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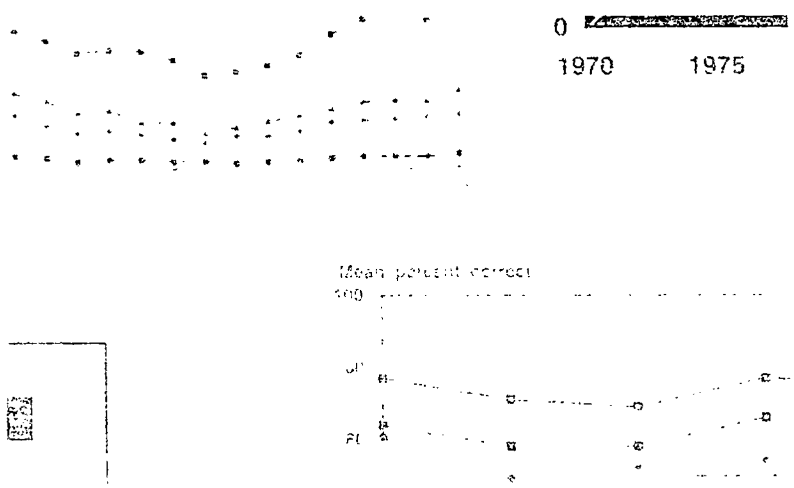
ABSTRACT

This report presents a new synthesis of statistical indicators and research findings on the quality of science and mathematics education in the United States. In more detail than any other report, it addresses the progress made toward the U.S. national goal of ranking first in the world in mathematics and science by the year 2000. It draws on research and statistical surveys supported by the National Science Foundation and other federal agencies, such as the National Center for Education Statistics, to describe changes that have occurred between 1970 and 1990. This report is intended for use by anyone seeking authoritative information about the students, teachers, and school systems involved in science and mathematics education in the United States. The chapters, following a background and summary section, are: (1) "Cognitive Achievement"; (2) "Science and Mathematics Curricula"; (3) "Science and Mathematics Teachers"; (4) "Persistence and Career Choice"; and (5) "Higher Education." Appendixes that constitute nearly half of the document include detailed data tables and technical notes. A list of acronyms and abbreviations, and an index conclude the document. (PR)

INDICATORS



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Contents

List of Figures and Text Tables

Background and Summary

Chapter 1 Cognitive Achievement

Chapter 2 Science and Mathematics Curricula

Chapter 3 Science and Mathematics Teachers

Chapter 4 Persistence and Career Choice

Chapter 5 Higher Education

Text Tables

Background and Summary

Report Purpose and Content

This report presents a new synthesis of statistical indicators and research findings on the quality of science and mathematics education in the United States.[1] In more detail than any other report, it addresses the progress made toward the U.S. national goal of ranking first in the world in mathematics and science by the year 2000. It draws on research and statistical surveys supported by the National Science Foundation (NSF) and other Federal agencies, such as the National Center for Education Statistics (NCES), to describe changes that occurred between 1970 and 1990. This report is intended for use by anyone seeking authoritative information about the students, teachers, and school systems involved in science and mathematics education in the United States.

Issues and Organizing Themes

Several enduring issues about science and mathematics education concern national leaders and are the focus of this report. The primary purpose of Federal funding initiatives is to increase the understanding of science and mathematics topics of all graduates, both secondary and postsecondary. Federal programs are initiated with the belief that every school student can learn scientific principles. Thus, this report presents indicators that show whether students leave secondary and postsecondary institutions adequately prepared for the demands of a highly technical world and whether adults retain even very basic knowledge of science once they leave formal education.

Other topics of interest to national leaders are maintaining student persistence in science and mathematics subjects, improving the qualifications of teachers, increasing the diversity and caliber of instruction in science and mathematics classrooms, and maintaining a high quality of undergraduate education. Each of these topics is addressed in this report. Some important topics that are relevant to policy making for science and mathematics education—such as an examination of the level of state and local funding for science and mathematics school programs—are not addressed here because reliable statistical information does not exist. Thus, the results of this synthesis will provide a basis for identifying gaps in survey information and for improving future statistical studies of science and mathematics education.

Indicators

The report presents about 100 statistical indicators of how the status of science and mathematics education has changed during the past 20 years. The indicators were chosen by the authors of each chapter, who were guided by the members of an advisory committee and by publications on the status of indicators of science and mathematics education (NSF 1989, 1991; Shavelson et al. 1989; Murnane and Raizen 1988).

The indicators were selected from national surveys that include information on science and mathematics education. Some matters of concern to the authors were not, however, addressed in recently conducted surveys. The latest information for certain indicators was collected during the 1980s; nevertheless, the indicators are included here because they help enlighten the discussions of the status of science and mathematics education. Future reports will contain new survey information on these topics and will include new measures for undergraduate education.

[1]As specified in the Senate 1991 Appropriations Bill (HR 5158), this report is a congressionally mandated one:

"... In addition, the Committee expects the [National Science] Foundation to establish a biennial science and mathematics education indicator report, distinct from the science and engineering indicator report, that evaluates the progress of the United States in improving the science and math capability of its students, and the effectiveness of all Federal and State education programs as part of this process."

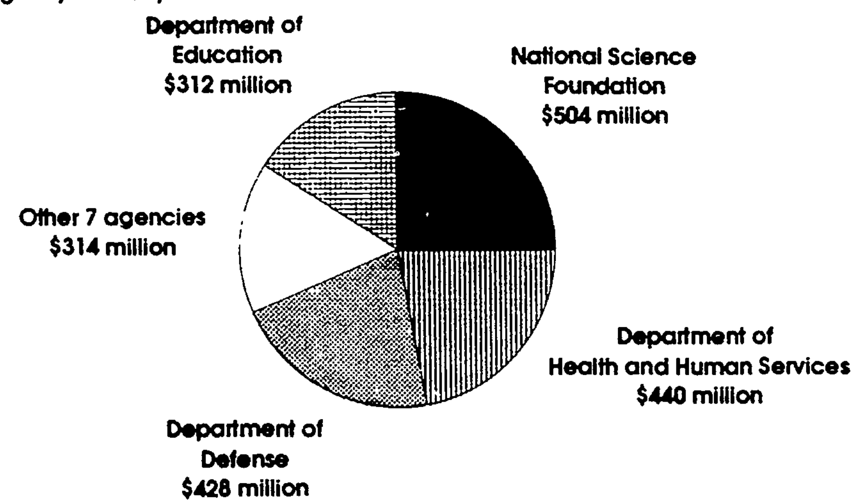
Discussions of statistics in this report are often based on sample survey estimates. All comparisons have been examined to ensure that the differences reported are statistically significant at the 95 percent level of confidence. A technical discussion of the surveys used in this report is presented in Appendix B.

The remainder of this introductory chapter consists of two parts. The first part provides a context for understanding the indicators reported in the other chapters. The context includes Federal funding and demographic issues that together drive the Nation's education reform efforts and account for recent changes in student characteristics. The second part of this chapter summarizes the key findings detailed in the later chapters.

Federal Funding

Heightened concern for improving science and mathematics education led to the formation of an interagency committee charged with integrating different approaches to science and mathematics education: the Committee on Education and Human Resources (CEHR) of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET). According to CEHR, 11 Federal agencies contributed just under $2 billion in 1992 for improving education in science and mathematics.[2] (See appendix table Intro-1.) The National Science Foundation contributed about one-fourth of the total Federal contribution to science and mathematics education. (See figure Intro-1.)

Figure Intro-1
Percent of Federal budget obligations for mathematics, science, and technical education, by Federal agency: Fiscal year 1992



NOTE: Other seven agencies include the Department of Agriculture, Department of Commerce, Department of Energy, Department of the Interior, Smithsonian Institution, National Aeronautics and Space Administration, and Environmental Protection Agency.

See appendix table Intro-1. NSF Education Indicators—1992

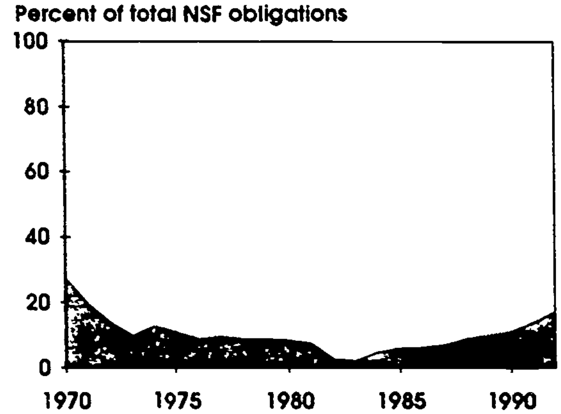
SOURCE: Special tabulation provided by the working group on the budget of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) Committee on Education and Human Resources.

[2]Not all education-related activities are included in this estimate of Government spending for science and mathematics education that was provided by CEHR-FCCSET. Some technology-oriented agencies that provide funding for education have not been included.

The Federal funds for science and mathematics education as reported by CEHR are intended to improve the teaching and learning of science and mathematics and to increase student participation in science and engineering courses at the undergraduate and graduate levels. These funds mainly support graduate education and elementary and secondary education. Somewhat less Federal support goes to undergraduate education. (See appendix table Intro-1.)

Increasing priority was given to NSF's education programs between 1983 and 1992. The proportion of NSF funds going to the Directorate for Education and Human Resources (EHR), the organizational unit that has the major role in programs for science and mathematics education, increased from about 5 percent in 1985 to about 17 percent in 1992. (See figure Intro-2.) Most of the 1990 funds for EHR (about 60 percent) provided a stimulus for curricular content and pedagogical change in science and mathematics classrooms at the elementary and secondary levels. (See figure Intro-3.) Change in the funding level for

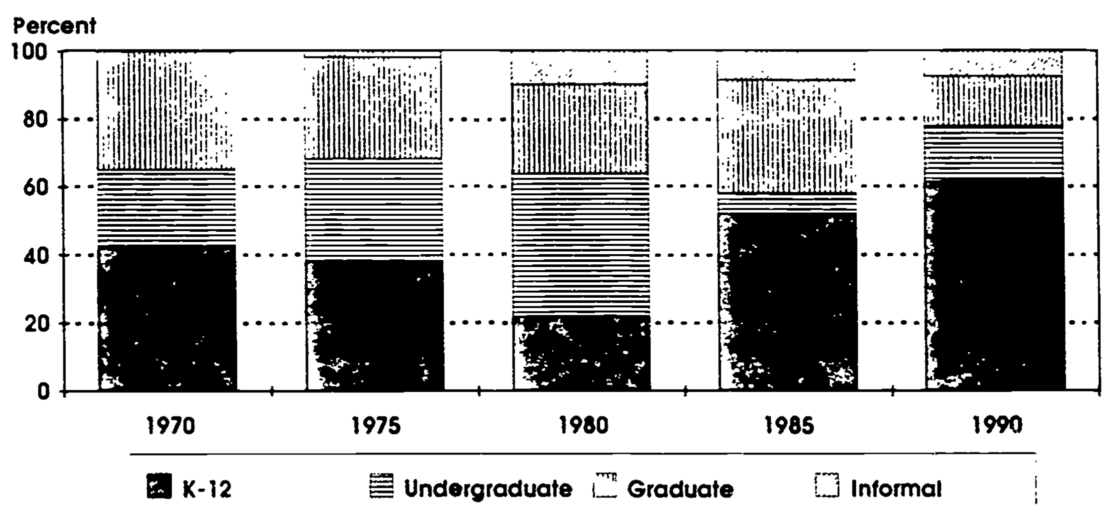
Figure Intro-2
Percent obligated for the Directorate for Education and Human Resources (EHR) out of total NSF obligations: 1970 to 1992



See appendix table Intro-2. NSF Education Indicators—1992

SOURCES: National Science Foundation. *EHR Directory of Awards: Fiscal Year 1990*. NSF 92-75 (Washington, DC: NSF); and unpublished NSF budget figures.

Figure Intro-3
Percent of EHR education obligations, by level of schooling: 1970 to 1990



See appendix table Intro-2. NSF Education Indicators—1992

SOURCES: National Science Foundation. *EHR Directory of Awards: Fiscal Year 1990*. NSF 92-75 (Washington, DC: NSF); and unpublished NSF budget figures.

EHR is one useful indicator of the priority given to science and mathematics education by the Administration and Congress.

In addition to these funds, NSF supported education through its research directorates, which provide awards for undergraduate and graduate students in specific science, mathematics, and engineering fields. The funding for graduate and undergraduate students supported through research awards increased from $76 million in 1983 to $193 million in 1992, a 150-percent increase in the past 10 years. Thus, significant and increasing support for improving U.S. performance in science and mathematics education at all levels has been provided by NSF.

Demographic Changes and Student Achievement

In recent years, the cultural, familial, and economic diversity of the U.S. student population has increased. Since 1970, the number of students in elementary and secondary school has declined, the educational levels of their parents have increased, the number of persons speaking a language other than English at home has grown, the proportion of children living in poverty is greater, and a higher proportion of students live in families with only one parent. These changes in the makeup of the student population affect the average levels of many of the indicators reported in this volume.

Some changes, such as the higher educational levels attained by parents, could help produce a higher average U.S. student achievement. Other changes, such as the larger proportion of students in low-income families, may lead to lower average achievement levels. The following overview of recent demographic changes in the U.S. student population provides a context in which to better interpret the changes in indicators of student achievement and of teaching practices presented in later chapters of this report.

Race and Ethnicity

The number of students attending elementary and secondary school was somewhat lower in 1990 than in 1970. This decline in total enrollment reflected a 19 percent decline in the number of white students. On the other hand, between 1970[3] and 1990—

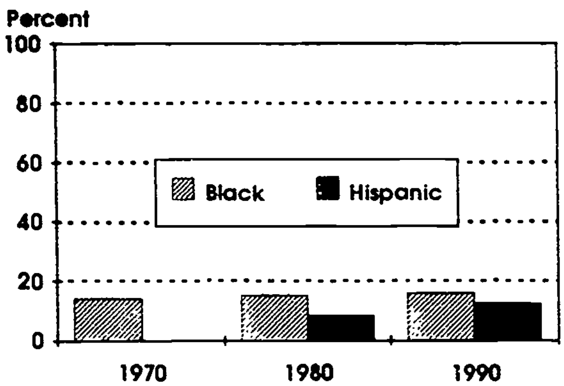
- The number of African American students decreased by only 1 percent and accounted for 16 percent of all students in 1990. (See figure Intro-4.)
- The number of students of Hispanic origin increased by nearly 50 percent (from 1975 to 1990) to 12 percent of all students. (See appendix table Intro-3.)
- The number of students of "other races"—namely, Asians, Pacific Islanders, and Native Americans—grew by 200 percent, to account for 4 percent of the elementary and secondary student population by 1990. (See appendix table Intro-3.)

