaho	63,653	22	1	1	3	1	10	—	0.5	0.2
Illinois	486,990	—	—	—	—	—	—	—	—	—
Indiana	274,823	16	10	1	3	1	9	3	0.4	2
Iowa	135,744	29	1	—	3	2	16	—	—	—
Kansas	117,951	26	3	1	4	—	10	2	1	1
Kentucky	176,459	27	—	1	5	2	12	—	0.3	1
Louisiana	—	—	—	—	—	—	—	—	—	—
Maine	58,898	23	—	—	—	—	16	—	—	—
Maryland	186,084	—	—	—	—	—	—	—	—	—
Massachusetts	230,165	—	—	—	—	—	—	—	—	—
Michigan	416,535	—	—	—	—	—	—	—	—	—
Minnesota	216,836	22	5	—	9	0	13	—	—	2
Mississippi	127,704	28	6	1	17	1	13	—	0.2	1
Missouri	229,211	23	1	—	8	4	11	—	—	2
Montana	42,677	25	0.1	2	3	0.1	12	1	1	0.5
Nebraska	78,185	22	6	—	5	—	12	—	—	—
Nevada	54,076	21	6	0.3	5	1	10	—	0.3	0.4
New Hampshire	47,313	—	—	—	—	—	—	—	—	—
New Jersey	291,788	—	—	—	—	—	—	—	—	—
New Mexico	78,366	28	2	0.3	2	1	9	—	0.4	—
New York	714,244	27	0	1	0.4	2	14	—	0.5	0.1
North Carolina	302,825	27	0.2	1	4	1	12	—	0.4	1
North Dakota	33,435	27	0.1	—	8	1	16	—	—	1
Ohio	506,364	24	—	1	2	3	13	—	0.4	—
Oklahoma	155,510	25	—	0.2	5	5	9	—	0.2	1
Oregon	138,431	20	2	1	2	—	9	1	0.4	1
Pennsylvania	476,198	23	0.5	—	4	—	14	—	—	2
Puerto Rico	163,679	23	0	—	—	—	15	0	—	—
Rhode Island	37,661	—	—	—	—	—	—	—	—	—
South Carolina	171,431	25	1	1	2	1	12	0	0.3	1
South Dakota	34,727	—	—	—	—	—	—	—	—	—
Tennessee	229,080	22	4	0.4	2	1	11	—	0.2	0.3
Texas	889,388	23	5	—	2	2	10	—	—	1
Utah	125,578	23	2	2	2	1	9	0.3	1	0.2
Vermont	23,844	15	6	1	3	1	10	3	0.2	0.3
Virginia	270,218	23	3	1	3	—	13	1	1	1
Washington	236,546	—	—	—	—	—	—	—	—	—
West Virginia	95,457	27	0.3	0.2	5	3	12	1	.1	1
Wisconsin	231,732	27	1	1	4	0.4	11	3	1	1
Wyoming	28,096	21	0.3	0.3	4	—	8	0.2	0.1	1
SUM (39 states)		**22 %**	**3 %**	**0.4 %**	**3 %**	**2 %**	**11 %**	**1 %**	**0.2 %**	**1 %**

Note — Data not available
Source State Departments of Education Data on Public Schools, Fall 1991. California Fall 1990. NCES CCD Fall Membership 1991
Council of Chief State School Officers. State Education Assessment Center Washington, DC, 1993

APPENDIX TABLE A-13
STUDENTS TAKING PHYSICS AND EARTH SCIENCE COURSES IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRADES 9—12

STATE	Student Membership (Grades 9—12)	Physics 1st Year % 9—12	Physics 1st Year Applied % 9—12	Physics 2nd Year AP % 9—12	Physics 2nd Year Advanced % 9—12	Earth Science 1st Year General % 9—12	Earth Science 1st Year Applied % 9—12	Earth Science 2nd Year % 9—12
Alabama	195,531	2 %	1 %	0.3 %	0.2 %	0.3 %	— %	— %
Alaska	29,556	—	—	—	—	—	—	—
Arizona	166,311	—	—	—	—	—	—	—
Arkansas	122,209	3	—	—	0	3	—	0.2
California	1,354,457	3	—	—	0.5	2	—	1
Colorado	156,273	5	—	—	0.5	10	—	1
Connecticut	125,575	5	4	0.3	0.2	8	1	1
Delaware	27,641	3	1	0.1	0.2	5	1	.1
Dist. of Columbia	17,922	3	—	0.2	—	1	—	0.3
Florida	504,518	4	0.1	0.3	0.3	12	2	2
Georgia	309,439	—	—	—	—	—	—	—
Hawaii	43,495	3	2	0.2	—	7	1	0.1
Idaho	63,653	3	—	0.1	—	11	5	0.2
Illinois	486,990	—	—	—	—	—	—	—
Indiana	274,823	3	1	0.3	0.3	5	2	1
Iowa	135,744	7	—	—	0.2	8	—	—
Kansas	117,951	4	1	0.1	0.3	6	0.3	0.4
Kentucky	176,459	3	—	0.2	0.1	1	—	—
Louisiana	—	—	—	—	—	—	—	—
Maine	58,898	12	—	—	—	—	—	—
Maryland	186,084	—	—	—	—	—	—	—
Massachusetts	230,165	—	—	—	—	—	—	—
Michigan	416,535	—	—	—	—	—	—	—
Minnesota	216,836	6	—	—	1	2	1	0.2
Mississippi	127,704	4	—	0.1	0.1	—	—	0.2
Missouri	229,211	4	—	—	0.4	3	—	1
Montana	42,677	6	0.1	0	0.2	19	.1	1
Nebraska	78,185	5	0.3	—	—	8	—	—
Nevada	54,076	3	1	0 1	0.4	15	.1	0.3
New Hampshire	47,313	—	—	—	—	—	—	—
New Jersey	291,788	—	—	—	—	—	—	—
New Mexico	78,366	3	1	0.4	—	2	—	1
New York	714,244	6	—	1	1	16	—	1
North Carolina	302,825	3	—	0.1	0.2	3	—	1
North Dakota	33,435	6	0.2	—	0	0.1	—	1
Ohio	506,364	5	—	0.2	—	5	—	1
Oklahoma	155,510	2	0 1	0.2	0.1	1	—	0.2
Oregon	138,431	4	1	0.3	0.3	4	0.2	0.2
Pennsylvania	476,198	7	—	—	2	6	—	1
Puerto Rico	163,679	7	—	—	—	9	—	—
Rhode Island	37,661	—	—	—	—	—	—	—
South Carolina	171,431	3	1	0.1	0.1	0.1	—	—
South Dakota	34,727	—	—	—	—	—	—	—
Tennessee	229,080	3	—	0.2	—	2	—	—
Texas	889,388	3	---	—	0.5	1	—	1
Utah	125,578	4	1	0.4	0.3	16	0.1	0.2
Vermont	23,844	6	1	0.1	0.1	11	2	1
Virginia	270,218	6	.1	0.2	0.3	24	1	1
Washington	236,546	—	—	—	—	—	—	—
West Virginia	95,457	3	0.1	0	.1	1	0.3	.1
Wisconsin	231,732	6	1	0.3	1	5	2	0.4
Wyoming	28,096	3	1	—	—	9	2	—
SUM (39 states)		**4 %**	**0.2 %**	**0.1 %**	**0.4 %**	**6 %**	**0.3 %**	**1 %**

Note: — Data not available
Source: State Departments of Education, Data on Public Schools, Fall 1991. California Fall 1990. NCES, CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENOIX TABLE A-14
STUDENTS TAKING GENERAL, PHYSICAL, INTEGRATEO, AND OTHER SCIENCE COURSES, AND COMPUTER SCIENCE COURSES IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRAOES 9—12

STATE	Student Membership (Grades 9—12)	General Science % 9—12	Physical Science % 9—12	Integrated Science % 9—12	Other Science % 9—12	Computer Science Prog. I % 9—12	Advanced Comp. Sci./ Prog. II % 9—12	Comp. Sci. Advanced Placement % 9—12	Comp. Sci./ Comp. Prog. % 7—8
Alabama	195,531	2 %	22 %	— %	0.1 %	2 %	— %	— %	0.3 %
Alaska	29,556	—	—	—	—	—	—	—	—
Arizona	166,311	—	—	—	—	—	—	—	—
Arkansas	122,209	7	25	—	0.4	4	—	—	—
California	1,354,457	3	12	—	3	1	—	—	8
Colorado	156,273	4	7	—	4	4	1	—	9
Connecticut	125,575	7	7	0.4	1	2	0.2	0.1	2
Delaware	27,641	1	12	1	2	3	1	0.2	38
Dist. of Columbia	17,922	24	—	—	1	5	0.2	—	4
Florida	504,518	2	12	.1	0.2	2	0.4	0.1	1
Georgia	309,439	—	—	—	—	—	—	—	—
Hawaii	43,495	5	17	1	4	1	0.1	.1	4
Idaho	63,653	1	8	—	2	1	0.3	0.1	7
Illinois	486,990	—	—	—	—	—	—	—	—
Indiana	274,823	5	8	2	—	1	0.2	—	0.4
Iowa	135,744	10	11	—	0.4	1	0.2	—	—
Kansas	117,951	8	13	—	4	9	2	0 2	30
Kentucky	176,459	—	12	12	0.4	2	0 1	0.3	.1
Louisiana	—	—	—	—	—	—	—	—	—
Maine	58,898	—	—	—	—	—	—	—	—
Maryland	186,084	—	—	—	—	—	—	—	—
Massachusetts	230,165	—	—	—	—	—	—	—	—
Michigan	416,535	—	—	—	—	—	—	—	—
Minnesota	216,836	—	8	—	—	3	—	—	—
Mississippi	127,704	9	—	—	0.1	3	0.4	0 1	2
Missouri	229,211	7	18	—	1	2	1	—	1
Montana	42,677	2	3	2	.1	7	2	0	1
Nebraska	78,185	6	11	—	3	6	1	—	4
Nevada	54,076	6	3	0.2	0.3	3	1	0.1	2
New Hampshire	47,313	—	—	—	—	—	—	—	—
New Jersey	291,788	—	—	—	—	—	—	—	—
New Mexico	78,366	7	14	—	1	4	—	0.1	—
New York	714,244	4	8	—	4	3	—	0.3	18
North Carolina	302,825	0.3	24	—	1	6	—	0.1	2
North Dakota	33,435	—	29	—	1	5	1	—	—
Ohio	506,364	12	7	—	0.2	7	—	0.1	15
Oklahoma	155,510	4	19	—	4	4	1	0.1	—
Oregon	138,431	6	10	—	6	6	1	0.3	16
Pennsylvania	476,198	7	8	—	2	7	2	0	52
Puerto Rico	163,679	21	0.3	—	—	—	—	—	—
Rhode Island	37,661	—	—	—	—	—	—	—	—
South Carolina	171,431	6	23	—	0	2	0.1	0 2	—
South Dakota	34,727	—	—	—	—	—	—	—	—
Tennessee	229,080	4	20	—	1	—	—	—	—
Texas	889,388	—	23	.1	0 1	0 4	0	.1	—
Utah	125,578	—	4	.1	6	2	0.2	.1	3
Vermont	23,844	3	4	1	5	2	1	.1	4
Virginia	270,218	—	1	—	1	1	—	.4	—
Washington	236,546	—	—	—	—	—	—	—	—
West Virginia	95,457	6	19	0	0.4	—	—	—	—
Wisconsin	231,[illegible]	6	14	—	6	6	3	0.3	—
Wyoming	28,096	5	7	1	3	6	2	0.2	15
SUM (38 states)		**4 %**	**13 %**	**0.3 %**	**2 %**	**3 %**	**0.4 %**	**0.1 %**	**12 %**