Not surprisingly, the number of children of elementary school age who speak a language other than English at home has also increased. Between 1980—when these data were first collected in the decennial census—and 1990, this proportion increased from 10 percent to about 14 percent of persons 5 to 17 years old. (See appendix table Intro-4.)

Thus, the real change in school population in the past 20 years has not been one of numbers. Total enrollment shifted far more dramatically during the

[3]Data are available on Hispanic enrollment beginning in 1975.

Figure Intro-4
Percent of elementary and secondary students who are black or Hispanic: 1970 to 1990



NOTE: Data on Hispanic enrollment are available beginning in 1975.

See appendix table Intro-3. NSF Education Indicators—1992

SOURCES: For 1970 to 1985, Bureau of the Census, U.S. Department of Commerce, *School Enrollment—Social and Economic Characteristics of Students: 1989*, Current Population Reports, Population Characteristics Series P-20, No. 443; for 1990, *School Enrollment—Social and Economic Characteristics of Students: 1990*, Current Population Reports, Population Characteristics Series P-20, No. 460 (Washington, DC: U.S. Government Printing Office, 1992).

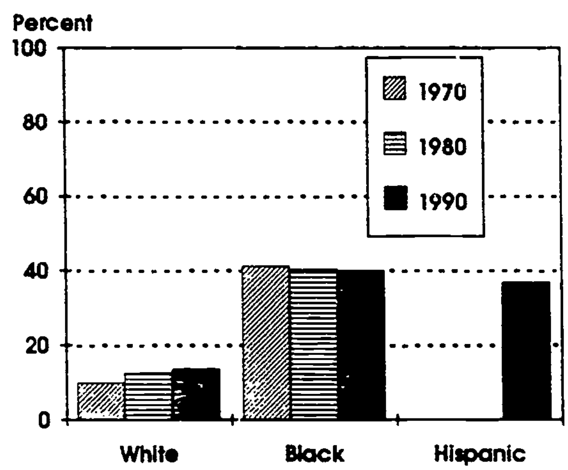
baby boom years of the 1950s and 1960s than it did in the past 20 years.[4] Instead, the change lies in a greater cultural diversity among U.S. students. A somewhat greater percentage of all elementary and secondary students are of African descent, of Hispanic heritage, belong to "other races," or speak a language other than English at home. The extent of this diversity must be considered when figures representing the total student population of 1990 are examined.

Income

The percentage of persons of elementary and secondary school age who live below the poverty level increased among white families between 1970 and 1990 and remained about the same for black families. (See figure Intro-5.) However, blacks remain much more likely than whites to live below the poverty level. In 1990, the proportion of school-age children living below the poverty level was three times higher among blacks than whites—40 percent compared with 13 percent.

If the economic circumstances of families affect student readiness for schooling, then the greater number of white children living in poverty by 1990 might have reduced their potential for high achievement levels. The lack of change in the economic conditions of families of black children was not

Figure Intro-5
Percent of white, black, and Hispanic children ages 6–17 below the poverty level: 1970 to 1990



NOTE: Data on Hispanic children ages 6-17 under the poverty level are not available for 1970 and 1980.

See appendix table Intro-5. NSF Education Indicators—1992

SOURCES: For 1970, Bureau of the Census, U.S. Department of Commerce, *Characteristics of the Low-Income Population: 1970*, Current Population Reports, CPS P-60 No. 18 (Washington, DC: U.S. Government Printing Office (GPO), 1971); for 1980, Bureau of the Census, U.S. Department of Commerce, *Characteristics of the Population Below the Poverty Level: 1980*, Current Population Reports, CPS P-60 No. 133 (Washington, DC: U.S. GPO, 1981); for 1990, Bureau of the Census, U.S. Department of Commerce, *Poverty in the United States: 1990*, Current Population Reports, CPS P-60 No. 175 (Washington, DC: U.S. GPO, 1991).

[4] Elementary and secondary enrollment increased steadily from 1950 to 1970 by 80 percent. Then enrollment declined by 12 percent between 1971 and 1984. See *Digest of Education Statistics 1991*, National Center for Education Statistics, U.S. Department of Education (NCES 91-697), 12, Table 3.

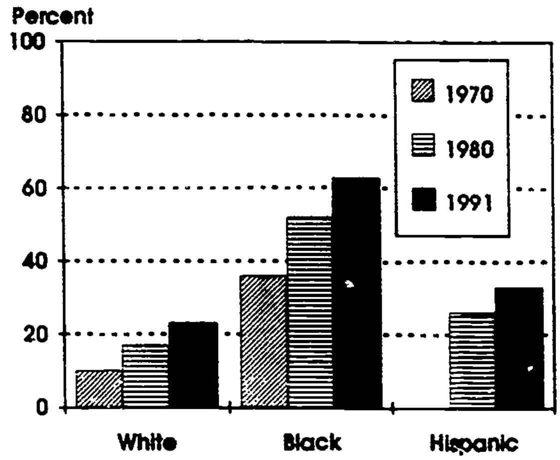
great enough to explain changes in their levels of achievement.

Family Characteristics

In 1970, about 87 percent of elementary school-age children lived in two-parent families. By 1991, that proportion had decreased to 71 percent. Thus, an increasingly large percentage of all children under 18 live in one-parent families. The proportion of children living in one-parent families is much greater for black and Hispanic children than for white children. (See figure Intro-6.) The effect of these changes on student achievement is unknown.

The educational levels of householders (the householder might be a parent, grandparent, or other relative of the child) of elementary and secondary students have increased during the past 20 years. (See figure Intro-7.) By 1990, about 80 percent of

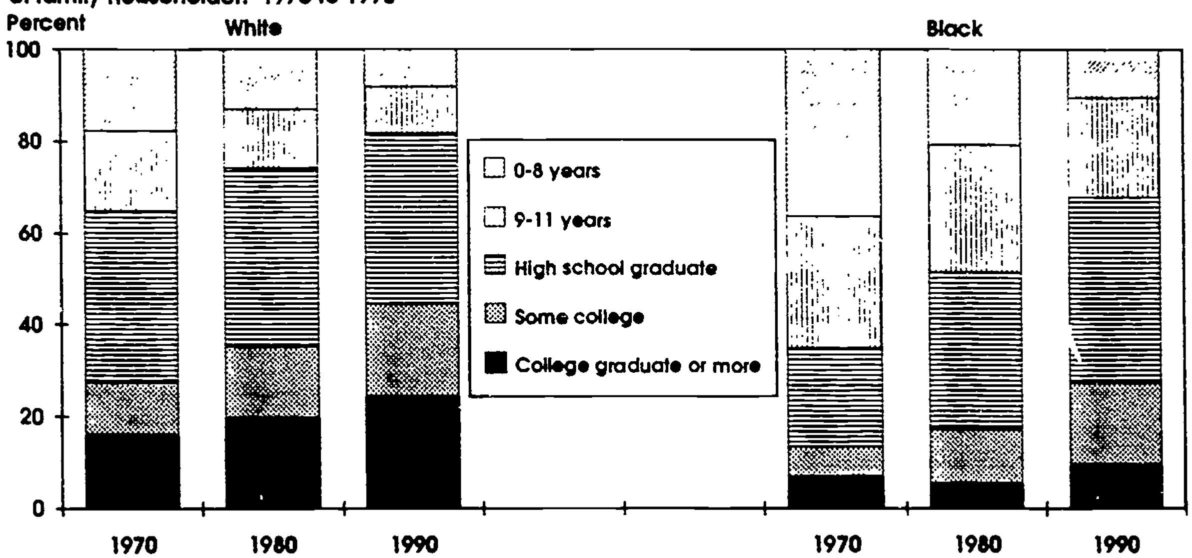
Figure Intro-6
Percent of white, black, and Hispanic families with one parent: 1970 to 1991



See appendix table Intro-6. NSF Education Indicators—1992

SOURCE: Bureau of the Census, U.S. Department of Commerce, *Household and Family Characteristics: March 1991*, Current Population Reports, Population Characteristics Series P-20, No. 458, 10, table G.

Figure Intro-7
Percent of white and black elementary and secondary school students, by educational level of family householder: 1970 to 1990



See appendix table Intro-7. NSF Education Indicators—1992

SOURCES: For 1970, Bureau of the Census, U.S. Department of Commerce, *Population Characteristics, School Enrollment: October 1970*, Current Population Reports, Population Characteristics Series P-20 No. 222 (Washington, DC: U.S. Government Printing Office (GPO), 1971); for 1980, Bureau of the Census, U.S. Department of Commerce, *School Enrollment—Social and Economic Characteristics of Students: October 1981 and 1980*, Current Population Reports, Population Characteristics Series P-20 No. 400 (Washington, DC: U.S. GPO); for 1990, Bureau of the Census, U.S. Department of Commerce, *School Enrollment—Social and Economic Characteristics of Students: October 1990*, Current Population Reports, Population Characteristics Series P-20, No. 400 (Washington, DC: U.S. GPO).

householders had completed high school, and about 22 percent had graduated from college. The changes in educational levels were particularly dramatic for the household heads of black elementary and secondary school children, who were twice as likely to graduate from high school in 1990 as in 1970. Still, in 1990 about one-third of householders of black elementary and secondary school children were not high school graduates; the percentage of college graduates increased to only 10 percent—considerably lower than the corresponding proportion for whites.

Parent educational levels have been shown to relate to student performance on achievement tests. (See appendix tables 1-15, 1-16, 2-21 to 2-24, and 4-1 to 4-6.) To date, however—and in spite of the large increases in parent educational levels—little improvement in overall student achievement has been found. Furthermore, there is no indication that the changes in the educational levels of parents were sufficient to reduce the achievement level differences between black and white children. Large changes in educational levels might have been counterbalanced by other factors, such as increases in the proportion of students from low-income families or increases in the number of students speaking English as a second language.

Summary of Report Findings

This section summarizes the primary findings detailed in the later chapters of this report. Tables and charts cited here are found in each chapter of the report.

Student Performance

Are elementary and secondary students performing better today in mathematics and science subjects than they were previously? Are improvements in achievement levels being made by minorities and women or in specific regions of the country?

Overall, little detectable change occurred in the average achievement scores in mathematics and science among elementary and secondary students between 1970 and 1990.[5] However, some general trends are notable in specific age groups and for minorities. For example, in both mathematics and science, larger increases occurred during the 1980s for black students than for white students. These increases were particularly noticeable for 17-year-old black students. (See figures 1-11 and 1-12.)

Male students achieved higher levels of performance than female students in twelfth-grade mathematics and twelfth-grade science. (See figures 1-1 and 1-2.)

Student achievement levels differed among geographic regions, with the Southeast having the lowest scores. Large state-by-state differences were found in eighth-grade public school mathematics performance in 1990. (See text table 1-1 and figure 1-5.)

Have U.S. mathematics and science achievement levels changed with respect to achievement levels in other countries?

Close examination of the results of studies of middle-grade science and mathematics student achievement conducted in seven technologically advanced countries between 1965 and 1985 suggests that U.S. achievement levels remained about the same during that period. U.S. students performed relatively poorly, even on material that most closely reflected what they had been taught. (See figure 1-13.)

[5]The studies of changes in student performance have been made possible by the National Assessment of Educational Progress (NAEP), a regular system of assessing science and mathematics learning of elementary and secondary students begun in 1970, and by international studies of student achievement in mathematics and science that were initiated during the 1960s. No national measure of student achievement before the 1960s is available.

Public opinion surveys of adults aimed at gauging their understanding of science and mathematics topics show that U.S. adults did not greatly differ in the breadth of their understanding from adults in Europe. (See figure 1-21.)

What changes have occurred in the understanding of scientific concepts among undergraduate and graduate students?

No national sample surveys of postsecondary students collect information on student learning. However, each year, a number of students in engineering and science fields take advanced exams (Graduate Record Examinations) in those fields. These measures of performance levels of students in engineering, mathematics, and economics show that student performance remained about the same or actually increased between 1978 and 1991. (See figure 5-5.)

Curriculum and Instructional Practices

What educational reforms have been undertaken by the states?

Many state and local school districts have changed teaching and curriculum practices for science and mathematics subjects. Some NSF funding is provided to states to assist them in reform efforts to improve instruction. These efforts are expected to introduce new materials into classrooms that will provide students with the latest methods of scientific research practices (such as new computer technologies that model scientific discoveries). Also, funding is provided to give science and mathematics teachers new training in the subjects they teach so that their instruction can reflect the latest knowledge of science topics.

Have schools and states increased student course-taking requirements in mathematics and science?

The number of states requiring more than 2 years of mathematics courses for graduation increased from 2 percent in 1980 to 24 percent in 1990. (See figure 2-3.) Enrollment in some advanced science and mathematics courses increased as state graduation requirements for science and mathematics were raised across the country. However, few students took the most advanced science courses offered in schools.

What are the effects of textbook and evaluative tests on student learning?

A study of the content of the six major tests used in the United States to evaluate student progress in elementary and secondary schools found that these tests stressed knowledge gained by memorization rather than higher order thinking. Only around 5 percent of the test items required more than mere memorization of facts by students (Madaus et al. 1992). Moreover, the classroom instruction practices of many teachers are influenced by the content of these tests. The study found that teachers in classrooms with large percentages of minority students were more likely to teach by memorization than were other teachers. The achievement levels of students may have been adversely affected by the continual use of tests that require simple memorization of facts rather than more extensive exploration of subjects.

New research into testing has been directed toward developing new approaches, such as performance testing, that require students to perform and interpret scientific experiments and observations. These tests are believed to challenge students to learn more about science and mathematics (Madaus et al. 1992). Reporting of student performance on these new tests has not yet occurred on a national level, but several states have adopted these methods and are evaluating their use.

How is student understanding of mathematics and science affected by classroom coverage of the subjects?

Studies of the relationships between instructional coverage and student achievement are found only at the international level. A reexamination of the results of the international studies found that student achievement levels were clearly related to classroom coverage for eighth-grade arithmetic and algebra, but the results were less clear for other mathematics topics (geometry, measurement, and statistics) and for science topics. (See appendix table 2-35.) New studies of the influence of classroom coverage of science and mathematics topics will be under way in 1993 and 1994, both in the United States and in a large number of other countries. These studies will be used to determine whether student achievement in mathematics and science can be improved by increasing the classroom coverage of these topics.

To what extent are science and mathematics concepts learned outside the school classroom?

Time spent doing homework was found to be positively related to achievement for secondary school students but not for elementary school students. Time spent watching television was negatively related to achievement at all school levels. (See appendix tables 2-29 to 2-34.)

Less than half (about 13 to 39 percent) of eighth-grade students watched science and mathematics programs on television. Slightly more than half of them watched "National Geographic" specials. About 60 percent of secondary school students had visited a science museum. Attending museums was as common among rural students as urban, but it was most common among suburban students. No effect on overall student performance was measured. (See appendix tables 2-21 and 2-22.)

Quality of Teaching Force

How well prepared for teaching mathematics and science are today's U.S. elementary and secondary teachers?

Several recent surveys of the elementary and secondary school teaching force address the issue of teacher preparedness. Most elementary teachers who specialized in teaching science or mathematics did not earn bachelor's degrees in science/science education or in mathematics/mathematics education. (See figure 3-5.) Fewer science teachers than, for example, reading teachers reported that they felt very well qualified to teach their subjects. (See figure 3-13.)

Many teachers of high school science and mathematics subjects taught those courses as a second assignment. (See appendix table 3-4.) Teachers with a second assignment in science or mathematics instruction were less prepared than teachers whose main assignment was science or mathematics—that is, they were much less likely to have degrees in mathematics or science.

How is the profile of current and prospective science and mathematics teachers changing with respect to age, race and ethnicity, and gender?

Most minority students do not have minority teachers. (See text table 3-2.) In an increasingly heterogeneous society, however, all students need to see effective teachers who come from different backgrounds, ethnic groups, and races.

Male teachers were underrepresented at the elementary level, accounting for only 10 percent of all teachers in 1987–88; however, the male underrepresentation was less pronounced for teachers who specialized in teaching mathematics (18 percent) and science (34 percent). At the secondary level, women were underrepresented in chemistry and physics.

About two-thirds of all public school teachers in 1991 were aged 30 to 49. The current abundance of middle-aged teachers may signal a teacher shortage within the next two decades.

Do students with different socioeconomic backgrounds have equal access to the most qualified mathematics and science teachers?

Students in poor schools tend to have less well-prepared teachers—that is, teachers with majors in education rather than in a subject matter field—compared with students in wealthy schools. (See text table 3-5.)

What changes have occurred in the preparation of college faculty?

No recent survey results regarding college faculty were available to include in this report. However. new information about postsecondary science and mathematics faculty will be collected in 1993.

Persistence in Science and Mathematics Courses

Have changes occurred in student persistence in mathematics and science?

Student persistence in mathematics courses increased during the late 1980s. A larger proportion of high school seniors completed geometry and algebra 2 in 1990 than in 1980. (See figure 4-1.) This finding suggests that the reform efforts of such groups as the National Council of Teachers of Mathematics and the increased public attention on student performance may have had some effect on student persistence in mathematics. Similar trends were found for science subjects. Between 1980 and 1990, a larger proportion of students completed high school having had laboratory-based science instruction. (See figure 4-2.)

Do students remain interested in science throughout secondary school and enroll in advanced courses?

Student interest in science fields is measured in this report by the number of student completions of advanced mathematics and science courses, the interest expressed in science careers, and the level of understanding of course requirements for a career as a scientist or engineer. The results of a survey of youth indicated that a significant proportion of students avoided taking advanced courses in mathematics and science when they were offered a choice. For example, only 42 percent of public high school seniors had completed a course in chemistry in 1990—up from 37 percent in 1980. (See figure 4-2.) Also, about one-half of the 1990 public high school seniors had completed both geometry and algebra 2. (See figure 4-1.)

Many students were not well informed about high school course requirements for science and engineering occupations. For instance, only about 40 percent of eighth-grade students reported that taking high school trigonometry and calculus was necessary for a career in engineering. However, by their senior year in high school, about 75 percent of students correctly understood the requirements for a career as an engineer. (See appendix table 4-12.)

Higher Education

To what extent have undergraduate students completed courses of instruction to prepare for scientific careers?

The number of students earning bachelor's degrees in natural sciences and in engineering declined between 1986 and 1990, while the number of degrees awarded in social and behavioral sciences increased. During the same period, the number of master's degrees earned in social and behavioral sciences. engineering, and most natural sciences increased. (See figures 5-8 and 5-9.)

About 20 percent of bachelor's degree recipients in science and engineering had completed some courses in a 2-year college. Only 7 percent of the same group had received an associate's degree. (See Chapter 5.)

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Chapter 1: Cognitive Achievement

Overview

Statistical information about students' knowledge and skills yields important indicators of the state of mathematics and science education. Measures of levels of achievement show what students at particular ages know and can do; trends over time show whether students' knowledge and skills have improved relative to past measures. Comparisons reveal disparities in achievement by sex or race within the United States as well as disparities between the performance of this Nation's students and that of their peers around the world.

By revealing some of the outcomes of schooling, achievement indicators shed light on the strengths and weaknesses of the education system. For example, the results of mathematics and science achievement tests consistently show that U.S. students have reasonably good basic skills but that very small proportions of them have mastered the more demanding "higher order" skills. Similarly, the recent state-by-state student performance in mathematics shows substantial disparities that state policy makers will want to address (NCES 1991a).

Achievement test results appear to provide a convenient summary of the education system's accomplishments and failings, yet they leave much unsaid. The results do not, by themselves, tell what accounts for the level of performance. They do not tell us, for example, whether achievement scores are driven by students' out-of-school experiences and motivation or by the work of teachers and schools. Thus, both trends over time and comparisons of different countries' performances can be interpreted in different ways.

The standardized tests used to measure student achievement are especially likely to draw criticism. These tests provide only a limited picture of achievement. For example, they underrepresent the range of skills that are expected of students because their format calls on test-takers to solve relatively manageable problems within a limited time. Nevertheless, student performance on these tests provides some insight into what young people in the United States can and cannot do. Until alternative forms of assessment come into widespread use—and even the most ardent advocates of these alternative formats say that widespread use lies several years in the future—the current tests will form the basis for public reporting of student achievement.

This chapter presents the best available national survey information about student outcomes in mathematics and science. It implicitly poses questions to which other chapters of this report offer at least partial answers: Why are students in the United States making greater strides in mastering basic skills than higher order skills, and what should be done to improve their performance in higher order skills? What differences in opportunity to learn could help explain the persistent gap in performance between white students and members of some minority groups? What do the international indicators suggest about an agenda for altering the Nation's approach to teaching mathematics and science?

This chapter begins with a brief description of the most comprehensive source of data on the achievement of U.S. students, the National Assessment of Educational Progress (NAEP). It reviews the 1990 NAEP results[1] and discusses the relative performance of different groups of students. Next, it classifies achievement indicators by geographic location (region, state, and urbanicity). Finally, the chapter examines trends over time in both overall achievement and achievement of the subgroups. After reviewing domestic results, the chapter addresses international comparisons. It discusses trends over

[1]Detailed results and analyses of the 1992 results were not available for use in this report.

time in comparative performance across a small set of countries that have participated consistently in international studies. The most recent data available from these studies are presented. The chapter concludes with a section on international comparisons of adult understanding of scientific terms and concepts.

National Mathematics and Science Achievement

The results of nationwide achievement tests administered in 1990 indicate that, although a majority of students had a grasp of basic facts or skills in mathematics and science, the percentage of students reaching higher levels of achievement was minimal. For example, only 1 in 20 high school graduates could deal competently with problems requiring several successive steps. The U.S. focus on basic competencies appears to have helped an increasing percentage of students master basic skills in mathematics and science, but students have not made strides toward solving problems that require analytic capabilities. According to the 1990 results—

- More than one-half of all U.S. twelfth-grade students had not mastered mathematics skills typically covered by the seventh grade.
- Approximately one-third of eighth-grade students had not mastered the skills typically introduced in elementary school.
- Very few high school students had mastered advanced skills: only 5 percent of twelfth-grade students were prepared to study advanced mathematics in college, and only 9 percent had the detailed scientific knowledge deemed necessary for college-level science classes (NCES 1991a, 1992).

The picture of U.S. student achievement in mathematics and science has changed little in the past two decades. U.S. student achievement declined during the 1970s but regained most of the lost ground during the 1980s. In mathematics, 13- and 17-year-old white students made no overall progress between 1973 and 1990, whereas Hispanic students at ages 9, 13, and 17 demonstrated slightly higher proficiency. African American students at all three age levels experienced significant improvement during the 17-year period. More students could solve problems requiring them to use decimals and fractions, but the percentage of students who could demonstrate advanced mathematics skills remained about the same.

News about the science proficiency of U.S. students was even less encouraging. Although student achievement improved significantly in the late 1980s, 17-year-olds did not come back up to the level set in 1970. Nine- and 13-year-olds merely returned to the levels they had reached in 1970. From 1982 to 1990, 17-year-old African American students experienced a significant shift from the lower levels of performance to levels where they demonstrated the ability to apply and interpret general scientific information and to analyze scientific procedures and data. However, the average score in 1990 was no higher than it had been in 1970. Overall, the percentage of students of any race who had the scientific knowledge to integrate scientific information and draw conclusions remained low.

Although minority students made gains in the past decade in both mathematics and science, the troubling gap between white and minority students remained. Similarly, differences between male proficiency and female proficiency persisted, even though female proficiency scores in both mathematics and science rose. In mathematics, significant gender differences occurred at the twelfth-grade level; in science, at the eighth- and twelfth-grade levels.

National Assessment of Educational Progress

In the United States, a limited number of assessment tools measure educational achievement in broad terms. National standardized test results must therefore be relied upon to describe levels of student proficiency. This section focuses on data from NAEP, the Federal Government's primary indicator of the Nation's educational achievement. In many respects, NAEP is the best indicator of the achievement of U.S. students (Koretz 1991); however, it has limitations:

- NAEP is a "low-stakes" test. Some observers are concerned that older students do not take the test seriously and, therefore, do not perform as well as they could.
- Because NAEP tests only those children who are in school and not those who have dropped out, it may overstate proficiency for high school students.
- NAEP includes very few problems in higher level areas of mathematics, such as calculus and trigonometry; therefore, students with mathematics proficiency at these levels do not display their full range of knowledge and skills.
- The NAEP sample is insufficient for detailed analysis of Native American students, of Asian students beyond observation of average scores, or of each of the community types. (For detail on NAEP community types, see page 28.) The sample is also insufficient for a detailed analysis of all minority groups.

Description of the NAEP 1990 mathematics proficiency scale

- **Level 200: Simple Additive Reasoning and Problem Solving With Whole Numbers** — Students at this level have some degree of understanding simple quantitative relationships involving whole numbers. These students can identify solutions to one-step word problems. They also can determine the value of coins. In geometry, these students can recognize simple figures.
- **Level 250: Simple Multiplicative Reasoning and Two-Step Problem Solving** — Students at this level have extended their understanding of quantitative reasoning with whole numbers from additive to multiplicative settings. They can solve routine one-step multiplication and division problems involving remainders and two-step addition and subtraction problems involving money. In geometry, they demonstrate an initial understanding of basic terms and properties, such as parallelism and symmetry.
- **Level 300: Reasoning and Problem Solving Involving Fractions, Decimals, Percents, Elementary Geometric Properties, and Simple Algebraic Manipulations** — Students at this level are able to represent, interpret, and perform simple operations with fractions and decimal numbers. They are able to locate fractions and decimals on number lines, simplify fractions, and recognize the equivalence between common fractions and decimals, including pictorial representations. In geometry, they have some mastery of the definitions and properties of geometric figures and solids. In algebra, they can perform simple algebraic manipulations.
- **Level 350: Reasoning and Problem Solving Involving Geometric Relationships, Algebraic Equations, and Beginning Statistics and Probability** — Students at this level have extended their knowledge of number and algebraic understanding to include some properties of exponents. They can find the circumferences of circles and the surface areas of solid figures. In geometry, they can apply the Pythagorean theorem to solve problems involving indirect measurement.

SOURCE: NCES 1991a.

- NAEP does not include detailed measures of socioeconomic status such as family income. It collects information about parent education on the basis of students' reports, which may be unreliable because of reporting errors.

NAEP has assessed student achievement for ages 9, 13, and 17 in mathematics and science—as well as in reading, writing, history, geography, and other subjects—since 1970. The mathematics NAEP was conducted every 4 years between 1972–73 and 1989–90; the science NAEP began in 1969–70 and has continued on the same schedule as the mathematics NAEP from 1982 to the present. In 1983, the NAEP sample was expanded to allow reporting of grade-level results. The 1990 assessments report results for students in grades 4, 8, and 12.

The NAEP achievement scales range from 0 to 500 for both mathematics and science, but the scales are not equivalent. Within each subject, the scale permits comparison among groups, such as grades or demographic subgroups. The 1990 mathematics scale was computed using a weighted composite of proficiency on five content-area subscales—numbers and operations; measurement; geometry; data analysis, statistics, and probability; and algebra and functions. To help interpret the 0-to-500-point scale, NAEP developed characterizations of two scales—the 1990

Description of the NAEP trend scale for mathematics proficiency

- **Level 150: Simple Arithmetic Facts** — Students at this level know some basic addition and subtraction facts, and most can add two-digit numbers with regrouping. They recognize simple situations in which addition and subtraction apply. They are also developing rudimentary classification skills.
- **Level 200: Beginning Skills and Understanding** — Students at this level have considerable understanding of two-digit numbers. They can add two-digit numbers but are still developing an ability to regroup in subtraction. They know some basic multiplication and division facts, recognize relations among coins, can read information from charts and graphs, and use simple measurement instruments. They are developing some reasoning skills.
- **Level 250: Basic Operations and Beginning Problem Solving** — Students at this level have an initial understanding of the four basic operations. They are able to apply whole-number addition and subtraction skills to one-step word problems and money situations. In multiplication, they can find the product of a two-digit and a one-digit number. They can also compare information from graphs and charts and are developing an ability to analyze simple logical relations.
- **Level 300: Moderately Complex Procedures and Reasoning** — Students at this level are developing an understanding of number systems. They can compute with decimals, simple fractions, and commonly encountered percents. They can identify geometric figures, measure lengths and angles, and calculate areas of rectangles. These students are also able to interpret simple inequalities, evaluate formulas, and solve simple linear equations. They can find averages, make decisions on information drawn from graphs, and use logical reasoning to solve problems. They are developing the skills to operate with signed numbers, exponents, and square roots.
- **Level 350: Multi-Step Problem Solving and Algebra** — Students at this level can apply a range of reasoning skills to solve multistep problems. They can solve routine problems involving fractions and percents, recognize properties of basic geometric figures, and work with exponents and square roots. They can solve a variety of two-step problems using variables, identify equivalent algebraic expressions, and solve linear equations and inequalities. They are developing an understanding of functions and coordinate systems.

SOURCE: NCES 1991b.

mathematics scale and the trend scale—using proficiency levels, which represent 5 anchor points on the 500-point scale. (See descriptions of the scales in the sidebars.)