Note Enrollments in SS & C courses in California, Iowa and Puerto Rico not counted in 1991-92 — Data not available
Source State Departments of Education, Data on Public Schools, Fall 1991 California, Fall 1990. NCES. CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center. Washington DC. 1993

APPENDIX TABLE A-15
STUDENTS TAKING REVIEW MATHEMATICS (E.G., GENERAL MATH) AND INFORMAL MATH (E.G., PRE-ALGEBRA) IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRADES 9—12

STATE	Student Membership (Grades 9—12)	General Remedial (Level 1) % 9—12	Consumer, Applied (Level 2) % 9—12	General (Level 3 & 4) % 9—12	Sum Review Math % 9—12	Pre-Algebra (Level 1) % 9—12	Basic Geometry & Algebra 2 (Level 2-3) % 9—12	Sum Informal Math % 9—12
Alabama	195,531	11 %	10 %	— %	21 %	4 %	— %	4 %
Alaska	29,556	—	—	—	—	—	—	—
Arizona	166,311	—	—	—	—	—	—	—
Arkansas	122,209	21	0	4	26	8	1	8
California	1,354,457	15	2	—	17	7	—	7
Colorado	156,273	5	4	—	9	11	—	11
Connecticut	125,575	7	5	3	14	11	9	20
Delaware	27,641	6	5	3	15	9	4	13
Dist. of Columbia	17,922	4	1	—	5	13	6	19
Florida	504,518	12	16	1	29	12	1	13
Georgia	309,439	—	—	—	—	—	—	—
Hawaii	43,495	14	22	1	37	12	4	16
Idaho	63,653	5	1	1	8	—	—	—
Illinois	486,990	—	—	—	—	—	—	—
Indiana	274,823	8	6	—	14	7	1	8
Iowa	135,744	7	6	7	19	6	—	6
Kansas	117,951	3	4	1	8	13	3	16
Kentucky	176,459	8	2	4	14	10	4	14
Louisiana	—	—	—	—	—	—	—	—
Maine	58,898	—	—	—	—	—	—	—
Maryland	186,084	—	—	—	—	—	—	—
Massachusetts	230,165	—	—	—	—	—	—	—
Michigan	416,535	—	—	—	—	—	—	—
Minnesota	216,836	6	3	—	10	—	—	—
Mississippi	127,704	9	7	—	16	8	—	8
Missouri	229,211	11	3	—	15	7	—	7
Montana	42,677	4	3	1	8	10	1	11
Nebraska	78,185	14	2	—	17	—	—	—
Nevada	54,076	5	11	0.1	17	15	0.2	15
New Hampshire	47,313	—	—	—	—	—	—	—
New Jersey	291,788	—	—	—	—	—	—	—
New Mexico	78,366	13	5	—	18	13	—	13
New York	714,244	8	4	0.3	13	8	3	12
North Carolina	302,825	9	7	1	17	11	—	11
North Dakota	33,435	2	4	—	6	5	—	5
Ohio	506,364	11	0	7	19	8	—	8
Oklahoma	155,510	6	2	—	8	7	3	11
Oregon	138,431	4	3	3	11	13	5	18
Pennsylvania	476,198	8	7	1	16	15	—	15
Puerto Rico	163,679	—	—	41	41	—	—	—
Rhode Island	37,661	—	—	—	—	—	—	—
South Carolina	171,431	21	8	4	33	10	—	10
South Dakota	34,727	—	—	—	—	—	—	—
Tennessee	229,080	6	5	1	11	10	—	10
Texas	889,388	4	5	—	9	15	6	22
Utah	125,578	3	4	1	8	15	—	15
Vermont	23,844	4	5	3	11	7	4	11
Virginia	270,218	8	6	0	14	12	3	15
Washington	236,546	—	—	—	—	—	—	—
West Virginia	95,457	8	18	2	29	5	—	5
Wisconsin	231,732	9	4	3	15	—	—	—
Wyoming	28,096	5	4	—	9	3	—	3
SUM (38 states)		**9 %**	**5 %**	**2 %**	**16 %**	**10 %**	**2 %**	**12 %**

Note — Data not available
Source: State Departments of Education, Data on Public Schools, Fall 1991. California, Fall 1990. NCES, CCD Fall Membership 1991
Council of Chief State School Officers, State Education Assessment Center, Washington DC, 1993

APPENDIX TABLE A-16
STUDENTS TAKING FORMAL MATHEMATICS (ALGEBRA—CALCULUS) IN OCTOBER 1991 AS A PERCENT OF STUDENTS IN GRADES 9—12

STATE	Student Membership (Grades 9—12)	Algebra 1/ Integrated Math 1 (Level 1) % 9—12	Geometry/ Integrated Math 2 (Level 2) % 9—12	Algebra 2/ Integrated Math 3 (Level 3) % 9—12	Trigonometry Pre-Calculus (Level 4) % 9—12	Calculus (Level 5) % 9—12	Calculus, AP (Level 5) % 9—12	Sum Formal Math % 9—12
Alabama	195,531	20 %	14 %	12 %	4 %	1 %	1 %	52 %
Alaska	29,556	—	—	—	—	—	—	
Arizona	166,311	—	—	—	—	—	—	—
Arkansas	122,209	24	15	13	6	1	—	60
California	1,354,457	21	12	10	5	2	—	49
Colorado	156,273	18	15	12	7	2	—	54
Connecticut	125,575	17	16	14	9	2	1	59
Delaware	27,641	14	10	10	6	1	1	42
Dist. of Columbia	17,922	22	18	10	4	1	—	54
Florida	504,518	19	13	11	5	0.5	1	49
Georgia	309,439	—	—	—	—	—	—	—
Hawaii	43,495	14	9	8	4	0.1	1	36
Idaho	63,653	16	16	16	6	2	1	56
Illinois	486,990	—	—	—	—	—	—	—
Indiana	274,823	21	14	13	7	1	1	57
Iowa	135,744	25	19	16	8	3	—	71
Kansas	117,951	23	17	15	7	2	1	64
Kentucky	176,459	21	17	15	7	—	1	61
Louisiana	—	—	—	—	—	—	—	—
Maine	58,898	21	21	17	12	—	—	71
Maryland	186,084	—	—	—	—	—	—	—
Massachusetts	230,165	—	—	—	—	—	—	—
Michigan	416,535	—	—	—	—	—	—	—
Minnesota	216,836	23	18	15	8	3	—	67
Mississippi	127,704	24	16	15	6	0.4	1	62
Missouri	229,211	24	16	15	4	2	—	61
Montana	42,677	21	20	14	8	1	.1	65
Nebraska	78,185	24	17	14	5	3	—	63
Nevada	54,076	18	13	11	4	1	0.3	47
New Hampshire	47,313	—	—	—	—	—	—	—
New Jersey	291,788	—	—	—	—	—	—	—
New Mexico	78,366	26	14	12	5	1	1	60
New York	714,244	21	15	11	6	1	2	54
North Carolina	302,825	19	17	13	9	1	1	59
North Dakota	33,435	27	20	19	12	2	—	80
Ohio	506,364	20	15	12	8	1	1	57
Oklahoma	155,510	24	13	15	5	1	0.5	59
Oregon	138,431	17	13	11	5	2	1	49
Pennsylvania	476,198	24	15	15	12	3	1	69
Puerto Rico	163,679	27	17	—	2	—	—	46
Rhode Island	37,661	—	—	—	—	—	—	—
South Carolina	171,431	18	14	12	7	1	1	53
South Dakota	34,727	—	—	—	—	—	—	—
Tennessee	229,080	22	14	13	6	1	—	58
Texas	889,388	25	16	15	5	1	—	63
Utah	125,578	20	18	16	8	1	3	65
Vermont	23,844	17	14	13	7	2	1	54
Virginia	270,218	16	16	14	9	2	1	58
Washington	236,546	—	—	—	—	—	—	—
West Virginia	95,457	18	14	12	6	1	1	51
Wisconsin	231,732	26	20	14	8	3	2	74
Wyoming	28,096	21	16	14	7	3	1	62
SUM (39 states)		**21 %**	**15 %**	**13 %**	**6 %**	**1 %**	**1 %**	**58 %**

Note — Data not available
Source State Departments of Education. Data on Public Schools Fall 1991. California Fall 1990. NCES CCD Fall Membership 1991
Council of Chief State School Officers State Education Assessment Center Washington DC 1993

APPENDIX TABLE A-17
PERCENT CHANGE IN STUDENTS TAKING HIGH SCHOOL MATHEMATICS BY STATE GRADUATION REQUIREMENTS: 1990 TO 1992

STATE	Algebra 1/ Integrated Math 1: % Change	Algebra 2/ Integrated Math 3: % Change	Calculus: % Change
2.5 to 3 Credits			
Arkansas	7	7	1
Connecticut	7	-2	0
Florida	0	4	-2
Kentucky	8	7	1
New Mexico	0	4	0
Pennsylvania	0	3	3
South Carolina	7	-1	2
Texas	5	13	2
Virginia	9	3	3
Average	**4.8**	**4.3**	**1.2**
2 Credits			
Alabama	13	4	1
California	-3	-2	0
Hawaii	6	-2	0
Maine	7	9	—
Mississippi	10	6	1
Missouri	0	5	3
New York	4	-1	1
North Dakota	0	12	3
Ohio	6	3	2
Oklahoma	0	3	-2
Tennessee	2	3	1
West Virginia	6	7	5
Average	**4.3**	**3.9**	**1.3**
Local Board Policies			
Iowa	3	17	3
Minnesota	5	7	1
Nebraska	10	4	8
Average	**6.0**	**7.0**	**4.0**

Source State Departments of Education. Data on Public Schools. Fall 1991. California, Fall 1990. NCES, CCD Fall Membership 1991 Council of Chief State School Officers. State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE A-18
PERCENT CHANGE IN STUDENTS TAKING HIGH SCHOOL SCIENCE BY STATE GRADUATION REQUIREMENTS 1990-1992

STATE	Biology: % Change	Chemistry: % Change	Physics: % Change
2.5 to 3 Credits			
Arkansas	0	10	1
Florida	0	3	2
Pennsylvania	0	3	2
Virginia	0	2	2
Average	**0**	**4.5**	**1.8**
1 to 2 Credits			
Alabama	0	5	-5
California	-2	0	-1
Connecticut	0	1	1
Hawaii	7	1	3
Kentucky	0	6	1
Maine	1	11	—
Mississippi	0	2	0
Missouri	4	5	2
New Mexico	0	7	1
New York	0	2	0
North Dakota	0	13	4
Ohio	-2	4	2
Oklahoma	2	2	1
South Carolina	0	5	1
Tennessee	7	4	2
Texas	0	6	3
West Virginia	0	8	2
Average	**1.0**	**4.8**	**1.0**
Local Board Policies			
Iowa	0	7	3
Minnesota	0	8	2
Nebraska	0	4	3
Average	**0**	**6.3**	**2.6**