The panel that developed these performance descriptions characterized the performance levels as follows:

- **Level 200**—material typically covered by approximately the third grade.
- **Level 250**—material typically covered by approximately the fifth grade.
- **Level 300**—material typically covered by approximately the seventh grade.
- **Level 350**—material typically covered in high school mathematics courses in preparation for the study of advanced mathematics. (NCES 1991a)

The science scale was computed using a weighted composite of proficiency in four content-area subscales—life sciences, physical sciences, earth and space sciences, and the nature of science (NCES 1992). To help interpret the 0-to-500-point scale, NAEP characterized student performance using five anchor points on the 500-point scale, as described in the sidebar. The description associated with each level can be used as a guide to the performance typical of students at that level. These descriptions are only general guides that were added to the scale after it was created. Sample questions for the different performance levels in mathematics and science are shown on page 19.

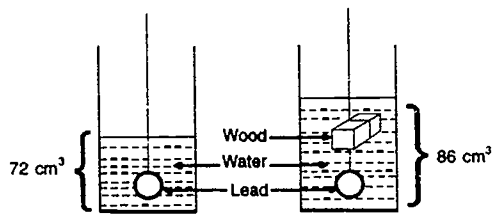
Description of the NAEP science proficiency scale (main and trend)

- **Level 150: Knows Everyday Science Facts** — Students at this level know some general scientific facts of the type that could be learned from everyday experiences. They can read simple graphs, match distinguishing characteristics of animals, and predict the operation of familiar apparatuses that work according to mechanical principles.
- **Level 200: Understands Simple Scientific Principles** — Students at this level are developing some understanding of simple scientific principles, particularly in the life sciences. For example, they exhibit some rudimentary knowledge of the structure and function of plants and animals.
- **Level 250: Applies Basic Scientific Information** — Students at this level can interpret data from simple tables and make inferences about the outcomes of experimental procedures. They exhibit knowledge and understanding of life sciences, including a familiarity with some aspects of animal behavior and of ecological relationships. These students also demonstrate some knowledge of basic information from the physical sciences.
- **Level 300: Analyzes Scientific Procedures and Data** — Students at this level can evaluate the appropriateness of the design of an experiment. They have more detailed scientific knowledge and the skill to apply their knowledge in interpreting information from text graphs. These students also show a growing understanding of principles for the physical sciences.
- **Level 350: Integrates Specialized Scientific Information** — Students at this level can infer relationships and draw conclusions using detailed scientific knowledge from the physical sciences, particularly chemistry. They also can apply basic principles of genetics and interpret the societal implications of research in this field.

SOURCE: NCES 1992.

Test items illustrating selected NAEP proficiency levels

Sample science item #4 level 300: Analyzes scientific procedures and data



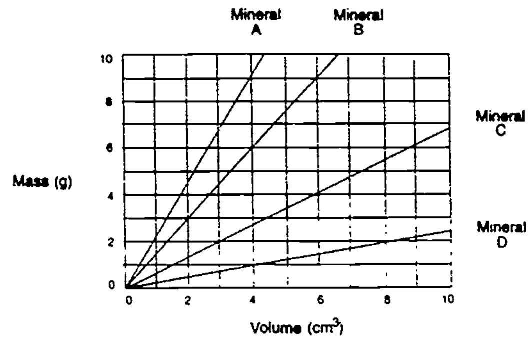
The volume of a block of wood can be found by suspending it in water, as the diagrams above show. What is the volume of the block?

- ● $(86 - 72)\ cm^3$
- ○ $(72 - 86)\ cm^3$
- ○ $86\ cm^3$
- ○ $(72 + 86)\ cm^3$

Response Percentages

	Grade 7	Grade 11
*Foil 1	34	65
Foil 2	27	13
Foil 3	20	12
Foil 4	17	9
Missing	2	1

Sample science item #5 level 350: Integrates specialized scientific information



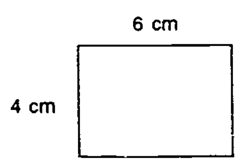
Water has a density of 1 gram per cubic centimeter. Which mineral(s) would float in water?

- ○ A only
- ○ A and B only
- ○ D only
- ● C and D only

Response Percentages

	Grade 11
Foil 1	7
Foil 2	30
Foil 3	25
*Foil 4	36
Missing	2

Sample mathematics item #4 level 300: Moderately complex procedures and reasoning



What is the area of this rectangle?

- ○ 4 square cm
- ○ 20 square cm
- ○ 6 square cm
- ● 24 square cm
- ○ 10 square cm
- ○ I don't know

Response Percentages

	Grade 3	Grade 7	Grade 11
Foil 1	13	1	0
Foil 2	9	2	0
Foil 3	31	19	5
Foil 4	18	27	23
*Foil 5	5	45	70
I don't know	23	4	1

Sample mathematics item #5 level 350: Multistep problem solving and algebra

Suppose you have 10 coins and have at least one each of a quarter, a dime, a nickel, and a penny. What is the least amount of money you could have?

- ○ 41¢
- ○ 50¢
- ● 47¢
- ○ 82¢

Response Percentages

	Grade 7	Grade 11
Foil 1	34	41
*Foil 2	21	42
Foil 3	23	7
Foil 4	13	8

SOURCES: I.V.S. Mullis and L.B. Jenkins, *The Science Report Card: Elements of Risk and Recovery*, Report No. 17-S-01 (Princeton: Educational Testing Service, 1988); J.A. Dossey, I.V.S. Mullis, M.M. Lindquist, and D.L. Chambers, *The Mathematics Report Card: Are We Measuring Up?* Report No. 17-M-01 (Princeton: Educational Testing Service, 1988).

Student Achievement: 1990

Analysis of the 1990 NAEP results reveals that, by the time they graduated from high school, U.S. students had not mastered advanced skills such as solving multistep mathematics problems or analyzing scientific information. Although nearly all U.S. high school students understood basic concepts (Level 200 or lower on the NAEP scale), very few attained higher levels of achievement (Level 350). (See figures 1-1 and 1-2.) Fewer than 10 percent of twelfth-grade students reached an advanced level of science achievement at which they demonstrated the knowledge required to integrate scientific information and draw conclusions (Level 350). Even fewer—about 5 percent—achieved a level in mathematics advanced enough to demonstrate the problem-solving skills needed to work in algebra and geometry. More than three-quarters of the students exhibited an understanding of mathematics and science at an intermediate level (Level 250 and Level 300).

One reason average achievement scores are not higher is that nearly 50 percent of students drop out of mathematics and science each year after the more advanced courses became elective. African Americans, Hispanics, and other minorities drop out at even greater rates (Steen 1989). Consequently, after a majority of students complete basic mathematics and science courses, they do not pursue the valuable, more advanced—but more difficult—subjects.

Achievement by Sex

> "There is clear evidence that the educational system is not meeting girls' needs. Girls and boys enter school roughly equal in measured ability. On some measures of school readiness, such as fine motor control, girls are ahead of boys. Twelve years later, girls have fallen behind their male classmates in key areas such as higher-level mathematics and measures of self-esteem." (AAUW 1992)

This report presents results for males and females separately to monitor the recent trends in female student performance.

In the early grades, NAEP 1990 average proficiency scores for males and females were nearly identical; by twelfth grade, however, the gap between male proficiency and female proficiency in mathematics became noticeable (scores of 298 and 293, respectively). The differences were greater in science, where male and female average scores were similar only in fourth grade. At eighth grade, a slight gap began to appear; by twelfth grade, the difference in average science performance widened to 10 points (299 versus 289). In both mathematics and science, slightly more male than female twelfth-grade students reached the highest levels of achievement. (See appendix tables 1-3 and 1-4 as well as figures 1-1 and 1-2 for the distribution of scores.)

Achievement by Race and Ethnicity

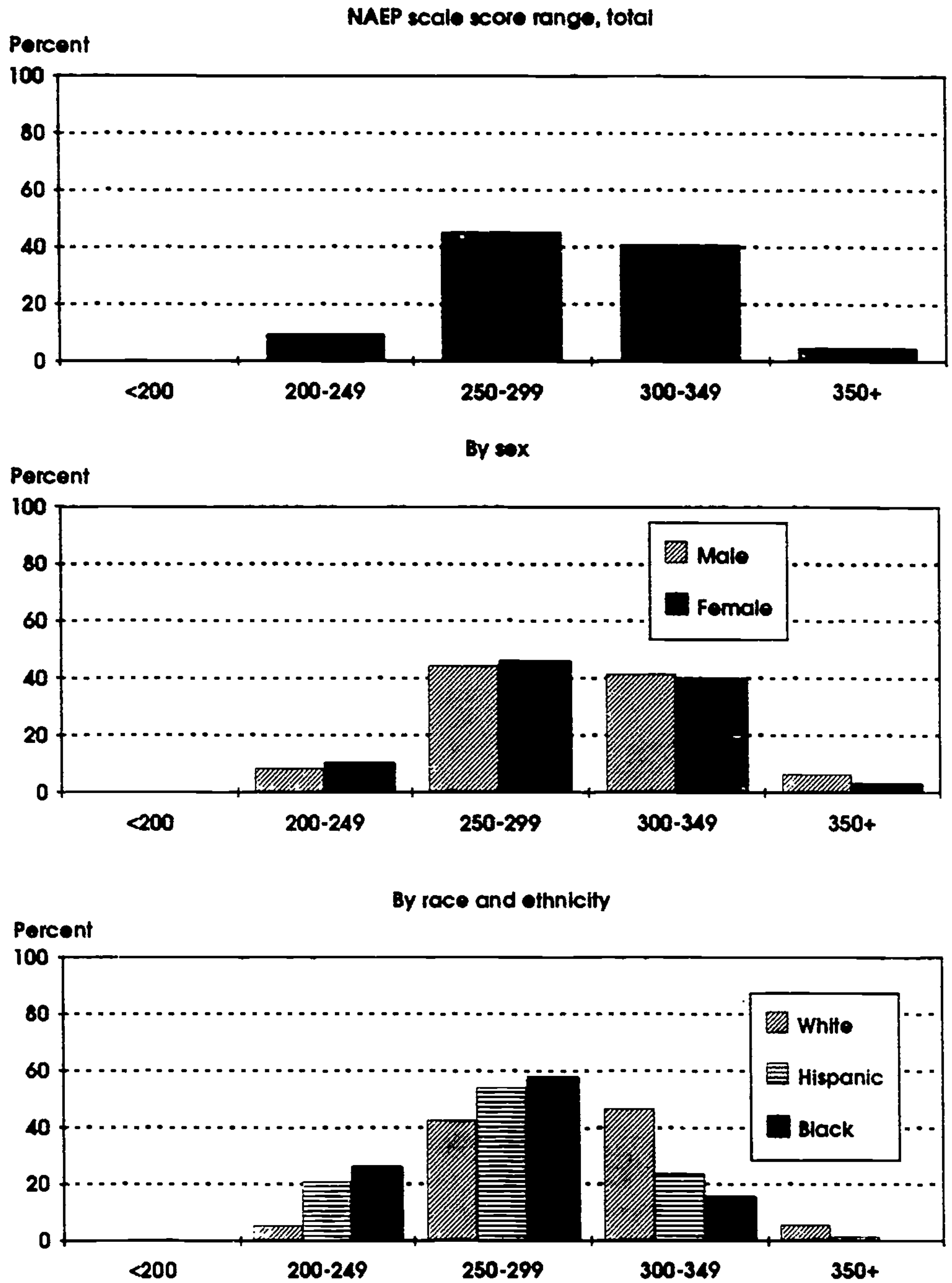
Walter Massey, Director of the National Science Foundation, said in 1992,

> "The effort to make the United States number one in math and science achievement must reflect the diversity of our country and our democratic approach to education. Everyone, not just a select few, must reap the benefits of our efforts to provide a world class education to our students." (NSF 1992)

This report presents the results separately for different racial and ethnic categories to monitor recent trends in minority performance. The difference in achievement levels among racial and ethnic groups has long been a national concern. It should be noted that average scores are not adjusted for differences in student background, which can be considerable.

The 1990 NAEP results show that most black and Hispanic students lacked proficiency in higher level mathematics and science activities. (See sidebar.) (Racial and ethnic disparities in opportunity to learn

Figure 1-1
Percent of 12th-grade students at each scale score range in mathematics: 1990

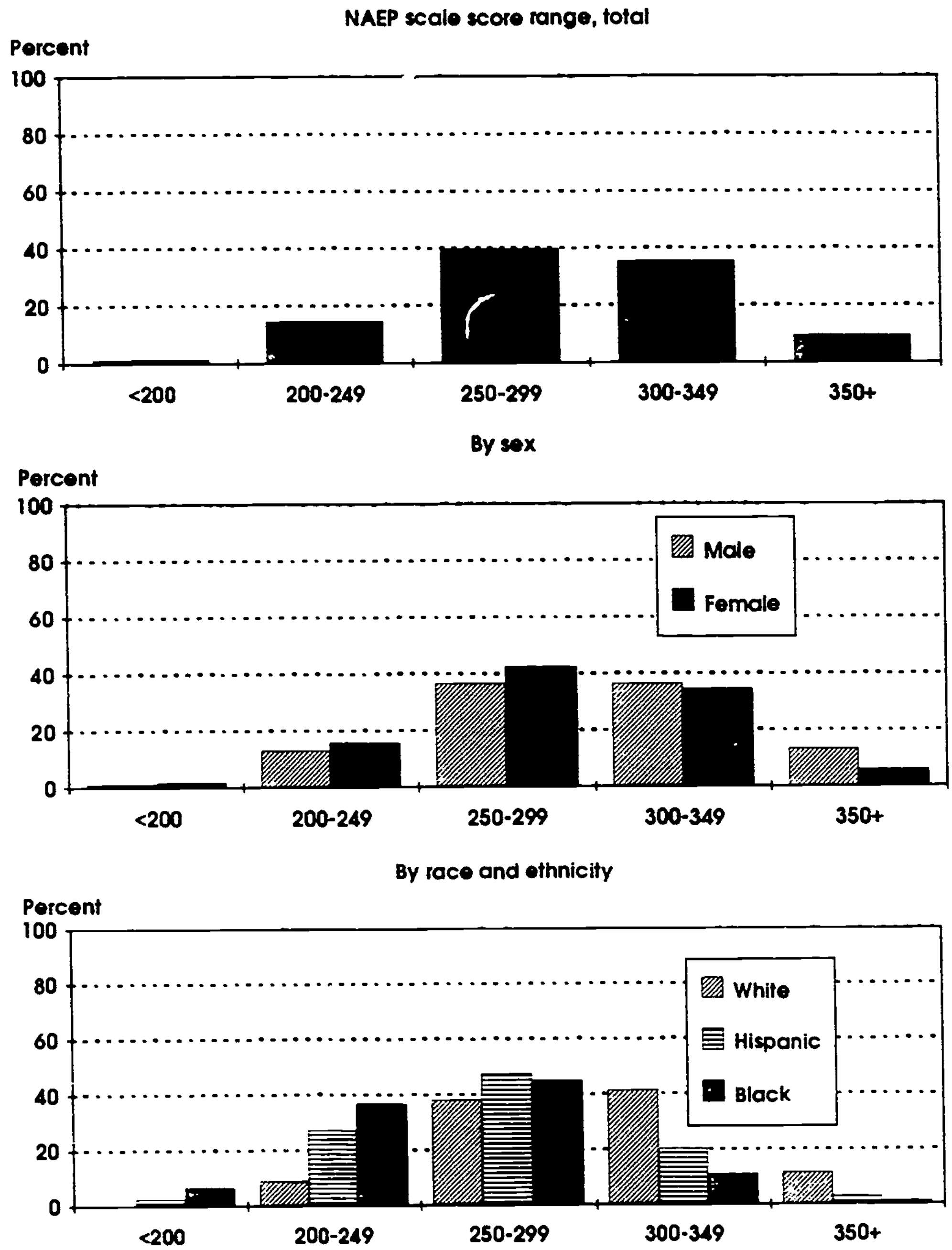


See appendix table 1-1.