Source State Departments of Education Data on Public Schools Fall 1991 California Fall 1990. NCES. CCD Fall Membership 1991 Council of Chief State School Officers, State Education Assessment Center, Washington, DC. 1993

APPENDIX B

APPENDIX TABLE B-1
MATHEMATICS TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Total	Mathematics: Main Assignment %	Mathematics: Other Assignment %
Alabama	1,608	51%	49%
Alaska	—	—	—
Arizona	1,050	96	4
Arkansas	709 *	—	—
California	9,837	69	31
Colorado	1,275	91	9
Connecticut	1,545	81	19
Delaware	192 *	—	—
Dist. of Columbia	—	—	—
Florida	8,880	71	29
Georgia	—	—	—
Hawaii	578	62	38
Idaho	747	38	62
Illinois	3,799	97	3
Indiana	2,270	84	16
Iowa	1,534	—	—
Kansas	1,224	—	—
Kentucky	1,568	86	14
Louisiana	—	—	—
Maine	825	—	—
Maryland	—	—	—
Massachusetts	3,329 *	—	—
Michigan	3,380	91	9
Minnesota	1,787	76	24
Mississippi	1,142	83	17
Missouri	2,029	84	16
Montana	506	79	21
Nebraska	—	—	—
Nevada	474	69	31
New Hampshire	471	—	—
New Jersey	3,677	91	9
New Mexico	716	82	18
New York	7,555	73	27
North Carolina	3,318	77	23
North Dakota	468	65	35
Ohio	4,210	81	19
Oklahoma	1,701	91	9
Oregon	1,207	87	13
Pennsylvania	6,443 *	96	4
Puerto Rico	1,562	66	34
Rhode Island	413	97	3
South Carolina	1,845	87	13
South Dakota	467	68	32
Tennessee	1,892	78	22
Texas	10,612	74	26
Utah	1,243	66	34
Vermont	278	78	22
Virginia	—	—	—
Washington	—	—	—
West Virginia	1,019	98	2
Wisconsin	—	—	—
Wyoming	275	85	15
NATION	**116,849**	**79%**	**21%**

**Arkansas, Delaware Main assignment only. Massachusetts K—12 Pennsylvania 7—12*
Note Main Assignment = Half time or more assigned to subject or primary assignment Other = Less than half time assigned to subject
National totals include imputation for nonreporting states — Data not available

Source State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990
Council of Chief State School Officers State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-2
BIOLOGY AND CHEMISTRY TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

	Biology			Chemistry		
STATE	Total	Main Assignment %	Other Assignment %	Total	Main Assignment %	Other Assignment %
Alabama	826	27%	73%	378	9%	91%
Alaska	—	—	—	—	—	—
Arizona	934 *	95	5	—	—	—
Arkansas	629	44	56	306	33	67
California	3,887	59	41	1,365	54	46
Colorado	1,131 *	91	9	—	—	—
Connecticut	679	62	38	375	58	42
Delaware	51 *	—	—	16 *	—	—
Dist. of Columbia	—	—	—	—	—	—
Florida	2,427	58	42	691	60	40
Georgia	—	—	—	—	—	—
Hawaii	194	54	46	59	64	36
Idaho	253	46	54	131	34	66
Illinois	1,369	96	4	687	99	1
Indiana	1,015	75	25	507	72	28
Iowa	746	—	—	426	—	—
Kansas	632	—	—	391	—	—
Kentucky	716	70	30	344	59	41
Louisiana	—	—	—	—	—	—
Maine	363	—	—	211	—	—
Maryland	—	—	—	—	—	—
Massachusetts	741	—	—	441	—	—
Michigan	863	86	14	438	74	26
Minnesota	741	67	33	501	42	58
Mississippi	792	68	32	548	40	60
Missouri	1,038	65	35	588	43	57
Montana	251	45	55	167	32	68
Nebraska	—	—	—	—	—	—
Nevada	211	59	41	77	57	43
New Hampshire	181	—	—	67	—	—
New Jersey	922	93	7	448	91	9
New Mexico	313	62	38	143	38	62
New York	5,047	66	34	1,835	65	35
North Carolina	1,368	62	38	571	63	37
North Dakota	261	30	70	176	17	83
Ohio	1,797	69	31	1,014	60	40
Oklahoma	914	66	34	463	31	69
Oregon	362	80	20	—	—	—
Pennsylvania	1,939	87	13	1,065	85	15
Puerto Rico	414	93	7	231	85	15
Rhode Island	153	88	12	88	81	19
South Carolina	664	69	31	346	61	39
South Dakota	228	43	57	155	21	79
Tennessee	697	66	34	362	64	36
Texas	4,367	58	42	1,682	51	49
Utah	456	67	33	124	62	38
Vermont	127	72	28	80	56	44
Virginia	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	381	84	16	162	71	29
Wisconsin	—	—	—	—	—	—
Wyoming	147	76	24	88	67	33
NATION	**46,864**	**68%**	**32%**	**21,277**	**59%**	**41%**

**Arizona, Colorado Science, all fields. Delaware Main assignment only*
Note: Main Assignment = Half time or more assigned to subject or primary assignment Other = Less than half time assigned to subject
National totals include imputation for nonreporting states — Data not available

Source State Departments of Education, Data on Public Schools, Fall, 1991, California, Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-3
PHYSICS AND EARTH SCIENCE TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Physics Total	Physics Main Assignment %	Physics Other Assignment %	Earth Science Total	Earth Science Main Assignment %	Earth Science Other Assignment %
Alabama	286	2%	98%	21	5%	95%
Alaska	—	—	—	—	—	—
Arizona	—	—	—	—	—	—
Arkansas	238	6	94	64	55	45
California	922	26	74	550	32	68
Colorado	—	—	—	—	—	—
Connecticut	263	36	64	257	50	50
Delaware	30 *	—	—	8	—	—
Dist. of Columbia	—	—	—	—	—	—
Florida	401	49	51	1,323	40	60
Georgia	—	—	—	—	—	—
Hawaii	44	48	52	92	35	65
Idaho	91	11	89	148	39	61
Illinois	321	98	2	204	90	10
Indiana	366	31	69	287	62	38
Iowa	389	—	—	225	—	—
Kansas	274	—	—	98	—	—
Kentucky	219	12	88	51	22	78
Louisiana	—	—	—	—	—	—
Maine	177	—	—	162	—	—
Maryland	—	—	—	—	—	—
Massachusetts	261	—	—	309	—	—
Michigan	261	52	48	130	60	40
Minnesota	375	26	74	111	29	71
Mississippi	197	10	90	7	0	100
Missouri	378	15	85	162	43	57
Montana	134	12	88	175	35	65
Nebraska	—	—	—	—	—	—
Nevada	50	28	72	91	55	45
New Hampshire	37	—	—	26	—	—
New Jersey	163	88	12	327	97	3
New Mexico	98	14	86	41	24	76
New York	1,089	53	47	2,831	60	40
North Carolina	351	18	82	328	21	79
North Dakota	124	5	95	8	13	88
Ohio	748	27	73	410	53	47
Oklahoma	243	12	88	65	20	80
Oregon	—	—	—	—	—	—
Pennsylvania	693	70	30	778	81	19
Puerto Rico	119	75	25	94	84	16
Rhode Island	52	83	17	10	70	30
South Carolina	232	18	82	2	50	50
South Dakota	123	8	92	28	39	61
Tennessee	237	15	85	71	23	77
Texas	1,043	21	79	334	36	64
Utah	80	34	66	344	48	52
Vermont	73	48	52	77	43	56
Virginia	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	108	20	80	283	74	26
Wisconsin	—	—	—	—	—	—
Wyoming	71	61	39	63	63	37
NATION	**13,610**	**34%**	**66%**	**12,273**	**54%**	**46%**

*Delaware Main assignment only
Note Main Assignment = Half time or more assigned to subject or primary assignment Other = Less than half time assigned to subject
National totals include imputation for nonreporting states — Data not available

Source State Departments of Education. Data on Public Schools, Fall, 1991. California, Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington DC 1993

APPENDIX TABLE B-4
GENERAL AND PHYSICAL SCIENCE TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

	General Science			Physical Science		
STATE	Total	Main Assignment %	Other Assignment %	Total	Main Assignment %	Other Assignment %
Alabama	72	0%	100%	649	3%	97%
Alaska	—	—	—	—	—	—
Arizona	—	—	—	—	—	—
Arkansas	208	28	72	488	46	54
California	602	29	71	2,147	39	61
Colorado	—	—	—	—	—	—
Connecticut	214	29	71	210	23	77
Delaware	12 *	—	—	—	—	—
Dist. of Columbia	—	—	—	—	—	—
Florida	467	12	88	1,204	32	68
Georgia	—	—	—	—	—	—
Hawaii	136	16	84	121	47	53
Idaho	21	14	86	96	27	73
Illinois	500	89	11	206	96	4
Indiana	294	34	66	386	42	58
Iowa	436	—	—	301	—	—
Kansas	474	—	—	127	—	—
Kentucky	—	—	—	357	42	58
Louisiana	—	—	—	—	—	—
Maine	161	—	—	157	—	—
Maryland	—	—	—	—	—	—
Massachusetts	1,277	—	—	—	—	—
Michigan	1,622	79	21	—	—	—
Minnesota	—	—	—	255	48	52
Mississippi	—	—	—	—	—	—
Missouri	374	29	71	661	41	59
Montana	30	3	97	48	13	88
Nebraska	—	—	—	—	—	—
Nevada	60	50	50	21	29	71
New Hampshire	109	—	—	24	—	—
New Jersey	387	95	5	529	95	5
New Mexico	107	37	63	160	46	54
New York	1,443	49	51	2,146	55	45
North Carolina	49	6	94	1,213	49	51
North Dakota	—	—	—	248	19	81
Ohio	1,208	41	59	573	48	52
Oklahoma	182	25	75	547	50	50
Oregon	404	85	15	273	70	30
Pennsylvania	2,526	78	22	238	57	43
Puerto Rico	316	58	42	9	44	56
Rhode Island	123	73	27	19	58	42
South Carolina	213	32	68	572	51	49
South Dakota	28	14	86	183	24	76
Tennessee	189	36	64	617	57	43
Texas	—	—	—	3,558	47	53
Utah	2	50	50	142	48	52
Vermont	23	13	87	42	43	55
Virginia	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	129	57	43	90	48	52
Wisconsin	—	—	—	—	—	—
Wyoming	71	61	39	53	72	28
NATION	**14,469**	**57%**	**43%**	**18,670**	**46%**	**54%**

*Delaware Main assignment only
Note Main Assignment = Half time or more assigned to subject or primary assignment Other - Less than half time assigned to subject -- Data not available

Source State Departments of Education Data on Public Schools, Fall 1991. California, Fall 1990
Council of Chief State School Officers State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-5
INTEGRATED AND COMPUTER SCIENCE TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Integrated Science Total	Integrated Science Main Assignment %	Integrated Science Other Assignment %	Computer Science Total	Computer Science Main Assignment %	Computer Science Other Assignment %
Alabama	—	—%	—%	114	1%	99%
Alaska	—	—	—	—	—	—
Arizona	—	—	—	80	69	31
Arkansas	—	—	—	155	25	75
California	—	—	—	478	16	84
Colorado	—	—	—	—	—	—
Connecticut	15	13	87	141	16	84
Delaware	—	—	—	4 *	—	—
Dist. of Columbia	—	—	—	—	—	—
Florida	7	14	86	338	25	75
Georgia	—	—	—	—	—	—
Hawaii	22	5	95	29	21	79
Idaho	—	—	—	161	18	82
Illinois	—	—	—	539	65	35
Indiana	122	24	76	161	24	76
Iowa	—	—	—	159	—	—
Kansas	—	—	—	300	—	—
Kentucky	397	34	66	131	19	81
Louisiana	—	—	—	—	—	—
Maine	—	—	—	195	—	—
Maryland	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—
Michigan	—	—	—	319	54	46
Minnesota	—	—	—	222	12	88
Mississippi	—	—	—	113	27	73
Missouri	—	—	—	220	34	66
Montana	2	0	100	0	—	—
Nebraska	—	—	—	—	—	—
Nevada	—	—	—	37	30	70
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	294	57	43
New Mexico	—	—	—	75	27	73
New York	—	—	—	1,716	35	65
North Carolina	—	—	—	498	43	57
North Dakota	—	—	—	97	5	95
Ohio	—	—	—	777	52	48
Oklahoma	—	—	—	295	32	68
Oregon	138	75	25	169	37	63
Pennsylvania	63	62	38	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	34	68	32
South Carolina	—	—	—	112	31	69
South Dakota	—	—	—	279	31	69
Tennessee	—	—	—	39	13	87
Texas	4	100	0	613	37	63
Utah	0	—	—	107	50	50
Vermont	10	0	100	43	40	63
Virginia	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	0	—	—	0	—	—
Wisconsin	—	—	—	—	—	—
Wyoming	13	77	23	90	54	46
NATION	**793**	**41%**	**59%**	**9,134**	**37%**	**63%**

*Delaware Main assignment only

Note. Main Assignment = Half time or more assigned to subject or primary assignment Other = Less than half time assigned to subject. — Data not available.

Source. State Departments of Education Data on Public Schools, Fall 1991. California, Fall 1990
Council of Chief State School Officers. State Education Assessment Center, Washington, DC. 1993.

APPENDIX TABLE B-6
MATHEMATICS AND SCIENCE TEACHERS IN GRADES 7—8, BY TIME ASSIGNED

STATE	Mathematics Total	Mathematics Main Assignment	Mathematics Other Assignment	Science Total	Science Main Assignment	Science Other Assignment	Computer Science Total	Computer Science Main Assignment	Computer Science Other Assignment	General Assignment (includes Math/Science) Total	General Assignment Main Assignment	General Assignment Other Assignment
Alabama	1,359	57%	43%	1,261	57%	43%	6	0%	100%	—	—%	—%
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	—	—	—	—	—	—	—
Arkansas	—	—	—	—	—	—	—	—	—	—	—	—
California	6,908	58	42	4,821	66	34	871	31	69	575	89	11
Colorado	1,032	76	24	974	76	24	—	—	—	973	92	8
Connecticut	937	71	29	782	83	17	32	50	50	—	—	—
Delaware	123	—	—	122	—	—	3	—	—	907	—	—
Dist. of Columbia	—	—	—	—	—	—	—	—	—	—	—	—
Florida	3,029	58	42	6,119	65	35	79	24	76	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	360	56	44	221	52	48	23	13	87	—	—	—
Idaho	405	50	50	325	56	44	68	26	74	32	47	53
Illinois	1,166	98	2	1,072	98	2	62	95	5	3,331	97	3
Indiana	1,601	77	23	1,470	78	22	14	29	71	45	29	71
Iowa	—	—	—	—	—	—	—	—	—	—	—	—
Kansas	628	—	—	652	—	—	101	—	—	1,031	—	—
Kentucky	1,189	69	31	980	75	25	1	0	100	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—	—	—
Maine	425	—	—	368	—	—	39	—	—	211	—	—
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—	—	—
Michigan	1,953	83	17	1,767	84	16	164	52	48	—	—	—
Minnesota	963	60	40	843	64	36	—	—	—	—	—	—
Mississippi	1,038	68	32	832	68	32	34	44	56	—	—	—
Missouri	1,294	72	28	1,289	71	29	17	41	59	—	—	—
Montana	401	42	58	381	46	54	0	—	—	80	0	100
Nebraska	—	—	—	—	—	—	—	—	—	—	—	—
Nevada	300	84	16	198	75	25	9	22	78	—	—	—
New Hampshire	89	—	—	—	—	—	—	—	—	—	—	—
New Jersey	2,322	67	33	1,237	83	17	340	82	18	—	—	—
New Mexico	483	67	33	456	74	26	—	—	—	—	—	—
New York	6,092	54	46	5,382	68	32	1,026	41	59	—	—	—
North Carolina	2,774	49	51	2,173	57	43	63	51	49	—	—	—
North Dakota	459	27	73	392	28	72	—	—	—	—	—	—
Ohio	2,634	74	26	2,220	79	21	261	79	21	1,585	74	26
Oklahoma	922	70	30	850	69	31	—	—	—	303	14	86
Oregon	645	76	24	476	88	12	120	43	57	570	97	3
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	1,412	77	23	748	85	15	—	—	—	—	—	—
Rhode Island	232	98	2	217	98	2	11	91	9	1	0	100
South Carolina	1,637	54	46	1,168	55	45	—	—	—	—	—	—
South Dakota	319	46	54	298	47	53	—	—	—	25	80	20
Tennessee	—	—	—	—	—	—	—	—	—	—	—	—
Texas	6,421	61	39	5,742	67	33	—	—	—	—	—	—
Utah	272	75	25	217	67	33	36	64	36	11	91	9
Vermont	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—	—	—
West Virginia	461	99	1	276	98	2	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—	—	—	—	—	—	—
Wyoming	231	81	19	199	81	19	55	45	55	49	94	6
NATION	**52,516**	**64%**	**36%**	**46,528**	**69%**	**31%**	**3,435**	**47%**	**53%**	**9,729**	**86%**	**14%**

Note General Assignment includes middle school teachers teaching multiple subjects and self-contained grade 7—8 teachers. — Data not available

Source. State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-7
NEW MATH AND SCIENCE TEACHERS IN LARGE CITY DISTRICTS

STATE/City	% New Math	% New Science	Math % Newly Hired	Science % Newly Hired
California	5 %	5 %	10 %	9 %
11 Large City Districts	5.5	5	8	7
High	6	7	7	8
Low	1	0	7	0
New York	[illegible]	2	4	5
3 Large City Districts	2.1	2	6	6
High	2	2	6	6
Low	2	0	4	0
Ohio	3	3	6	5
5 Large City Districts	1	1	1	1
High	3	4	3	4
Low	0	0	0	0
Texas	6	6	14	14
9 Large City Districts	5.6	4	8.6	6
High	6	9	9	10
Low	1	0	5	1

Source State Departments of Education. Data on Public Schools. Fall 1991; California, Fall 1990
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993.

APPENDIX TABLE B-8
SECONDARY SCIENCE AND MATHEMATICS TEACHERS: STATE CERTIFICATION REQUIREMENTS

		Course Credits by Certification Field			
STATE	**Math**	**Broad-Field Science**	**Biology, Chemistry, Physics**	**Earth Science**	**General Science**
Alabama	36	60	27	27	60
Alaska	IHE	IHE	IHE	IHE	IHE
Arizona	30	30	30	30	30
Arkansas	21	—	24	24	24
California	IHE	—	IHE (Biological, Physical)	—	—
Colorado	IHE	IHE	IHE	IHE	IHE
Connecticut	18	—	18	18	21
Delaware	30	—	39-45	39	36
Dist. of Columbia	27	30	30	30	36
Florida	30	—	21	21	20
Georgia	60qtr	70qtr	40qtr	40qtr	—
Hawaii	IHE	IHE	IHE	IHE	IHE
Idaho	20	45	20	20	—
Illinois	25	32	24	24	24
Indiana	36	—	36	36	36
Iowa	24	24	24	24	24
Kansas	IHE	IHE	IHE	IHE	IHE
Kentucky	30	30	30	30	—
Louisiana	20	—	20	20	32
Maine	36	—	36 (Life, Physical)	—	—
Maryland	30	—	46	46	—
Massachusetts	36	36	36	36	36
Michigan	Major(30) Minor(20)	30/20	30/20	30/20	30/20
Minnesota	IHE	—	IHE (Biology, Physical)	IHE	—
Mississippi	IHE	IHE	IHE	IHE	IHE
Missouri	30	30	20	20	20
Montana	30	60	30	30	—
Nebraska	30	56	24	24	—
Nevada	30	36	30	30	30
New Hampshire	IHE	IHE	IHE	IHE	IHE
New Jersey	30	—	30	30	—
New Mexico	24	24	—	—	—
New York	24	—	15	36	36
North Carolina	IHE	IHE	IHE	IHE	—
North Dakota	IHE	IHE	IHE	IHE	—
Ohio	30	60	30	30	30
Oklahoma	40	—	40	40	40
Oregon	21/42	45	45	45	45
Pennsylvania	IHE	IHE	IHE	IHE	IHE
Rhode Island	30	30	30	—	30
South Carolina	IHE	IHE	IHE	IHE	IHE
South Dakota	18	21	12	12	18
Tennessee	36qtr	48qtr	24qtr	24qtr	24qtr
Texas	24	48	24	24	—
Utah	45qtr	—	69qtr(Bio) 45qtr(Chem,Phys)	69qtr	—
Vermont	IHE	IHE	IHE	IHE	IHE
Virginia	27	—	24	24	30
Washington	24	41	34	24	24
West Virginia	IHE	IHE	IHE	IHE	IHE
Wisconsin	34	54	34	34	34
Wyoming	24	30	12	12	12
TOTAL (states with requirements)	**37 states 14 IHE**	**24 states 12 IHE**	**36 states 14 IHE**	**34 states 13 IHE**	**26 states 10 IHE**

Note — No State Certification Available. IHE = State-approved program of institutions of higher education; Physical Science Certification: Maryland—40 credits. Utah—69 qtr credits
"Credits" = Semester credits, unless quarter credits specified
Source State Departments of Education, Mathematics and Science Supervisors, Winter 1992
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993.