NSF Education Indicators—1992

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Figure 1-2
Percent of 12th-grade students at each scale score range in science: 1990



See appendix table 1-2.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992).

Race, Ethnicity, and Socioeconomic Status

A larger percentage of minority families than white families lives in poverty. According to the June 1990 Population Survey, 30 percent of African American and 25 percent of Hispanic families live in poverty, compared with 8 percent of white families. Given this disparity, some argue that it is unfair to correlate race and ethnicity with achievement without reference to socioeconomic status (SES). SES information, however, is limited. NAEP questionnaires do not inquire about family income or student poverty. NAEP did collect data on the levels of formal education reached by parents, which can be used as such an indicator. Information on parent education was reported by students who may not have known how much schooling their parents received. (See appendix table 1-17 for the percentages of students who did not report the educational levels of their parents.) Moreover, the small sample size for black and Hispanic students in NAEP led to high standard errors. Thus, the procedures followed for NAEP preclude reliable reporting of race or ethnicity by socioeconomic status. It can only be noted and emphasized that in analyzing statistics on race and ethnicity, SES accounts for some of the differences between white and minority achievement. Appendix A includes two previously unpublished tables from NAEP for student achievement in mathematics and science by race and ethnicity and parent's education level. (See appendix tables 1-15 and 1-16.)

(OTL)—measured by such indicators as teacher characteristics and course-taking opportunities—are discussed in Chapters 2 and 3.) Less than 0.5 percent of black students and 1 percent of Hispanic students in twelfth grade demonstrated an understanding of advanced mathematics applications. (See figure 1-1.) In terms of average proficiency scores, Asian students in grades 8 and 12 outperformed their peers. The mean mathematics proficiency scores for blacks and Hispanics fell around the 10th percentile of the distribution of scores for Asians. White students also lagged behind Asian students (except in fourth grade), but they performed better than the other racial and ethnic groups.[2] (See figure 1-3.)

The disparities among racial and ethnic groups were not as great in science. Three percent of Hispanic and 1 percent of black students in twelfth grade showed an understanding of advanced science applications. (See figure 1-2.) In terms of average proficiency scores, as in mathematics, the twelfth-grade Asian and white students scored, on average, significantly higher than did the other racial and ethnic groups. (See figure 1-4.) An examination of distributions shows that the scores of the 90th-percentile black students fell near the mean proficiency score for Asian students. Hispanic students performed better on science tests than did black students for all three grades, but they did not perform as well as other ethnic groups did. Unlike the results in mathematics, the average science proficiencies of white and Asian students did not differ significantly in grades 8 and 12; however, in fourth grade, white students outscored Asian students.

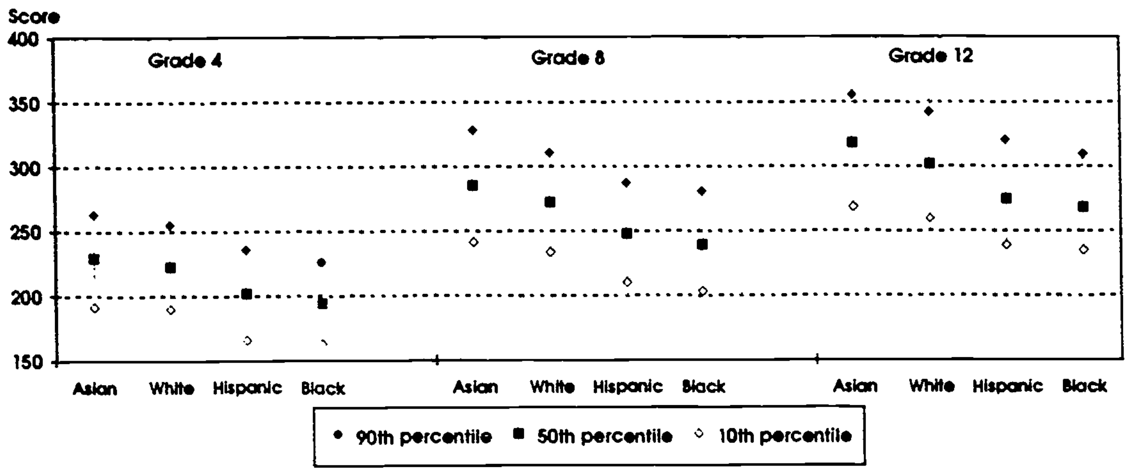
Achievement by Region

No significant differences emerged among profiles of students in the Northeast, Central, and West regions in either mathematics or science at any grade. Students in the Southeast region demonstrated significantly lower average achievement scores than did students in the other regions in both subjects for all grades. Text table 1-1 illustrates average mathematics and science proficiency for each grade level by region.

In both mathematics and science, the gap in learning between students in the Southeast and students in other regions was already in place by the fourth grade. At that point, 38 percent of fourth-grade students in the Southeast could not accomplish simple additive reasoning and problem solving with whole

[2] Native American students' scores are not reported here because the sample was too small to allow accurate determination of the variability of the estimated statistics. However, the NAEP reports provided test results for this subgroup.

Figure 1-3
Mathematics proficiency scores of highest and lowest deciles for students in grades 4, 8, and 12, by race and ethnicity: 1990



See appendix table 1-3. NSF Education Indicators—1992

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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

numbers (falling below Level 200), compared with about 25 percent in the other regions. Although about one-third of fourth-grade students in the Northeast could apply scientific information and interpret simple tables (science Level 250), only about one-fifth of fourth-grade students in the Southeast could do the same. By twelfth grade, less than 30 percent of students in the Southeast scored above 300 in mathematics or science. In the other regions, 35 percent of students scored above Level 300 in science and more than 40 percent scored above Level 300 in mathematics. (See appendix table 1-6.)

Achievement by State

In 1990, NAEP conducted the first Trial State Assessment in eighth-grade mathematics. Thirty-seven states, the District of Columbia, Guam, and the Virgin Islands volunteered to participate in the assessment. NAEP was administered to approximately 2,500 students in about 100 public schools in

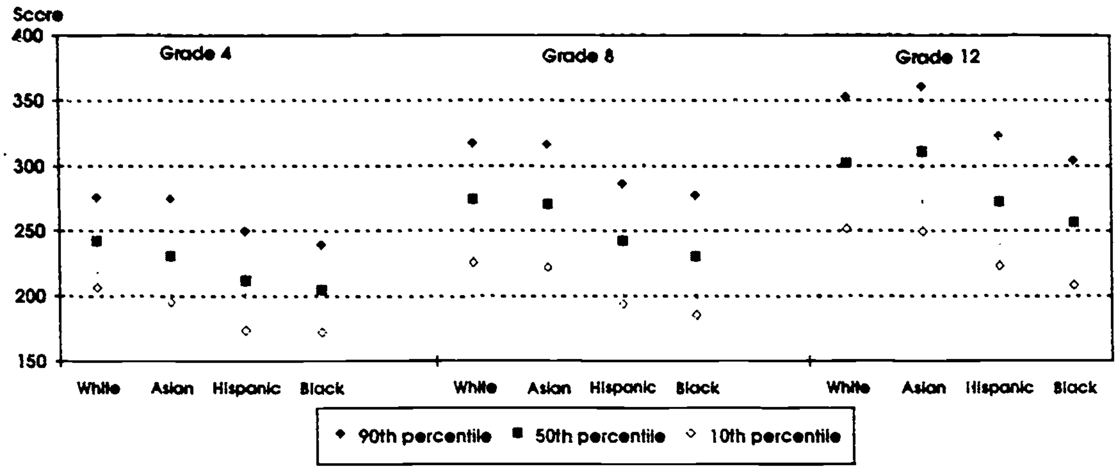
Text table 1-1
Average mathematics and science scores, by region, grades 4, 8, and 12: 1990

Subject and Grade	NAEP regions Northeast	Central	West	Southeast
Mathematics				
Grade 4	219	218	218	209
Grade 8	270	269	265	256
Grade 12	302	298	296	284
Science				
Grade 4	236	234	234	227
Grade 8	269	265	263	256
Grade 12	300	295	297	279

See appendix table 1-5. NSF Education Indicators—1992

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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Figure 1-4
Science proficiency scores of highest and lowest deciles for students in grades 4, 8, and 12, by race and ethnicity: 1990



See appendix table 1-4.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992).

each of the 40 locations. Private school students did not participate.

An analysis of subgroups by state is difficult because the samples from some of the populations were small. Figure 1-5 shows the overall distribution of mathematics proficiency across the country. Although 13 states did not participate in the test, the map clearly demonstrates that scores form regional patterns rather than differ randomly among states.

Figure 1-6 compares statistics from the highest scoring state, a state in the middle range, the lowest scoring state, and the District of Columbia. Information on the other participants can be found in appendix table 1-7. A comparison among the states shows that eighth-grade students in North Dakota achieved the highest average proficiency scores (281). Several other states posted average achievement that is not significantly different from this. Students in Louisiana scored significantly lower (246), and eighth-grade students in the District of Columbia scored the lowest (231). To gauge the extent of the variation among states, note that the mean score for Louisiana was the same as the score at the 10th percentile in North Dakota; and the mean score for eighth graders in the District of Columbia was more than 10 points below the 10th percentile in North Dakota.

Achievement by Type of Community

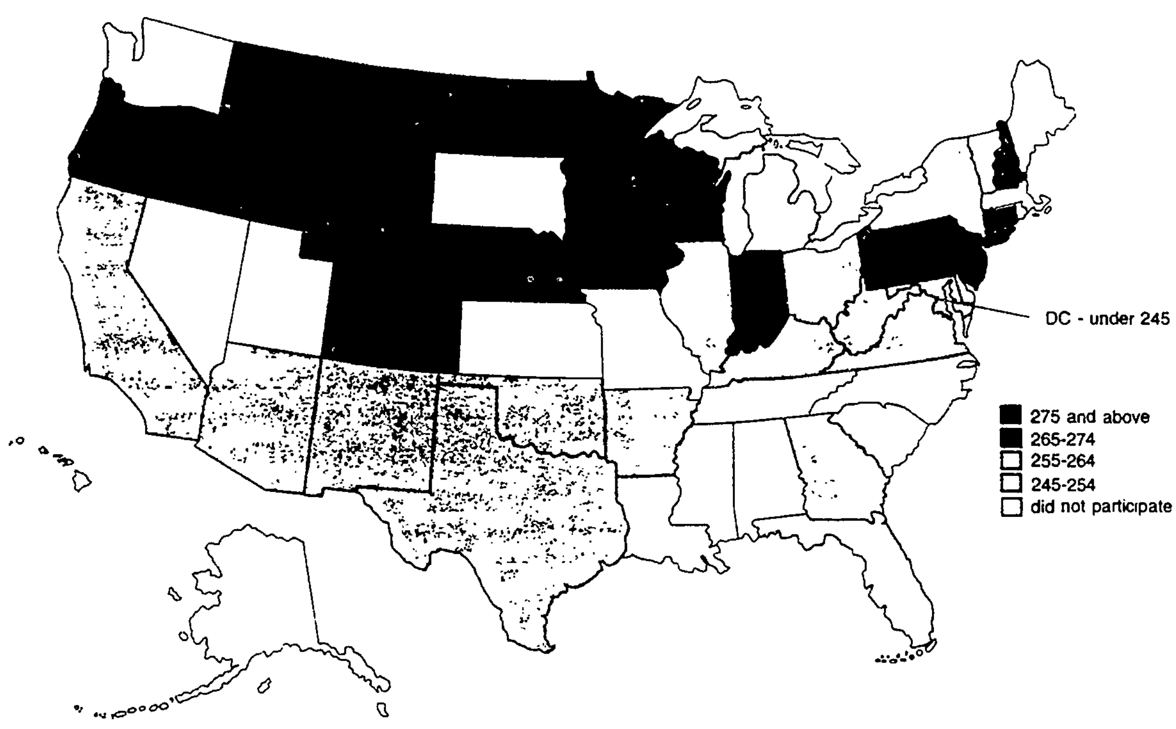
Another indicator of a student's educational opportunity is the type of community in which the student resides. The NAEP survey divided student residence areas into seven types of communities. These groups are defined in the sidebar on page 28.

Examining achievement differences by community type is difficult because of small sample sizes and a lack of precision in determining the sampling variability. The small sample sizes preclude any analysis of student achievement by race, sex, or parent education among the community types; however, general analysis is possible.

Mathematics scores did not vary much by community for students in grades 4, 8, or 12. Students living in advantaged urban areas scored somewhat higher than those living in other areas, whereas students in the disadvantaged urban areas scored the lowest. The differences in scores between the two types of urban areas ranged between 25 and 31 points. Among students living in all other areas, there were no differences in proficiency levels in grades 4 and 8. By the twelfth grade, a pattern for student achievement emerged: students who resided in large cities—except for those living in disadvantaged urban areas—scored higher than students who resided in smaller cities or rural areas. Only those living in poor urban areas continued to score the lowest. (See appendix table 1-9.)

In science, the difference in proficiency scores between fourth-grade students in advantaged urban areas and fourth-grade students in disadvantaged urban areas was approximately 43 scale score points (252 and 209, respectively). In contrast to mathematics, fourth-grade students in rural and small places scored higher than students in large cities other than advantaged urban areas. By twelfth grade, however, students in large cities other than disadvantaged urban areas outscored those in rural and small places. Students in the disadvantaged urban areas continued to score lower than the other students. (See appendix table 1-9.)

Figure 1-5
Average mathematics proficiency of 8th-grade public school students, by state: 1990

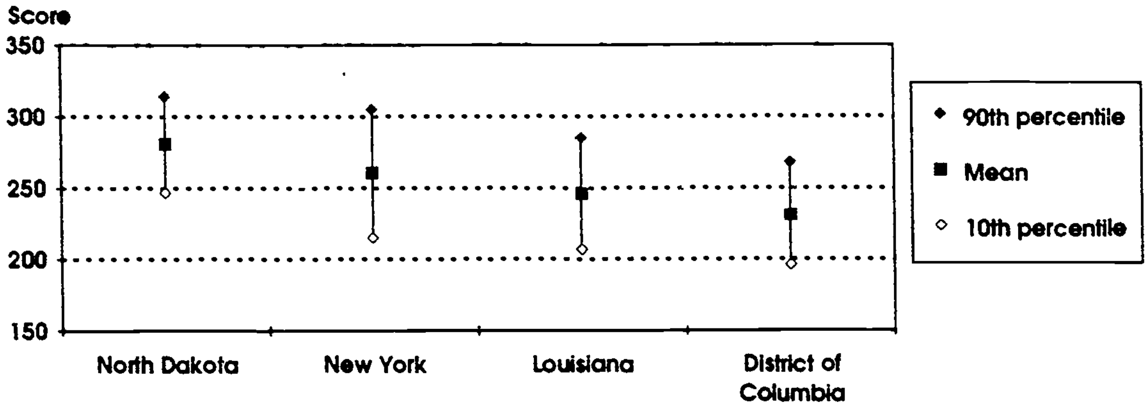


See appendix table 1-7.

NSF Education Indicators—1992

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Figure 1-6
Mathematics proficiency scores of three selected states and the District of Columbia for 8th-grade public school students: 1990



See appendix table 1-7. NSF Education Indicators—1992

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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Trends in Student Achievement: 1970 to 1990

Student achievement trends in mathematics and science changed little between 1970 and 1990. Although the 1980s witnessed improvement over the declines of the 1970s, achievement in 1990 did not differ much from what it had been in 1970. If that period is to be considered an indicator of student potential for progress, then the challenge in meeting the America 2000 goals cited below (Office of Science and Technology Policy 1992) is substantial:

- "American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter including . . . mathematics, science."
- "U.S. students will be first in the world in science and mathematics achievement."

Overall Proficiency Trends

Average mathematics proficiency levels changed little during the 1970s and 1980s. The average scores for 17-year-old students declined in the 1970s but have rebounded since then. The proficiency scores of the youngest (age 9) students continued to grow after 1982. (See figure 1-7 and appendix table 1-10.) Between 1978 and 1990, a larger percentage of 17-year-old students was proficient in such intermediate tasks as solving problems using fractions and decimals (Level 300), but the percentage of 17-year-old students who could solve problems in algebra and geometry (Level 350) remained unchanged. (See figure 1-8 and appendix table 1-11.)

The trends for science showed an overall mixture of stability and decline. Scores for each age-group decreased in the 1970s. Although each group's scores improved after 1982, the average score for 17-year-old students remained significantly below the 1970 level (15 points), whereas in 1990, the average score for both the 9- and 13-year-old students returned to the 1970 level. (See figure 1-9 and appendix table 1-12.) In 1990, the percentage of 17-year-old students who reached each level of achievement remained at the 1977 level. (See figure 1-10 and appendix table 1-13.)

NAEP community types

Community type	Percent of 12th grade students in 1990	Population size	Population characteristics
Extreme rural*	4	<2,500	High percent of farmworkers, low percent of professional and management
Disadvantaged urban	7	>200,000 or urban fringe	High percent of unemployed and welfare recipients
Advantaged urban*	13	>200,000 or urban fringe	High percent of professional and management
Main big city*	9	>200,000	Not living in advantaged or disadvantaged urban areas
Urban fringe	15	Fringe of area with >200,000	Not living in advantaged or disadvantaged urban areas
Medium city	15	Between 25,000 and 200,000	Not living in advantaged or disadvantaged urban areas
Small place	37	<25,000	Not living in urban fringe or extreme rural areas

*Interpret with caution—the nature of the sample does not allow accurate determination of the variability of the results for these subgroups.

SOURCE: E. Johnson, R. Zwick et al., *Focusing the New Design: The NAEP 1988 Technical Report*, 19-TR-20 (Princeton: Educational Testing Service, 1990).

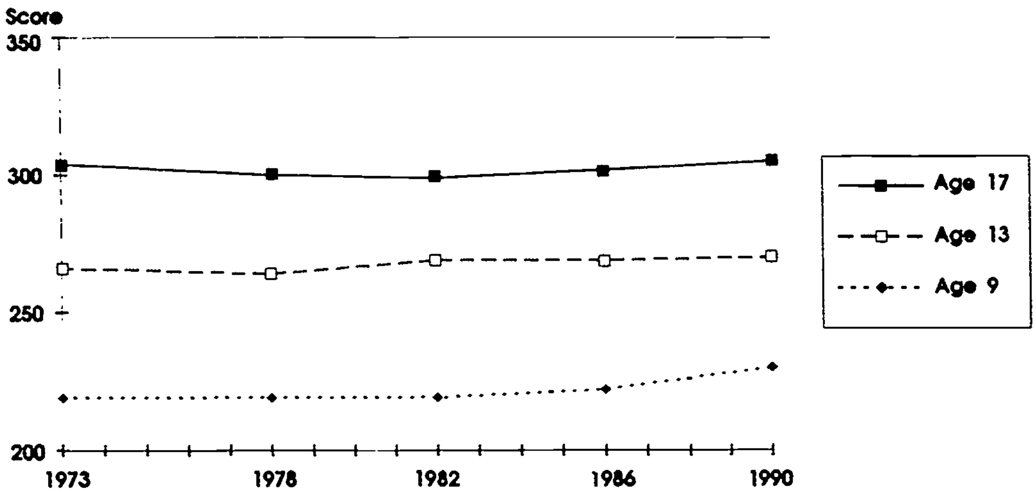
Proficiency Trends by Sex

After experiencing decreases in the 1970s, the mathematics proficiency scores of both male and female 17-year-olds returned to approximately their 1973 levels. At this age, gender differences in proficiency levels narrowed so that average scores were nearly equal: males had higher scores than females during the 1970s and 1980s but not in 1990. (See appendix table 1-10.) The percentage of females who could use fractions and decimals (Level 300) increased over time, whereas the percentage that could solve algebra and geometry problems (Level 350) remained stable. Males, on the other hand, experienced no shift in the percentage of those who reached higher levels of proficiency. (See appendix table 1-11.)

Between 1973 and 1990, there was no gap in mathematics performance between males and females aged 9 and 13. Both sexes improved their scores during that time. Scores for the 9-year-old male and female students experienced the most significant growth of any age-group (10 points) during that period; scores for 13-year-old males grew slightly, but scores for 13-year-old females did not. (See appendix table 1-10.)

Science achievement scores for both male and female students of all ages dropped in the 1970s. Scores then slowly began to improve for all students except 17-year-old males. In 1990, the average scores for 17-year-old males and females were significantly below 1970 levels (18 and 12 points,

Figure 1-7
Average mathematics proficiency scores, by age: 1973 to 1990



See appendix table 1-10.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. *Trends in Academic Progress.* Report No. 21-T-01 (Washington, DC: U.S. Department of Education. 1991).

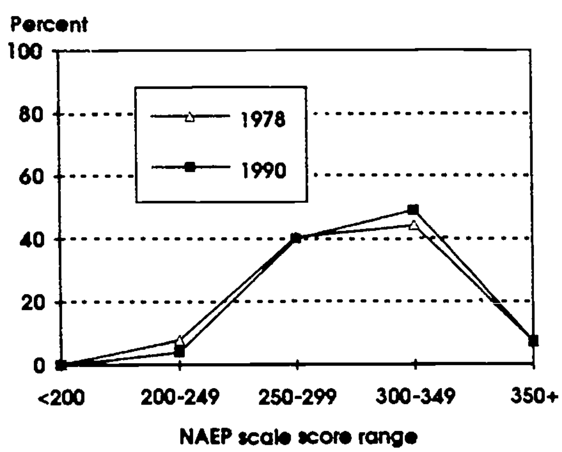
respectively), while the scores of 9- and 13-year-olds remained at 1970 levels. (See appendix table 1-12.)

The science achievement gap between male and female students continued from the 1970s to 1990. The gender gap in achievement scores remained constant for 17-year-old students between 1970 and 1990 and for 13-year-old students between 1977 and 1990. Although 13- and 17-year-old females made significant gains between 1982 and 1990 (while their male counterparts demonstrated no significant improvement), there was still a significant gender gap in scores at the older age levels. Only at age 9 was there no gender gap. (See appendix table 1-12.)

Proficiency Trends by Race and Ethnicity

Between 1973 and 1990, neither 13-year-old nor 17-year-old white students demonstrated improvement in average mathematics achievement scores. However, the scores for 9-year-old white students improved after 1973, with most of this achievement

Figure 1-8
Percent of students at each scale score range in mathematics, age 17: 1978 and 1990

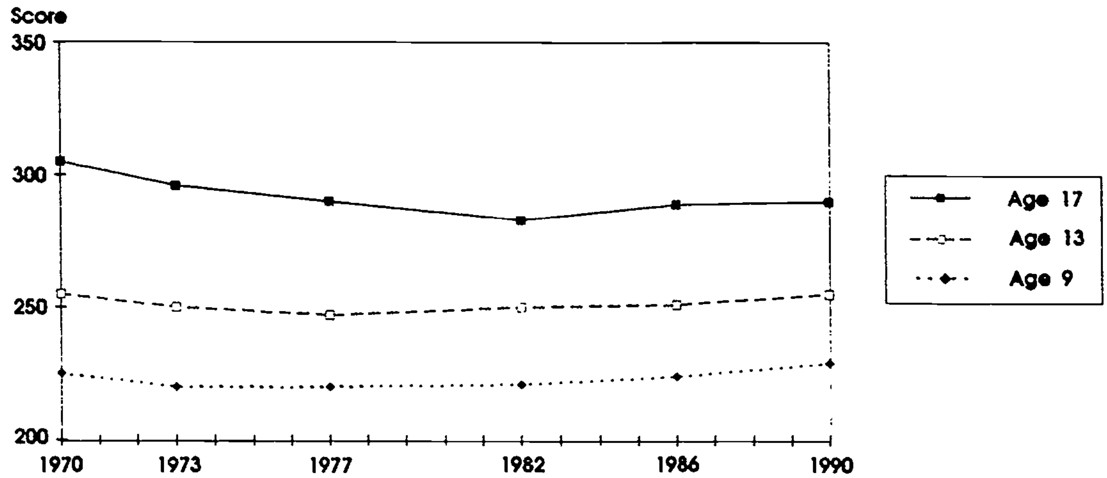


See appendix table 1-11.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *Trends in Academic Progress.* Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991).

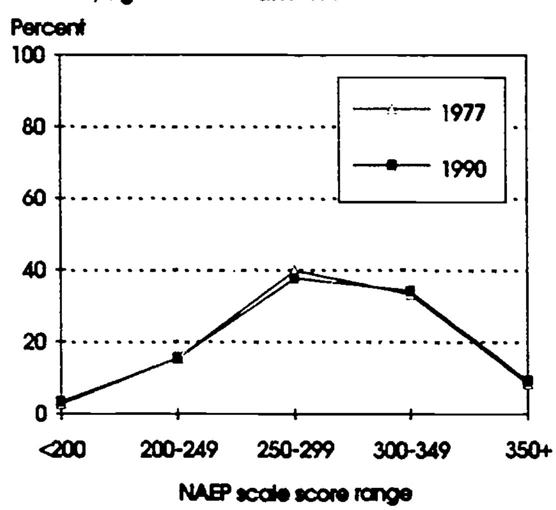
Figure 1-9
Average science proficiency scores, by age: 1970 to 1990



See appendix table 1-12. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. *Trends in Academic Progress.* Report No. 21-T-01 (Washington. DC: U.S. Department of Education. 1991).

Figure 1-10
Percent of students at each scale score range in science, age 17: 1977 and 1990



See appendix table 1-13. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. *Trends in Academic Progress.* Report No. 21-T-01 (Washington. DC: U.S. Department of Education. 1991).

occurring in the late 1980s. Scores for 9- and 13-year-old Hispanic students increased significantly (12 and 16 points, respectively), but scores for black students increased more rapidly (approximately 20 points) at all age levels. Although the mathematics achievement scores of minority students have increased while those of whites have remained unchanged, little progress has been made in closing the gap in proficiency levels between white and minority students. (See figure 1-11 and appendix table 1-10.)

At age 17, more black and white students could work with fractions and decimals (Level 300) in 1990 than in 1977, yet the percentage of both who could solve algebra and geometry problems (Level 350) remained essentially the same. Hispanic students experienced no significant shifts. (See appendix table 1-11.)

As with the overall population of students at age 17, mean science achievement scores of white, black, and Hispanic students decreased significantly: nearly 20 points for both white and black students between

1970 and 1982, and 13 points for Hispanic students between 1970 and 1982. Scores climbed steadily after 1982. (See appendix table 1-12.) Between 1982 and 1990, the scores of black and Hispanic students showed the largest increases (18 and 13 points, respectively), reaching their 1970 levels; the scores of white students gained somewhat (8 points) but remained below their 1970 levels. (See figure 1-12.) A pronounced shift occurred in the percentage of black students who could apply and interpret general scientific information (Level 250) and in the percentage who could analyze scientific procedures and data (Level 300). (See appendix table 1-13.) However, the percentage of black students possessing the scientific knowledge to integrate scientific information and draw conclusions (Level 350) remained very small and unchanged. White and Hispanic 17-year-olds experienced no shifts to higher levels of achievement.

The amount of student progress made in mathematics and science between grades was determined by analyzing the performance of the cohort of students who were 9 years old in 1986 and 13 years old in 1990. The cohort analysis of score changes for these students shows that minority students achieved the same gains as white students in both mathematics and science as the cohort aged from 9 to 13. (See text table 1-2.) The analysis also shows that students at the lowest 10 percent of proficiency made the greatest gains. These gains may have narrowed the gap between white and black 9- and 13-year-old students and between white and Hispanic 13-year-olds.