APPENDIX TABLE B-9
MIDDLE GRADES TEACHERS: STATE CERTIFICATION REQUIREMENTS IN SCIENCE AND MATHEMATICS

STATE	Separate Certification	Math	Course Credits	Science	Teaching Methods in Science/Math	Supervised Teaching Experience
Alabama	Yes	27		36	Science & Math	9 Sem. Cr.
Alaska	Yes		IHE		IHE	IHE
Arizona	No	—		—	—	—
Arkansas	Yes	18		18	—	12 Wks.
California	Yes		IHE		IHE	IHE
Colorado	Yes		IHE		Science & Math	400 Hrs.
Connecticut	No	—		—	—	—
Delaware	Yes	15		—	Math Only	6 Sem. Cr.
Dist. of Columbia	Yes	24		30	Science & Math	1 Full Sem.
Florida	Yes	21		18	Science & Math	1 Full Sem.
Georgia	No	—		—	—	15 Qtr. Cr.
Hawaii	No	—		—	—	—
Idaho	No	—		—	—	—
Illinois	No	—		—	—	—
Indiana	Yes	18		18	Science & Math	9 Wks.
Iowa	No	—		—	—	—
Kansas	Yes		IHE		Science & Math	10 Wks.
Kentucky	Yes	24		24	Science & Math	12 Wks.
Louisiana	Yes	12		16	—	9 Sem. Cr.
Maine	Yes		2 Minors		Science & Math	15 Wks.
Maryland	No	—		—	—	—
Massachusetts	Yes	36		36	Science & Math	300 Hrs.
Michigan	Yes	30		—	—	6 Sem. Cr.
Minnesota	Yes		IHE		Science & Math	1 Full Qtr.
Mississippi	No	—		—	—	—
Missouri	Yes	21		21	—	1 Full Year
Montana	No	—		—	—	—
Nebraska	Yes	15		30	Science Only	400 Hrs.
Nevada	No	—		—	—	—
New Hampshire	Yes		IHE		IHE	IHE
New Jersey	No	—		—	—	—
New Mexico	No	—		—	—	—
New York	Yes	18		36	—	1 Full Year
North Carolina	Yes		IHE		Science & Math	6 Sem. Cr.
North Dakota	Yes		IHE		Science & Math	10 Wks.
Ohio	Yes	20		20	Science & Math	IHE
Oklahoma	Yes	18		18	Science & Math	—
Oregon	No	—		—	—	—
Pennsylvania	No	—		—	—	—
Rhode Island	Yes	18		18	Science & Math	6 Sem. Cr.
South Carolina	Yes		IHE		IHE	60 Days
South Dakota	Yes	12		12	Science & Math	10 Wks.
Tennessee	No	—		—	—	—
Texas	No	—		—	—	—
Utah	No	—		—	—	—
Vermont	Yes		2 Minors		Science & Math	IHE
Virginia	Yes	15		15	—	6 Sem. Cr.
Washington	No	—		—	—	—
West Virginia	No	—		—	—	—
Wisconsin	Yes	22		22	Science & Math	1 Full Sem.
Wyoming	Yes	24		30	Science & Math	6 Sem. Cr.
TOTAL (states with requirements)	**Yes = 31 states**	**22 states**	**9 IHE**	**20 states**	**20 Science 20 Math 4 IHE**	**26 states 5 IHE**

Note "No" for Separate Certification=State teacher certification for these grades under elementary or secondary certification.
— No State Requirement. IHE = State-approved program of institutions of higher education. "Credits" = Semester credits, unless quarter credits specified

Source State Departments of Education, Mathematics and Science Supervisors, Winter 1992
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-10
CERTIFICATION STATUS OF MATH TEACHERS IN GRADES 7—8, BY TIME ASSIGNED

		Mathematics Main Assignment			Mathematics Other Assignment		
STATE	Math Teachers (Grades 7—8)	% Certified Math	% Certified Other	% Not Certified	% Certified Math	% Certified Other	% Not Certified
Alabama	1,359	56%	0%	1%	39%	0%	4%
Alaska	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	—	—
Arkansas	—	—	—	—	—	—	—
California	6,908	29	21	7	11	22	9
Colorado	1,032	43	17	16	4	7	13
Connecticut	937	41	30	0.1	8	16	5
Delaware	123	75	25	0	0	0	0
Dist. of Columbia	—	—	—	—	—	—	—
Florida	3,029	55	1	2	19	8	15
Georgia	—	—	—	—	—	—	—
Hawaii	360	—	—	—	—	—	—
Idaho	405	29	20	1	24	24	2
Illinois	1,166	—	95	3	—	2	0.3
Indiana	1,601	67	8	2	14	7	3
Iowa	—	—	—	—	—	—	—
Kansas	628	—	—	—	—	—	—
Kentucky	1,189	24	40	5	8	21	3
Louisiana	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—
Michigan	1,953	—	—	—	—	—	—
Minnesota	963	59	0	1	37	0	3
Mississippi	1,038	25	43	0.3	11	20	0.3
Missouri	1,294	67	0	5	24	0	4
Montana	401	23	18	0.5	23	34	2
Nebraska	—	—	—	—	—	—	—
Nevada	300	56	0	28	10	0	5
New Hampshire	89	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—
New Mexico	483	54	0	13	27	0	7
New York	6,092	51	0	3	41	0	5
North Carolina	2,774	45	3	1	24	23	4
North Dakota	459	19	7	0	39	34	0
Ohio	2,634	44	27	2	6	14	6
Oklahoma	922	36	33	1	20	9	1
Oregon	645	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—
Puerto Rico	1,412	64	0	13	20	0	3
Rhode Island	232	98	0	0	2	0	0
South Carolina	1,637	34	19	1	9	23	14
South Dakota	319	46	0	0.3	52	0	2
Tennessee	—	—	—	—	—	—	—
Texas	6,421	—	—	—	—	—	—
Utah	272	63	0	12	13	0	12
Vermont	81	74	36	0	21	17	0
Virginia	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—
West Virginia	461	97	0	2	1	0	0
Wisconsin	—	—	—	—	—	—	—
Wyoming	231	65	16	0	9	11	0
SUM (29 states)		**45%**	**15%**	**4%**	**20%**	**11%**	**6%**

Note: Certified Other = Certified in Science, Middle/Junior High, General Elementary, and/or General Secondary — Data not available

Source: State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

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APPENDIX TABLE B-11
CERTIFICATION STATUS OF SCIENCE TEACHERS IN GRADES 7—8, BY TIME ASSIGNED

STATE	Science Teachers (Grades 7—8)	Science Main Assignment % Certified Science	% Certified Other	% Not Certified	Science Other Assignment % Certified Science	% Certified Other	% Not Certified
Alabama	1,261	48%	7%	2%	30%	7%	6%
Alaska	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	—	—
Arkansas	—	—	—	—	—	—	—
California	4,821	46	13	8	15	12	7
Colorado	974	61	8	7	8	6	10
Connecticut	782	57	26	0.3	5	9	3
Delaware	122	84	16	0	0	0	0
Dist. of Columbia	—	—	—	—	—	—	—
Florida	6,119	59	4	2	13	9	13
Georgia	—	—	—	—	—	—	—
Hawaii	221	—	—	—	—	—	—
Idaho	325	47	7	1	30	12	3
Illinois	1,072	—	95	4	—	1	1
Indiana	1,470	73	4	1	16	3	3
Iowa	—	—	—	—	—	—	—
Kansas	652	—	—	—	—	—	—
Kentucky	980	21	43	11	5	17	4
Louisiana	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—
Michigan	1 767	—	—	—	—	—	—
Minnesota	843	56	0	8	28	0	8
Mississippi	832	43	25	0.1	11	21	0.4
Missouri	1,289	61	0	11	23	0	5
Montana	381	17	29	0	18	35	1
Nebraska	—	—	—	—	—	—	—
Nevada	198	49	0	26	12	0	13
New Hampshire	—	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—
New Mexico	456	68	0	6	22	0	4
New York	5,382	62	0	6	25	0	7
North Carolina	2,173	54	1	2	27	12	4
North Dakota	392	22	6	0	49	23	0
Ohio	2,220	52	26	2	4	13	4
Oklahoma	850	52	16	1	23	7	1
Oregon	476	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—
Puerto Rico	748	84	0	1	14	0	0.4
Rhode Island	217	98	0	0	2	0	0
South Carolina	1,168	45	9	1	17	16	12
South Dakota	298	47	0	1	49	0	3
Tennessee	—	—	—	—	—	—	—
Texas	5,742	—	—	—	—	—	—
Utah	217	52	0	15	17	0	16
Vermont	70	64	34	1	23	10	1
Virginia	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—
West Virginia	276	95	0	3	2	0	0
Wisconsin	—	—	—	—	—	—	—
Wyoming	199	64	17	0	11	8	0
SUM (29 states)		**53%**	**11%**	**4%**	**17%**	**8%**	**7%**

Note Certified Other = Certified in Math, Middle/Junior High General Elementary and/or General Secondary — Data not available

Source State Departments of Education, Data on Public Schools, Fall 1991. California Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-12
CERTIFICATION STATUS OF MATHEMATICS TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Math Teachers Total	Main Assignment		Other Assignment	
		% Certified Math	% Not Certified	% Certified Math	% Not Certified
Alabama	1,608	51%	1%	46%	3%
Arkansas	709	98	2	—	—
California	9,837	61	8	18	13
Colorado	1,275	73	18	2	8
Connecticut	1,545	81	0.3	17	1
Delaware	192	94	6	—	—
Florida	8,880	64	7	7	22
Idaho	747	38	1	58	3
Illinois	3,799	76	20	3	1
Indiana	2,270	82	2	14	3
Kentucky	1,568	86	1	13	1
Minnesota	1,787	76	0.3	22	2
Mississippi	1,142	77	6	13	4
Missouri	2,029	84	0.2	15	0.5
Montana	506	79	0	20	1
Nevada	474	69	0.4	27	4
New Mexico	716	82	0.1	18	0.3
New York	7,555	70	3	23	5
North Carolina	3,318	73	3	20	4
North Dakota	468	65	0	35	0
Ohio	4,210	79	2	11	8
Oklahoma	1,701	88	3	7	2
Oregon	1,207	86	1	0	13
Pennsylvania	6,443	84	12	3	1
Puerto Rico	1,582	56	10	34	0.3
Rhode Island	413	97	0	3	0
South Carolina	1,845	84	3	8	5
South Dakota	467	68	0	30	1
Utah	1,243	60	5	28	6
Vermont	278	78	0	19	3
West Virginia	1,019	94	5	2	0.3
Wyoming	275	80	5	12	2
SUM (32 states)		**73%**	**6%**	**14%**	**7%**

Note: Several state percentages include teachers with general secondary certification Alabama—Main. 1 teacher. Other. 21 teachers. California—Main, 1004 teachers. Other. 680 teachers. Connecticut—Main, 36 teachers, Other. 32 teachers, Illinois—Main. 2901 teachers. Other 104 teachers, Montana—Main, 7 teachers. Other, 27 teachers. North Carolina—Main, 196 teachers. Other. 406 teachers. Ohio—Main, 1 teacher, Other. 8 teachers — Data not available

Source: State Departments of Education. Data on Public Schools, Fall 1991. California, Fall 1990 Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1993