Text table 1-2
Increases in average mathematics and science proficiency scores of students who were age 9 in 1986 and age 13 in 1990, by race and ethnicity

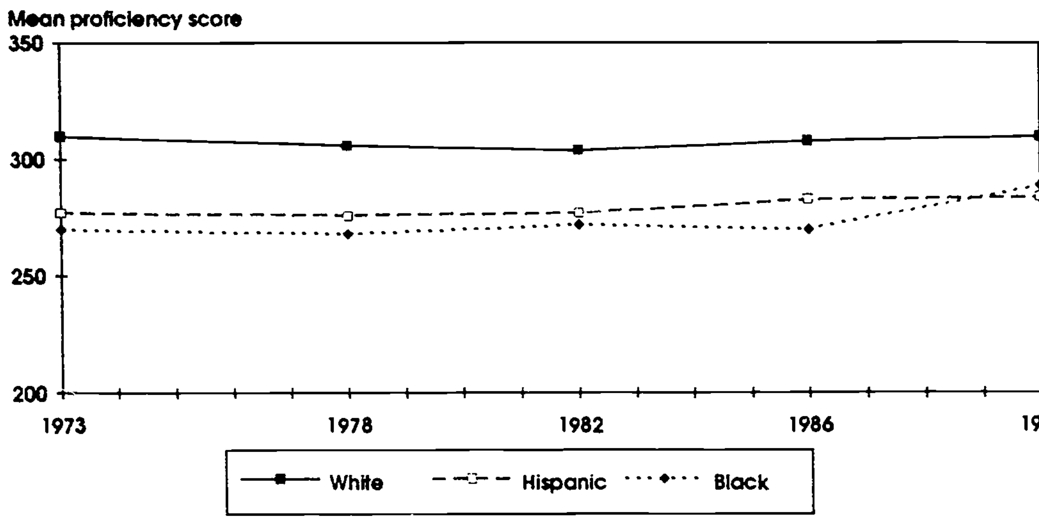
Subject and race and ethnicity	10th percentile	50th percentile	90th percentile
Mathematics			
White	55	49	46
Black	54	46	44
Hispanic	52	49	47
Science			
White	39	32	25
Black	35	30	23
Hispanic	37	31	28

See appendix table 1-14. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. *Trends in Academic Progress.* Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991).

However, for two decades the proficiency gap between white and minority students has remained approximately the same. (See appendix tables 1-10 and 1-12.) Following the same cohort to age 17 in 1994 could provide important information. Many low-achieving students, however, drop out of school by age 17 and thus do not participate in testing; so incomplete coverage of the cohort at age 17 prevents further analysis.

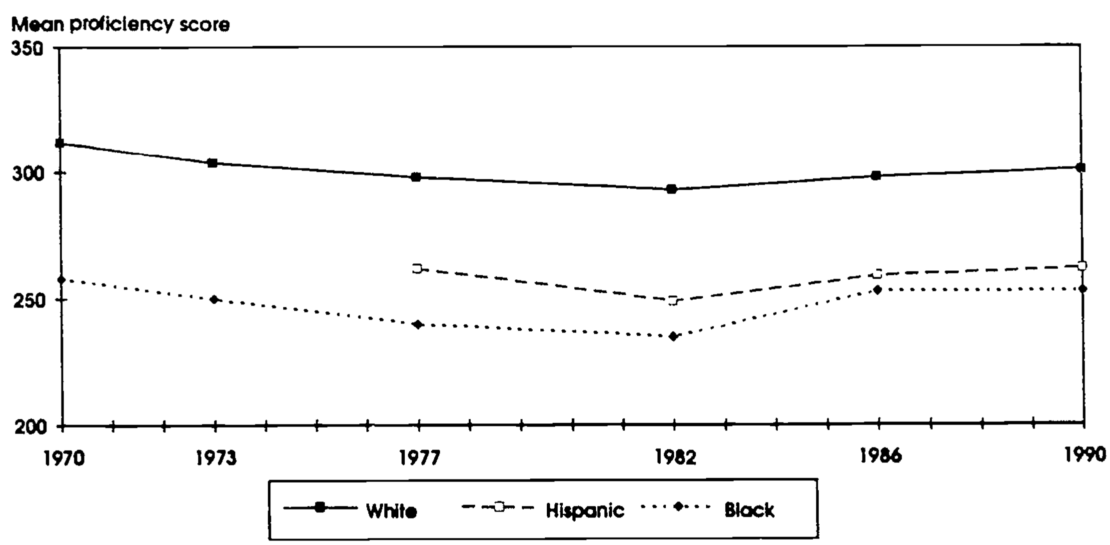
Figure 1-11
Average mathematics proficiency scores, by race and ethnicity, age 17: 1973 to 1990



See appendix table 1-10. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *Trends in Academic Progress*, Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991).

Figure 1-12
Average science proficiency scores, by race and ethnicity, age 17: 1970 to 1990



See appendix table 1-12. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *Trends in Academic Progress*, Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991).

International Mathematics and Science Achievement

During the past 30 years, several studies have measured mathematics and science achievement among students in various countries. These studies reveal that the United States faces a challenge as it attempts to reach first rank internationally in mathematics and science achievement. This section reexamines the existing international comparisons of student achievement for evidence of change in U.S. student achievement.

It must be noted that technical problems associated with international achievement data "make it difficult to know the degree to which sampling and non-sampling errors may bias the results reported" (Medrich and Griffith 1992). Even a very generous allowance for possible bias, however, does not justify ignoring the large gap in achievement that exists between the United States and the highest scoring countries. "The consistency of the results across studies and populations suggests that there is an important underlying theme of lagging U.S. performance" (Medrich and Griffith 1992).

The achievement gap seems to be less pronounced among younger students than older students. Younger U.S. students (9- and 10-year-olds) have consistently performed closer to the international mean in both mathematics and science than have students in higher grades—particularly those in their last year of secondary school. The achievement results for these oldest students may be influenced by sample selectivity or other factors;[3] however, these factors do not adequately explain why low achievement scores are apparent among U.S. students in the middle age range (13- and 14-year-olds).

This section highlights some major findings of the following international achievement surveys—

- The **First International Mathematics Study** (FIMS) of achievement among 13-year-olds and students in their last year of secondary school, conducted in 1963–64.
- The **First International Science Study** (FISS) of achievement among 10-year-olds, 14-year-olds, and students in their last year of secondary school, conducted in 1970–71.
- The **Second International Mathematics Study** (SIMS) of achievement among 13-year-olds and students in their last year of secondary school, conducted in 1980–82.
- The **Second International Science Study** (SISS) of achievement among 10-year-olds, 14-year-olds, and students in their last year of secondary school, conducted from 1983 to 1986.
- The **International Assessment of Educational Progress** (IAEP) in Mathematics and Science among 9- and 13-year-olds, conducted in 1991.

The first four of these studies—FIMS, FISS, SIMS, and SISS—were conducted by the International Association for the Evaluation of Educational Achievement (IEA), and the IAEP study was conducted by the Educational Testing Service (ETS).

Trends and Patterns in Achievement

The achievement results presented here indicate standards that students in each age-group can attain. Although it may be interesting to identify those countries that scored higher or lower than the United States on each test, efforts to officially "rank" countries are complicated and potentially misleading.

[3]Sample selectivity and other factors affecting the quality of international achievement data are described in the sidebar, "International Comparisons of Student Achievement in Science and Mathematics."

International Comparisons of Student Achievement in Science and Mathematics

International studies of student achievement provide benchmarks for achievement levels; they also provide insight into factors that may improve learning. International studies are designed to use differences in teaching practices and student activities to better clarify whether some school and home practices affect student learning.

Have the international studies been conducted adequately enough to allow them to be used to guide policy? Are country differences in educational practices too complex for statistical summary? Have sampling problems plagued each survey? And do international test scores provide "a narrow and highly questionable criterion" of student learning? (Rotberg 1991).

Sampling Quality. Comparisons of student achievement depend on the selection by each country of a representative sample of its students. The sample must include equal populations across participating countries, and the survey must have high response rates. Researchers and evaluators have discovered flaws in sampling procedures in some international studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). A panel selected by the National Academy of Sciences (NAS) found U.S. school participation levels unacceptably low in two studies conducted in the 1980s (Board on International Comparative Studies in Education (BICSE) 1990). Medrich and Griffith suggest that many IEA studies had "inconsistencies in sample design and sampling procedures, the nature of samples and their outcomes" (Medrich and Griffith 1992).

To improve the sampling procedures for new studies, in 1990 NAS issued standards for international participation (BICSE 1990). These standards were intended to guide researchers in developing samples that would reflect within-country student composition and ensure cross-country comparability. Studies carried out since that time have met these standards.

The U.S. portion of the first and second IEA mathematics and science studies did not achieve the high standards set by NAS. (U.S. sample sizes and response rates of schools and students in each international study are presented in tables 2 to 16 in the Technical Notes in Appendix B to this volume.) The U.S. studies followed proper sample design procedures, but they failed to gain the full participation of districts and schools. Analyses of the known sample results reveal that the U.S. sample was slightly biased toward higher achieving populations. Despite the problems associated with these studies, however, much can be learned about U.S. student academic standing that cannot be learned anywhere else (Bradburn et al. 1991).

Differences in Selectivity. National differences in student achievement may also reflect differing rates of student participation in educational systems. In the past, many countries (for example, Japan, England, and Sweden) applied standards more rigorous than those of the United States in admitting students to secondary schools. In these countries, therefore, relatively smaller segments of students participated in the testing, and these students probably represented the highest achieving individuals as well as those who were likely to have

This section, therefore, focuses on the following questions and issues:

- Do the scores of students in the United States compare favorably to the world-class standards that have been established by students in the highest achieving countries? How extensive are the differences?
- How have the scores of U.S. students changed over time?
- Given the accomplishments of their peers abroad, what can students in the United States reasonably be expected to achieve?

These questions are particularly relevant to meeting the America 2000 goal that U.S. students be first in the world in science and mathematics achievement.

Only six countries participated in all four studies—Japan, Sweden, the United States, England, Finland, and the Netherlands. (See the sidebar, "Countries Compared in This Analysis," which explains why these countries among all those surveyed were been taught advanced mathematics and science courses (Rotberg 1990). In contrast, countries with a more comprehensive school system (for example, the United States) included students from a wide range of ability groups in the testing. Relatively smaller proportions of these students would have been taught advanced courses.

The superiority of performance on international tests by some countries cannot be dismissed because of differences in student selectivity (Bradburn et al. 1991). Some test score differences are much too great to be easily explained by different populations. Still, the differences in selectivity must be considered in interpreting country scores to be sure that the participation rates are not greatly different. For example, at elementary school levels, international achievement comparisons of Western European countries, the United States, and Japan are not influenced by enrollment rates because more than 90 percent of elementary school-age children are enrolled in schools in most of those countries. (See tables 10 and 11 in Appendix B.) Secondary school enrollment rates are much more varied, and comparisons of achievement scores cannot be made without careful consideration of the populations covered. It may be useful to compare the achievement levels of advanced secondary school mathematics students among countries with different selection systems, but the results should not be used to represent mathematics achievement for all secondary students.

Subject Content Coverage. Achievement test items must be chosen to represent a fair selection of curriculum topics that cut across national instructional goals, objectives, and aspirations. Since the first studies were conducted, an analysis of country differences in school curriculum has accompanied the results of each test. Medrich and Griffith (1992) note that "even a cursory review of IEA national committee reports indicates that in each country, there are some categories of items tested that are not taught at all; some that are of low priority; and some that are entirely outside the instructional objectives for a particular age or grade group." In 1990, BICSE mandated that in designing achievement items, the curricula of all participating nations should be assessed to capture the core of learning objectives common to participating nations. At the same time, however, the question for U.S. educators becomes, "Should more of the topics covered in the curriculum of other countries be added to the U.S. curriculum?"

Cultural Differences. Differences in student aspirations for academic achievement among countries and the intensity with which each national culture pursues educational objectives may complicate the correct interpretation of score differences. For example, the effort that students apply to completing test items correctly may differ among countries. During visits to a few classrooms for quality control of the IAEP study in 1991, ETS observed and recorded differences in student and classroom behavior during test-taking. The observations were not systematic enough to judge differences in enthusiasm and how they could affect test results.

selected for discussion.) Comparing the performance of 13- and 14-year-old students in the United States to that of students in this subset of countries reveals that, in three of the four IEA tests (FISS is the exception), the United States averaged a lower mean score than most of the other five countries. (See appendix table 1-18.) Japanese students, who have consistently earned the highest scores worldwide in both mathematics and science over the years, outperformed U.S. students by approximately 10 percentage points in both science tests and by nearly 20 points in both mathematics tests.

The First and Second IEA Mathematics Studies

The gap between the performance of 13-year-olds in the highest achieving country and that of their peers in the United States remained relatively constant between FIMS and SIMS. Japanese students scored an average of 20 percentage points higher than the U.S. students in 1964 and 17 percentage points higher in 1982. (See figures 1-13a and 1-13b, and appendix table 1-18.) In both studies, U.S. students consistently lagged behind most of their peers in the eight industrialized nations included in the sample.

The mean percent of test items answered correctly by students in all countries was much lower in the earlier studies than in the later ones because the first studies, FISS and FIMS, included many more difficult items. The difference in test items prohibits a direct comparison of performance. For example, U.S. students answered 26 percent of the FIMS items and 45 percent of the SIMS items correctly. Although the content of each achievement test was altered, the average percent of items answered correctly by students in the highest achieving countries still provides a useful rank order of countries by student achievement.

Many difficulties are associated with examining changes in student achievement during the nearly 20-year period between FIMS and SIMS. Important, even sweeping, changes "in both the context and content of schooling" occurred in many of the participating countries during the interim period. These changes also make comparisons difficult, not only among countries but also within a country over time as its educational system changed (Robitaille and Taylor 1989).

For example, between 1964 and 1982, many countries changed their highly selective educational systems into ones in which increasing numbers of students were encouraged to remain in school for longer periods of time. Thus, the number of students in school as a percentage of their age cohort varied between the first and second studies both among and within countries (Robitaille and Taylor 1989). These changes in student participation rates and sample selection particularly affect information on the senior level (the last year of secondary school), complicating the interpretation of changes in test results.

Countries Compared in This Analysis

Many countries participated in the five international surveys discussed earlier; however, the countries analyzed in this chapter are—

- **FIMS**: Japan, Belgium, Finland, England. Scotland, the Netherlands, France, the United States, and Sweden.
- **SIMS**: Japan, Belgium, Finland, England/Wales, Scotland, the Netherlands, France, the United States, and Sweden. However, the Netherlands and France did not participate in the study of students in their last year of secondary school.
- **FISS**: Japan, Finland, England, the Netherlands, the United States, Sweden, Hungary, and Italy.
- **SISS**: Japan, Finland, England, the United States, Sweden, Hungary, and Italy. Australia, Norway, and Israel did not participate in FISS, but these countries were included in the SISS analysis; the Netherlands participated at the 14-year-old level only, to allow for comparison with FISS.
- **IAEP**: Canada, Hungary, Ireland, Israel, Slovenia, South Korea, Spain, Taiwan, and the United States. France, Jordan, and Scotland were also included in the study of 13-year-olds, but these countries did not participate in the study of 9-year-olds.

The selection of countries for analysis was guided by efforts to (1) control for methodological limitations of the samples in some countries, (2) keep the list of countries consistent between earlier and later studies of achievement in the same subject area, and (3) maintain a degree of parity among selected countries in terms of their international economic status. Specific factors guiding country selection are described in the next section.