APPENDIX TABLE B-13
CERTIFICATION STATUS OF BIOLOGY TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

		Main Assignment			Other Assignment		
STATE	Biology Teachers Total	% Certified Biology	% Certified Broad Field	% Not Certified	% Certified Biology	% Certified Broad Field	% Not Certified
Alabama	826	23%	4%	0%	52%	20%	2%
Arkansas	629	40	3	0.5	48	7	2
California	3,887	43	8	7	25	6	10
Colorado	1,131 *	0	89	2	0	4	5
Connecticut	679	62	0.1	0.4	33	2	3
Delaware	51	75	20	6	—	—	—
Florida	2,427	54	2	2	20	4	18
Idaho	253	30	15	1	30	21	3
Illinois	1,369	—	74	22	—	3	0.4
Indiana	1,015	73	0	2	23	0	2
Kentucky	716	69	0	1	29	0	2
Minnesota	741	52	15	1	27	5	1
Mississippi	792	58	0	10	22	0	10
Missouri	824	81	0	1	41	0	3
Montana	251	37	7	0.4	32	24	0
Nevada	211	12	47	0.5	7	33	1
New Mexico	313	0	62	0.3	0	38	0
New York	5,047	63	0	3	29	0	5
North Carolina	1,368	35	26	1	12	24	2
North Dakota	261	26	3	0	50	20	0
Ohio	1,797	56	12	1	20	8	3
Oklahoma	914	64	0	1	33	0	2
Oregon	362	80	0	1	16	0	4
Pennsylvania	1,939	62	17	8	8	3	1
Puerto Rico	414	92	0	1	7	0	0
Rhode Island	153	88	1	0	11	1	0
South Carolina	664	41	28	1	10	13	7
South Dakota	228	29	14	0	31	25	1
Utah	456	61	0	7	27	0	6
West Virginia	381	80	0	4	14	0	2
Wyoming	147	53	19	4	22	1	0
SUM (31 states)		**50%**	**13%**	**4%**	**22%**	**6%**	**5%**

*includes all science

Note General secondary certification included in broad field category Alabama—Main, 2 teachers Other, 4 teachers, California—Main, 323 teachers, Other 251 teachers, Connecticut —Main, 1 teacher, Other, 16 teachers, Illinois—Main, 1017 teachers, Other, 47 teachers, North Carolina—Main, 13 teachers, Other, 148 teachers — Data not available

Source State Departments of Education, Data on Public Schools, Fall 1991, California, Fall 1990 Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

APPENDIX TABLE B-14
CERTIFICATION STATUS OF CHEMISTRY TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Chemistry Teachers Total	Main Assignment: % Certified Chemistry	Main Assignment: % Certified Broad Field	Main Assignment: % Not Certified	Other Assignment: % Certified Chemistry	Other Assignment: % Certified Broad Field	Other Assignment: % Not Certified
Alabama	378	4%	4%	0.3%	41%	44%	6%
Arkansas	306	25	6	1	31	31	6
California	1,365	38	8	7	32	5	9
Connecticut	375	58	0.3	0	35	4	2
Delaware	16	75	25	0	—	—	—
Florida	691	58	2	1	31	6	2
Idaho	131	15	15	4	18	34	15
Illinois	687	—	83	16	—	1	0.1
Indiana	507	69	0	3	25	0	3
Kentucky	344	58	0	1	40	0	1
Minnesota	501	26	14	2	33	15	11
Mississippi	548	34	0	6	41	0	20
Missouri	444	56	0	1	69	0	7
Montana	167	23	10	0	20	47	1
Nevada	77	18	39	0	8	35	0
New Mexico	143	0	38	0	0	62	0
New York	1,835	64	0	2	30	0	5
North Carolina	571	18	44	0	7	30	0.2
North Dakota	176	10	7	0	24	59	0
Ohio	1,014	34	26	0	16	23	2
Oklahoma	463	31	0	0.2	65	0	3
Pennsylvania	1,065	54	23	8	5	9	1
Puerto Rico	231	84	0	1	15	0	0
Rhode Island	88	73	8	0	18	1	0
South Carolina	346	14	45	2	5	29	4
South Dakota	155	7	14	0	13	65	2
Utah	124	59	0	3	28	0	10
West Virginia	162	65	0	6	25	0	4
Wyoming	88	48	15	5	26	6	1
SUM (29 states)		**41%**	**15%**	**3%**	**25%**	**11%**	**5%**

Note: General secondary certification included in broad field category California—Main, 114 teachers, Other, 73 teachers, Connecticut—Main, 1 teacher, Other, 15 teachers; Illinois—Main, 567 teachers, Other, 7 teachers, North Carolina—Other, 1 teacher — Data not available

Source: State Departments of Education, Data on Public Schools, Fall 1991; California, Fall 1990
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993

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APPENDIX TABLE B-15
CERTIFICATION OF PHYSICS TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Physics Teachers Total	Main Assignment: % Certified Physics	Main Assignment: % Certified Broad Field	Main Assignment: % Not Certified	Other Assignment: % Certified Physics	Other Assignment: % Certified Broad Field	Other Assignment: % Not Certified
Alabama	286	1%	1%	0%	14%	65%	19%
Arkansas	238	5	1	0	29	54	11
California	922	19	4	3	49	10	14
Connecticut	263	35	—	1	41	12	11
Delaware	30	47	47	7	—	—	—
Florida	401	45	4	0.5	30	18	2
Idaho	91	5	2	3	10	43	36
Illinois	321	—	81	17	—	2	0.3
Indiana	366	28	—	4	58	—	11
Kentucky	219	12	0	0	72	0	16
Minnesota	375	18	7	1	41	24	9
Mississippi	197	8	0	2	43	0	48
Missouri	241	24	0	0	107	0	26
Montana	134	6	6	0	15	69	4
Nevada	50	10	18	0	14	54	4
New Mexico	98	0	14	0	0	85	1
New York	1,089	50	0	2	34	0	14
North Carolina	351	5	11	1	15	61	7
North Dakota	124	1	4	0	15	81	0
Ohio	748	14	12	0.4	26	45	3
Oklahoma	243	12	0	0.4	79	0	9
Pennsylvania	693	29	34	7	8	18	4
Puerto Rico	119	69	0	6	25	0	0
Rhode Island	52	77	6	0	13	4	0
South Carolina	232	3	14	1	9	66	7
South Dakota	123	3	5	0	7	78	7
Utah	80	30	0	4	53	0	14
West Virginia	108	18	0	3	70	0	9
Wyoming	71	42	13	6	37	1	1
SUM (29 states)		**23%**	**10%**	**3%**	**33%**	**21%**	**10%**

Note General secondary certification included in broad field category California—Main 36 teachers Other. 96 teachers Connecticut-Other 31 teachers. Illinois—Main 261 teachers. Other 6 teachers North Carolina - Other 1 teacher -- Data not available

Source State Departments of Education Data on Public Schools. Fall 1991 California. Fall 1990
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993

APPENDIX TABLE B-16
CERTIFICATION STATUS OF EARTH SCIENCE TEACHERS IN GRADES 9—12, BY TIME ASSIGNED

STATE	Earth Science Teachers Total	Main Assignment % Certified Earth Science	Main Assignment % Certified Broad Field	Main Assignment % Not Certified	Other Assignment % Certified Earth Science	Other Assignment % Certified Broad Field	Other Assignment % Not Certified
Alabama	21	0%	0%	5%	0%	90%	5%
Arkansas	64	48	2	5	38	3	5
California	550	25	4	3	49	10	9
Connecticut	257	44	0.4	5	29	3	18
Delaware	8	88	13	0	—	—	—
Florida	1,323	5	33	2	2	32	26
Idaho	148	7	31	1	8	43	10
Illinois	204	—	84	6	—	8	1
Indiana	287	48	—	14	17	—	21
Kentucky	51	14	0	8	31	0	47
Minnesota	111	15	6	7	36	19	16
Mississippi	7	0	0	0	86	0	14
Missouri	141	39	0	10	40	0	26
Montana	175	13	22	1	11	49	5
Nevada	91	10	41	4	3	38	3
New Mexico	41	0	24	0	0	73	2
New York	2,831	53	0	7	25	0	15
North Carolina	328	2	17	2	2	72	6
North Dakota	8	13	0	0	13	75	0
Ohio	410	28	25	0.5	10	32	5
Oklahoma	65	17	0	3	54	0	26
Pennsylvania	778	45	29	6	5	13	2
Puerto Rico	94	79	0	5	16	0	0
Rhode Island	10	0	70	0	0	30	0
South Carolina	2	0	0	50	0	50	0
South Dakota	28	7	32	0	4	57	0
Utah	344	31	0	17	33	0	19
West Virginia	283	71	0	3	26	0	0.4
Wyoming	63	46	14	3	27	10	0
SUM (29 states)		**34%**	**14%**	**6%**	**19%**	**13%**	**14%**

Note General secondary certification included in broad field category California—Main. 20 teachers. Other 57 teachers Connecticut—Main 1 teacher Other 8 teachers. Illinois—Main. 171 teachers. Other 17 teachers. North Carolina—Main. 1 teacher Other 36 teachers — Data not available

Source State Departments of Education. Data on Public Schools. Fall 1991. California. Fall 1990
Council of Chief State School Officers. State Education Assessment Center Washington, DC. 1993

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APPENDIX TABLE B-17
NEW MINORITY AND FEMALE TEACHERS IN MATH AND SCIENCE
(GRADES 9—12, OCTOBER 1991)

STATE	No. of New 1st Yr. Math	% Minority of New Math	% Female of New Math	% Over Age 30 of New Math	No. of New 1st Yr. Science	% Minority of New Science	% Female of New Science	% Over Age 30 of New Science
Alabama	62	6%	61%	31%	44	4%	65%	37%
Alaska	—	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	—	—	—
Arkansas	119	5	50	32	39	0	35	49
California	537	19	45	45	258	18	48	49
Colorado	55	5	47	38	54	2	67	36
Connecticut	12	8	67	67	17	9	73	32
Delaware	15	7	60	20	12	20	33	40
Dist of Columbia	—	—	—	—	—	—	—	—
Florida	484	21	63	59	159	20	56	58
Georgia	—	—	—	—	—	—	—	—
Hawaii	34	47	56	44	9	50	33	58
Idaho	76	0	41	33	28	0	50	42
Illinois	111	6	57	23	89	4	55	31
Indiana	42	0	50	14	45	2	64	25
Iowa	43	0	47	93	28	3	43	81
Kansas	45	0	44	16	47	2	43	25
Kentucky	87	1	66	23	38	6	61	49
Louisiana	—	—	—	—	—	—	—	—
Maine	19	—	42	—	5	—	57	—
Maryland	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—
Michigan	192	8	55	37	49	2	42	42
Minnesota	49	—	59	29	45	—	47	36
Mississippi	419	15	69	58	469	16	56	69
Missouri	102	1	62	21	82	4	52	45
Montana	45	0	36	24	26	0	15	47
Nebraska	—	—	—	—	—	—	—	—
Nevada	26	0	42	31	17	9	41	32
New Hampshire	—	—	—	—	—	—	—	—
New Jersey	66	12	70	18	36	11	47	34
New Mexico	53	13	47	51	25	28	31	53
New York	98	—	46	33	118	—	61	33
North Carolina	171	10	72	20	105	12	67	30
North Dakota	24	4	38	8	19	0	40	52
Ohio	125	2	60	22	82	0	50	35
Oklahoma	88	2	57	31	69	2	58	27
Oregon	46	—	—	43	9	—	—	25
Pennsylvania	101	10	51	36	55	11	40	53
Puerto Rico	70	100	56	41	27	100	77	57
Rhode Island	13	8	38	77	4	20	80	60
South Carolina	76	16	64	22	39	2	63	22
South Dakota	21	0	33	14	20	0	23	12
Tennessee	—	—	—	—	—	—	—	—
Texas	664	24	55	—	329	21	51	—
Utah	14	7	50	36	6	13	13	50
Vermont	3	0	33	67	5	0	67	33
Virginia	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—
West Virginia	—	—	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—	—	—
Wyoming	22	0	27	23	8	0	45	0
SUM (38 states)	**4,229**	**14%**	**55%**	**33%**	**2,519**	**12%**	**52%**	**41%**

Note New 1st year - 0 years teaching experience. Newly hired 0 years experience in current district Science = 1 or more periods assigned in Biology, Chemistry, or Physics adjusted for 1/3 of teachers with multiple science assignments Math = 1 or more periods assigned in Math. Minority = Sum of Black Hispanic Asian/Pacific Islander American Indian (Data on four categories of race/ethnicity available from CCSSO) — Data not available

Source State Departments of Education Data on Public Schools Fall 1991 California, Fall 1990
Council of Chief State School Officers. State Education Assessment Center, Washington, DC. 1993

APPENDIX TABLE B-18
CERTIFICATION OF HIGH SCHOOL MATH AND SCIENCE TEACHERS IN LARGE CITY DISTRICTS

STATE/City	% Math Not Certified	% Biology Not Certified	% Chemistry Not Certified	% Physics Not Certified	% Earth Science Not Certified
California	20	18	17	17	12
10 Large City Districts	29	27	26	27	11
High	34	32	28	28	33
Low	8	0	7	0	0
New York	8	8	7	16	23
3 Large City Districts	11	15	9	12	17
High	11	16	8	13	17
Low	3	1	4	0	3
Ohio	10	4	2	3	5
5 Large City Districts	9	4	3	5	5
High	16	7	9	13	8
Low	5	0	0	0	0

Source. State Departments of Education. Data on Public Schools, Fall 1991. California Fall 1990
Council of Chief State School Officers. State Education Assessment Center. Washington, DC. 1993

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APPENDIX TABLE B-19
PERCENTAGE OF GRADE 8 STUDENTS WITH TEACHERS WHO HAVE MATHEMATICS COURSEWORK IN SEVEN RECOMMENDED AREAS OF MATHEMATICS

STATE	Mathematics Coursework			Math Proficiency Score of Students
	6 or 7 Areas	4 or 5 Areas	0 to 3 Areas	
Alabama	46%	40%	14%	252
Arizona	30	27	43	259
Arkansas	41	41	18	256
California	41	29	30	256
Colorado	66	22	12	267
Connecticut	35	38	28	270
Delaware	52	35	14	261
District of Columbia	79	13	8	231
Florida	40	31	29	255
Georgia	38	29	33	258
Guam	26	42	32	231
Hawaii	52	31	17	251
Idaho	51	27	21	272
Illinois	36	33	31	260
Indiana	71	23	7	267
Iowa	54	28	18	278
Kentucky	25	30	45	256
Louisiana	36	28	36	246
Maryland	56	30	14	260
Michigan	39	34	26	264
Minnesota	85	13	2	276
Montana	59	24	17	280
Nebraska	69	19	12	276
New Hampshire	55	24	21	273
New Jersey	42	26	33	269
New Mexico	44	35	21	256
New York	57	28	14	261
North Carolina	43	28	29	250
North Dakota	74	15	12	281
Ohio	46	26	29	264
Oklahoma	30	41	29	263
Oregon	51	29	20	271
Pennsylvania	60	27	13	266
Rhode Island	63	29	8	260
Texas	39	42	19	258
Virgin Islands	52	29	19	218
Virginia	56	31	13	264
West Virginia	45	36	19	256
Wisconsin	50	24	26	274
Wyoming	65	24	11	272
Nation	**52%**	**29%**	**19%**	**261**

Source National Center for Education Statistics. The State of Mathematics Achievement NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States. *U S Department of Education. 1991*
Council of Chief State School Officers. State Education Assessment Center. Washington DC 1993

APPENDIX TABLE B-20
STANDARD ERRORS FOR TABLE 24

PERCENTAGE OF MATHEMATICS AND SCIENCE TEACHERS WITH MAJOR IN FIELD

STATE	Mathematics: Main Assignment: % with Major in Math	Mathematics: All Teachers % with Major in Math	Science: Main Assignment: % with Major in Science	Science: All Teachers % with Major in Science
Alabama	4.9	5.1	6.2	6.4
Alaska	9.8	6.5	4.8	6.2
Arizona	6.0	6.1	5.9	6.5
Arkansas	8.9	6.1	6.9	6.6
California	6.1	6.4	7.2	6.8
Colorado	5.7	5.5	3.3	3.9
Connecticut	8.3	7.7	3.9	4.4
Delaware	—	—	—	—
Dist. of Columbia	—	—	—	—
Florida	7.6	7.4	9.5	8.9
Georgia	4.8	5.4	5.2	5.7
Hawaii	—	—	—	—
Idaho	8.2	6.9	6.8	6.8
Illinois	7.2	8.0	5.9	5.3
Indiana	6.2	7.5	5.7	5.5
Iowa	7.2	8.3	6.9	8.9
Kansas	7.7	6.8	7.1	7.4
Kentucky	5.3	5.5	6.3	9.2
Louisiana	6.4	6.4	6.6	6.2
Maine	7.2	6.7	4.2	6.4
Maryland	6.7	7.6	5.4	8.8
Massachusetts	6.5	7.4	5.3	5.4
Michigan	6.9	7.5	6.4	7.0
Minnesota	3.3	3.9	4.4	5.4
Mississippi	4.2	4.4	6.2	5.6
Missouri	6.1	5.6	5.0	6.8
Montana	5.5	5.1	6.8	6.3
Nebraska	4.8	4.6	5.4	4.2
Nevada	—	10.0	—	—
New Hampshire	—	—	—	—
New Jersey	5.5	7.1	7.3	7.5
New Mexico	8.7	9.1	9.5	7.4
New York	6.4	7.2	4.4	5.3
North Carolina	6.6	6.8	4.7	5.1
North Dakota	4.2	4.3	5.6	5.0
Ohio	5.2	5.0	7.2	6.6
Oklahoma	5.5	5.8	6.5	6.6
Oregon	6.9	6.4	4.1	5.7
Pennsylvania	5.8	6.0	4.6	5.2
Rhode Island	—	—	—	—
South Carolina	7.7	8.4	7.3	6.6
South Dakota	3.3	3.8	6.0	5.1
Tennessee	5.6	5.1	6.4	6.3
Texas	5.8	5.4	6.1	5.8
Utah	7.4	5.3	7.4	7.9
Vermont	—	—	—	—
Virginia	6.9	6.8	5.7	6.3
Washington	7.7	7.8	5.8	5.2
West Virginia	6.6	6.4	8.1	7.7
Wisconsin	4.4	6.1	6.7	6.1
Wyoming	5.3	6.9	6.6	6.5
NATION	**1.5**	**1.6**	**1.3**	**1.4**

Source NCES. Schools and Staffing Survey Public School Teachers. Spring 1991
Council of Chief State School Officers State Education Assessment Center Washington DC 1993

APPENDIX TABLE B-21
STANDARD ERRORS FOR TABLE 25

AVERAGE CLASS SIZE IN MATHEMATICS AND SCIENCE AND PERCENT CLASSES OVER 30 STUDENTS (GRADES 9—12)

STATE	All Math Average Class	Advanced Math Average Class	Percent Advanced Over 30	All Science Average Class	Biology Average Class	Percent Biology Over 30
Alabama	0.8	1.3	1.3	0.8	1.0	2.7
Alaska	1.2	—	—	1.5	2.3	7.9
Arizona	1.0	1.1	5.6	1.1	1.0	4.9
Arkansas	0.8	—	—	0.7	0.9	<1
California	0.8	0.7	7.7	0.8	0.9	3.9
Colorado	0.9	1.1	6.4	0.6	0.6	1.9
Connecticut	0.9	0.9	0.0	2.0	—	—
Delaware	—	—	—	—	—	—
Dist. of Columbia	—	—	—	—	—	—
Florida	1.2	1.9	9.9	1.4	1.3	5.3
Georgia	1.2	1.5	4.7	0.9	1.3	<1
Hawaii	1.2	—	—	—	—	—
Idaho	0.8	1.4	5.4	0.7	0.8	1.2
Illinois	0.7	1.2	3.2	0.8	1.1	<1
Indiana	0.9	0.9	2.1	1.5	1.8	<1
Iowa	1.2	1.2	<1	1.0	0.9	<1
Kansas	1.2	1.1	<1	0.7	1.3	<1
Kentucky	1.3	1.2	7.6	0.9	2.0	3.7
Louisiana	1.1	1.3	2.6	1.2	1.5	5.8
Maine	0.7	0.8	0.0	1.6	—	—
Maryland	1.1	1.0	5.1	1.5	2.2	9.6
Massachusetts	0.5	1.0	<1	0.7	1.3	1.3
Michigan	1.2	1.2	3.1	0.9	1.4	6.2
Minnesota	0.7	1.5	5.8	0.8	0.7	3.0
Mississippi	0.7	0.8	<1	1.5	1.8	3.6
Missouri	0.6	1.4	2.2	0.8	1.2	<1
Montana	1.0	1.9	<1	0.8	1.3	<1
Nebraska	0.8	1.1	<1	1.3	1.0	<1
Nevada	0.9	—	—	1.6	—	—
New Hampshire	0.9	—	—	0.8	—	—
New Jersey	0.6	1.1	0.0	0.5	1.1	<1
New Mexico	1.4	3.7	7.8	0.8	1.2	2.8
New York	0.6	1.3	7.9	1.5	5.1	8.9
North Carolina	0.7	0.9	3.1	0.8	—	—
North Dakota	0.7	1.0	<1	1.0	1.0	<1
Ohio	0.7	1.1	<1	0.6	2.1	3.5
Oklahoma	0.7	1.0	<1	0.7	0.9	1.4
Oregon	0.6	0.7	3.2	0.7	0.7	3.3
Pennsylvania	0.7	1.3	<1	0.9	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	0.9	0.9	<1	0.8	1.3	2.8
South Dakota	1.3	1.1	1.7	0.8	0.9	1.8
Tennessee	0.9	1.3	5.5	0.7	1.0	5.6
Texas	0.5	0.7	1.0	0.6	1.3	2.6
Utah	0.9	1.4	6.7	0.9	0.7	5.1
Vermont	0.9	—	—	1.0	—	—
Virginia	0.9	0.7	3.4	0.6	—	—
Washington	0.7	1.3	4.4	1.0	0.9	6.1
West Virginia	0.7	0.8	1.7	0.8	0.8	0.6
Wisconsin	0.7	1.0	3.3	0.5	0.6	<1
Wyoming	1.2	—	—	0.5	1.0	<1
NATION	**0.2**	**0.3**	**1.3**	**0.2**	**0.5**	**0.9**

Notes <=1 Less than 1 percent of classes. — Respondents too few for a reliable state estimate

Source: NCES. Schools and Staffing Survey. Public School Teachers. Spring 1991
Council of Chief State School Officers. State Education Assessment Center. Washington. DC. 1993.

APPENDIX C

TECHNICAL APPENDIX

Computation of estimated proportion of high school students taking selected mathematics and science courses by graduation (Tables 5 and 8).

The percentages shown in Tables 5 and 8 for each course are statistical estimates of course taking of high school students by the time they graduate, based on the total course enrollment in grades 9-12 as of fall 1991 divided by the estimated number of students in a grade cohort during 4 years of high school.

Synthetic cohort statistics have been used previously in education. For example, a synthetic high school dropout statistic has been estimated, based on the sum of the percentages of students who drop out at each grade, for grades 9-12 (Kominski, 1987). Cross-sectional data on dropouts by grade are used to estimate a true dropout rate over a 4-year period of high school. A true dropout rate requires tracking the status of the same group of students (cohort) through 4 years of high school. If only cross-sectional data are available, the synthetic cohort statistic provides an estimate of the high school dropout rate.

The Science and Mathematics Indicators Project desired a synthetic cohort statistic of the proportion of graduates in a state that take a given course, e.g., algebra 1. Since most states do not collect data by grade, the approach used in computing a synthetic dropout statistic for dropouts had to be revised. First, the numerator is the total number of students in grades 9-12 that took a given course, e.g., algebra 1, in Fall 1991. The denominator is an estimate of the number of students in a cohort of students summed over a 4-year period of high school. For each state, the size of the cohort of students that have some probability of taking a given course, e.g., algebra 1, during 4 years of high school is estimated by: the state student membership in each grade (for grades 9-12) weighted by the regional percentage of students that took the course at each grade level, and summing the weighted memberships for each grade for grades 9-12 The state student memberships by grade are from the 1991-92 Common Core of Data (NCES) and the regional percentages were obtained from the 1990 National Transcript Study (Westat, 1993).

The computation of the science/mathematics course taking synthetic cohort statistic can be summarized as follows, using the example of algebra 1:

$$\text{Estimated proportion of students taking algebra 1 in state A} = \frac{\text{Algebra 1 enrollment (9-12) (Reported by State A)}}{\text{Estimated number of students in cohort in grades 9-12 (from CCD and regional weights based on NAEP transcript study)}}$$

$$\text{Estimated students in cohort} = (M9 \text{ X Alg } 1/9) + (M10 \text{ X Alg } 1/10) + (M11 \text{ X Alg } 1/11) + (M12 \text{ X Alg } 1/12)$$

where, M9 is the student membership for grade 9 (from NCES Common Core of Data) Alg 1/9 is the percentage of 1990 graduates in state A's region that took algebra 1 in grade 9 (from Westat, Inc. transcript data files).

(Four regions designated by Westat—Northeast, North Central, South Central, and West.)

The synthetic cohort statistic for rates of course taking is not directly comparable to course taking rates based on student transcripts, such as from the 1990 national transcript study. Beyond differences in data collection methods (universe vs. sample), there are at least two reasons for the synthetic cohort estimate to vary from a true rate based on tracking individual students. First, as with any synthetic cohort statistic, changes in policies or programs over a 4-year period of time (such as changes in state graduation requirements) that affect student behavior (such as course taking) are not accounted for by the statistic. Second, state course enrollment totals can include students taking a course a second time to earn a credit. The synthetic cohort statistic in this report, which is based on state cross-sectional counts, may be slightly higher than the true rate based on tracking individual students (who are typically counted only once per course credit). Currently, no data are available by state to determine the number of students repeating courses.

Variability is added to the state estimates through the weighted student membership based on regional weights. Since the weights are not state specific, each estimate has variability. For this reason, estimates over 95 percent of students cannot be made with precision and enrollments at this level are shown in Tables 5 and 8 as 95+ percent.

Course enrollment rates are based on enrollment as of fall 1991. Some states collect data on student course taking for fall and spring semesters. The state comparisons are based on cross-sectional data collected as of October 1. The indicator does not account for variation in course taking as of the spring semester.

Imputation of estimated proportion of high school graduates taking selected mathematics and science courses for nonreporting states.

In 1991-92, 38 states were able to report course enrollment data to CCSSO. To obtain a national total for the estimated proportion of graduates taking selected mathematics and science courses, the state proportions were imputed. The following formula was used for imputation:

Estimated proportion of students taking algebra 1 in nonreporting state B	=	(Reg. avg. % taking algebra 1 (9-12) x state B student membership (9-12)) / Sum of estimated numbers of students in cohort in grades 9-12 (from CCD and regional weights based on NAEP transcript study) (as above)

where, Reg. avg. % taking algebra 1 is the average (mean) percent of students taking algebra 1 among the reporting states in state B's region.

Imputation of number of teachers per field (in mathematics, biology, chemistry, physics, and earth science) for nonreporting states.

Imputed number of teachers of mathematics in state C	=	State student membership (9-12) / Regional ratio students/teacher	x	Regional ratio of mathematics teachers to total teachers (9-12)
Regional ratio students/teacher	=	State student membership (9-12) / State total teachers (9-12)		averaged for states in region
Regional ratio mathematics teachers to total teachers	=	State mathematics teachers (9-12) / State total teachers (9-12)		averaged for states in region

APPENDIX D

DIRECTORY OF CCSSO COURSE CATEGORIES BY STATE COURSE TITLES
State Science and Mathematics Indicators
(Fall 1991)

CCSSO INDICATORS
Science Course Categories
State Course Titles (from State data forms)

Grades 7-8

General Science, 7-8
General Science 7, 8
Earth/Life/Physical Science 7, 8
Life Science, 7-8
Life Science, 7, 8
Earth Science, 7-8
Earth Science, 7, 8
Physical Science, 7-8
Physical Science 7, 8
Integrated Science 7-8
Science 1, 2; SS&C Science (Scope, Sequence, & Coordination); Integrated Science, Science 7, 8

Grades 9-12

Biology, 1st Year
Biology I; General; College Prep.; Regents; Introductory
Biology, 1st Year, Basic/Applied
Basic Biology; Applied; Life Science; Biomedical Ed.; Animal Science; Horticulture Sci.; Bio. Science; Health Science; Nutrition; Man & Disease; Agricul. Science; Fundamentals of Biology
Biology, 2nd Year, Advanced Placement
Advanced Placement Biology
Biology, 2nd Year, Advanced
Biology II; Advanced; College; Psychobiology; Physiology; Anatomy; Microbiology; Genetics; Cell Biology; Embryology; Molecular Biology; Invertebrate/Vertebrate Biology
Biology, 2nd Year, Other
Zoology; Botany; Environmental Education, Biomedical careers; Field Biology; Ecology; Marine Biology; Other Biological Sciences
Chemistry, 1st Year
Chemistry I; General; Introductory; Regents
Chemistry, 1st Year Applied
Applied Chemistry; Consumer Chemistry; Technical Chemistry; Practical Chemistry; Chemistry in the Community
Chemistry, 2nd Year, Advanced Placement
Advanced Placement Chemistry
Chemistry, 2nd Year, Advanced
Chemistry II; Advanced: College; Organic: Inorganic; Physical; Biochemistry; Analytical
Physics, 1st Year
Physics I; General; Regents; Introductory
Physics, 1st Year, Applied
Applied Physics; Electronics; Radiation Physics; Practical Physics
Physics, 2nd Year, Advanced Placement
Advanced Placement Physics
Physics, 2nd Year, Advanced
Physics II; Advanced; College; Nuclear Physics; Atomic Physics
Physics, 2nd Year, Other
Electricity, Astronomy (or under Earth Science, 2nd year)
Earth Science, 1st Year
Earth Science; Earth-Space Science; Regents Earth Science
Earth Science, 1st Year, Applied
Applied Earth Science; Fundamentals of Earth Science; Soil Science
Earth Science, 2nd Year, Advanced/Other
Advanced Earth Science; Earth Science II; Oceanography; Meteorology; Astronomy, Geology
General Science
General Science, Basic; Introductory; Unified; Comprehensive Ideas of Investigations in Science; Life/Physical Science; Earth/Life/Physical Science
Physical Science
Physical Science; Interaction of Matter and Energy; Applied Physical Science
Integrated Science
Science 3, 4, etc.; SS&C Science; Integrated Science 9, 10.
Other Science
Technology; Science/Math; Engineering; Bioengineering; Special Interests Science; Energy; Research Topics; Science/Technology/Society; Aerospace Science

Mathematics Course Categories
State Course Titles (from state data forms)

Grades 7-8

Remedial Math, Grade 7
Remedial Math 7
Math, Grade 7, Regular
Math 7; Exper. Math 7
Math, Grade 7, Accelerated/Prealgebra
Accelerated Math 7; Prealgebra; Introductory Algebra; Enriched Math 7

Remedial Math, Grade 8
Remedial Math 8
Math, Grade 8, Regular
Math 8; Exper. Math 8—SS MCIS
Math, Grade 8, Enriched
Prealgebra; Accelerated Math 8; Honors Math 8
Math Grade 8, Algebra 1
Algebra 1; Beginning Algebra; Elementary Algebra

Grade 9-12

Review Mathematics

Level 1
General Math 1; Basic Math; Math 9; Remedial Math; Developmental; H.S. Arithmetic; Math Comp Test; Comprehensive Math; Terminal Math
Level 2
General Math 2; Vocational Math; Applied; Consumer; Technical; Business; Shop; Math 10; Career Math; Practical Math; Essential Math; Cultural Math
Level 3
General Math 3; Math 11; Intermediate Math; Applied Math II
Level 4
General Math 4; Math 12

Informal Mathematics

Level 1
Prealgebra; Introductory Algebra; Basic; Applications; Algebra 1A (first year of two-year sequence for Algebra 1); Noncollege Algebra
Level 2
Basic Geometry; Informal; Practical; Core
Level 3
Basic Algebra 2; Mathematics of Consumer Economics; (A course after Prealgebra prior to Algebra 1)

Formal Mathematics

Level 1
Algebra 1; Elementary; Beginning; Unified Math I; Integrated Math 1; Algebra 1B (second year of two-year sequence for Algebra 1)
Level 2
Geometry; Plane Geometry; Solid Geometry; Integrated Math 2; Unified Math II
Level 3
Algebra 2; Intermediate; Algebra and Trigonometry; Algebra and Analytic Geometry; Integrated Math 3; Unified Math III
Level 4
Trigonometry; Precalculus, Advanced Algebra; Algebra 3; College Algebra; Precalculus; Analytic/Advanced Geometry; Trigonometry and Analytic/Solid Geometry; Math Topics; Intro. to College Math; Number Theory; Math IV; College Prep Sr. Math; Elem. Functions; Math Analysis; Finite Math
Level 5
Calculus and Analytic Geometry; Calculus; Abstract Algebra; Differential Equations; Multivariate Calculus; Linear Algebra; Probability; Statistics; Theory of Equations; Vectors/Matrix Algebra
Level 5, Advanced Placement
Advanced Placement Calculus (AB, BC)

Computer Science Course Categories
State Course Titles (from state data forms)

Grades 7-8

Computer Science/Computer Programming
Introductory Programming (any language)

Grades 9-12

Computer Science/Programming I
Introductory Programming (any language); Programming I; Computer Language I
Advanced Computer Science/Programming II
Advanced Programming; Programming II; Computer Language II
Computer Science, Advanced Placement
Advanced Placement Computer Science

Source: Instructions and Reporting Forms for Data on Science and Mathematics Education in (each state). Council of Chief State School Officers, State Education Assessment Center, Washington, DC, Fall 1991.

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