Sampling. Important differences existed among the students tested in each country. For example, the countries varied in the percentage of the age-group that was still in school, the percentage of children included in the sampling frame, and the overall response rates. (See appendix tables 1-22, 1-32, and 1-33.)

The First and Second IEA Science Studies

In the 1970 science study, 14-year-old U.S. students performed on a par with most of their peers, placing below students in Japan and Hungary but about the same as students in five other countries selected for comparison. In the second science study, the U.S. performance appeared lower than that of most other countries. (See appendix table 1-18.) To allow for a more meaningful comparison, Keeves (1992) scaled the test scores in both studies to an international science achievement test scale. This scale reveals that the United States registered a loss of 25 scale score points between the two testing periods. Whereas each of the other countries experienced an increase in achievement between the two testing periods, achievement among students in the United States declined.

The extent of this decline became even more striking with further analysis. Keeves (1992) explains that some of the apparent score differences between FISS and SISS "were a consequence of changes between occasions in the design of samples from the defined target populations." Other inconsistencies included differences in the average ages and grade levels tested during each study. As a result, each country's score was adjusted to account for these changes. Although this adjustment reduced the size of the gains recorded in some countries, it did not change the overall pattern of results. Each of the other seven countries in the sample experienced achievement gains of between 5 and 42 scale points after these adjustments were made, whereas the United States showed a further decline of 47 scale points. (See appendix table 1-19.)

Furthermore, some of the countries sampled students only in certain language groups, certain cities, or certain regions instead of in the country as a whole. Because it is difficult to determine how and how much such factors influence achievement, all countries that differed notably from the United States in their sample definitions and selections were excluded from comparative analysis. Although several of the selected countries—including the United States—experienced problems (for example, low or unreported response rates) that give rise to questions about the representativeness of their samples, their relative similarity in this regard allows meaningful analysis of comparative student achievement. IAEP countries excluded because of incomplete national coverage were Italy, (the former) Soviet Union, and Switzerland, plus the areas of Fortaleza and Sao Paulo.

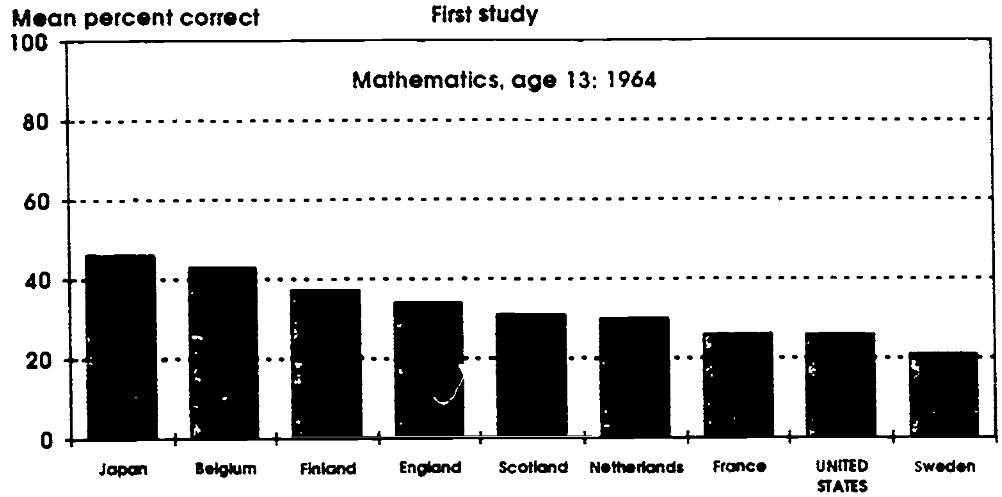
Participation. To allow comparisons between the earlier and later IEA studies, only those countries that participated in both FIMS and SIMS or in both FISS and SISS were included in the analyses. In those instances, however, where a detailed comparative analysis of countries in a single study (for example, SISS) was completed, other countries that satisfied the sampling and economic criteria were added to the list to show a more complete picture of the U.S. standing relative to a larger selection of countries. IAEP countries excluded because of low response rates were China, England, Mozambique, and Portugal.

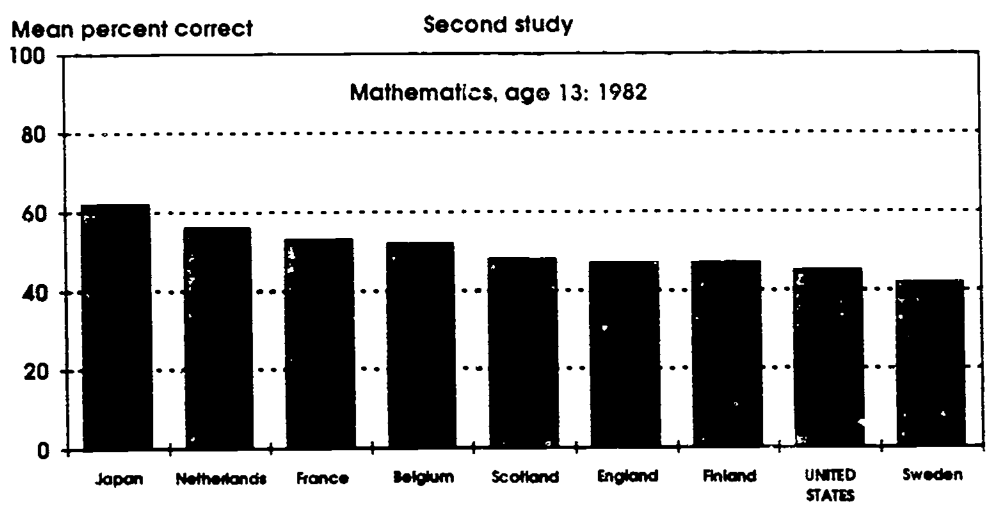
IAEP analysis was limited to statistics from a single year; however, countries included here varied by the age-group being studied. Thus, for example, France, Jordan, and Scotland were included in the analysis of achievement among 13-year-olds but not among 9-year-olds.

Economic Status. Academic achievement is strongly and positively correlated with a nation's level of wealth and economic development. To eliminate some of the bias that very wide disparities in resources and wealth may introduce, only those countries whose gross national product per capita exceeded $1,636 in 1984–85 (which placed them in the top two of four economic groups created by the World Bank for international economic classification) were selected (see Postlethwaite and Wiley 1992). The poorest countries that participated in some of these studies were excluded from this analysis.

Figure 1-13a

Order of selected countries ranked by mean percent of mathematics test items correct for the First and Second IEA International Studies





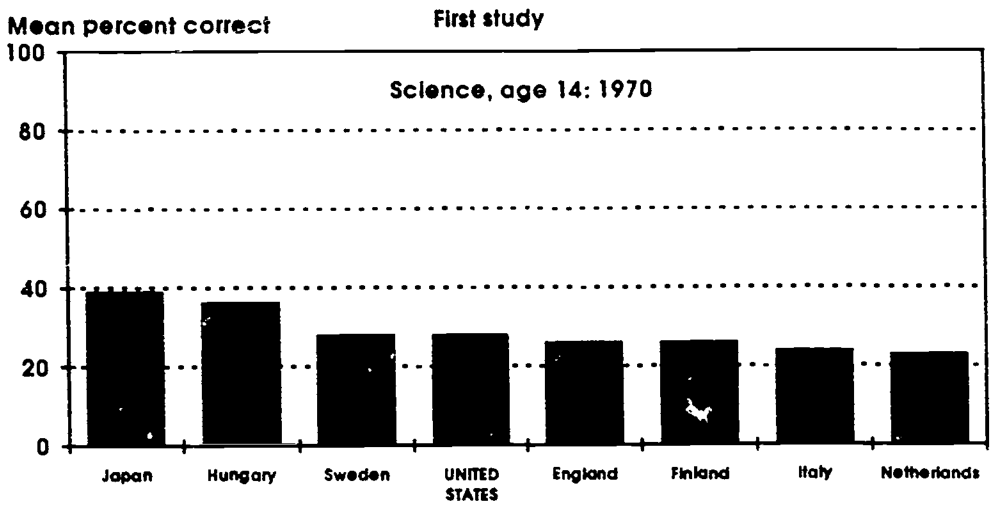
NOTE: The values for the second mathematics study are much higher than for the first study because a different set of items was used. The items in the second study were easier for students in all countries. Only large differences, of 4 percentage points or more, between countries are statistically significant; thus, the exact rank orders of countries with similar results are not detectable.

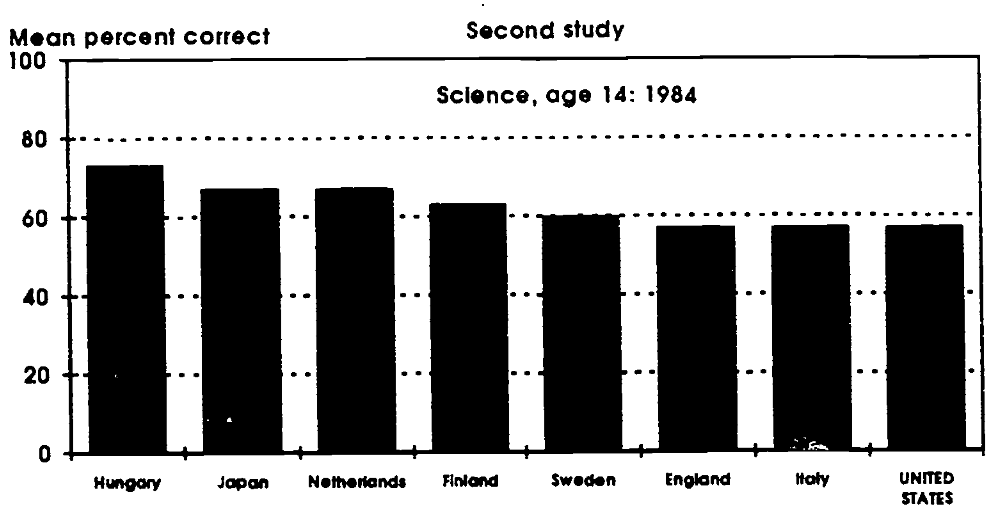
See appendix table 1-18. NSF Education Indicators—1992

SOURCES: National Center for Education Statistics, Digest of Education Statistics (Washington, DC: U.S. Department of Education, 1989); E.A. Medrich and J.E. Griffith, *International Science and Mathematics Assessments: What Have We Learned?* NCES 92-011 (Washington, DC: U.S. Department of Education, 1992).

Figure 1-13b

Order of selected countries ranked by mean percent of science test items correct for the First and Second IEA International Studies





NOTE: The values for the second science study are much higher than for the first study because a different set of items was used. The items in the second study were easier for students in all countries. Only large differences, of 4 percentage points or more, between countries are statistically significant: thus, the exact rank orders of countries with similar results are not detectable.

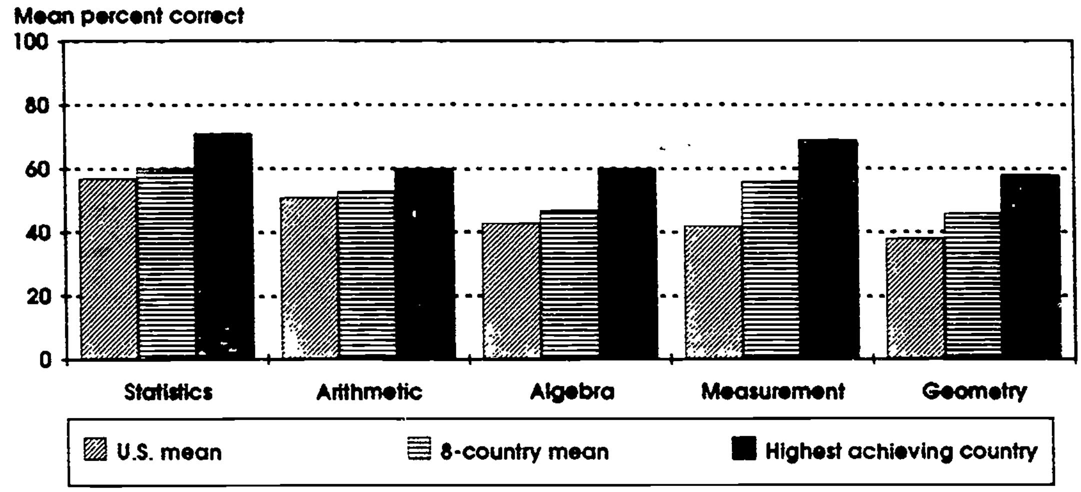
See appendix table 1-18.

NSF Education Indicators—1992

SOURCES: National Center for Education Statistics, Digest of Education Statistics (Washington. DC: U.S. Department of Education, 1989); E.A. Medrich and J.E. Griffith, *International Science and Mathematics Assessments: What Have We Learned?* NCES 92-011 (Washington, DC: U.S. Department of Education, 1992).

Figure 1-14

Mean percent of items correct in mathematics, by topic, grade 8: 1982



See appendix table 1-20.

NSF Education Indicators—1992

SOURCE: C.C. McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, IL: Stipes Publishing Company, 1987).

Results of the Second IEA Mathematics Study

Eighth-Grade Students

The Second IEA Mathematics Study measured the achievement levels of 13-year-old (U.S. eighth-grade) students in five areas: statistics, arithmetic, algebra, measurement, and geometry. The U.S. average performance in each of these areas was lower than the combined average for the eight other countries in the sample (the mean differences were less than 5 percentage points for statistics, arithmetic, and algebra). (See figure 1-14.) In addition, differences between the mean scores of the highest achieving country and the United States were large: they ranged from a high of 27 percentage points in measurement to a low of 9 percentage points in arithmetic. (See appendix table 1-20.)

A possible explanation of differences in achievement scores lies in students' opportunity to learn (OTL). Because international differences in achievement results may be affected in part by the correspondence between the international test material and national curricula, the international standards require teachers to provide information on student exposure to the material covered in the achievement test, either before or during the school year. In general, countries with the highest achievement had more coverage of the subject matter (except for statistics); however, a lack of consistent relationship existed between OTL ratings and performance among countries achieving in the middle and low ranges. (See appendix table 1-21.) Some measurement difficulties associated with teacher-reported OTL ratings may partly explain the lack of relationship: (1) teachers may not exactly know the past learning experiences of their students, (2) teachers may have different understandings of test items or employ different schemes in judging their meanings, and (3) teachers may not maintain the same level of concentration and attention in rating OTL for up to 100 or more test items.

Students in the Last Year of Secondary School

At the twelfth-grade level, SIMS tested students on six subtopics—sets and relations, algebra, number systems, probability and statistics, geometry, and elementary functions and calculus. In each of these subtopics, U.S. students scored below the international mean. (See appendix table 1-20.) U.S. twelfth-grade students lagged behind their peers most noticeably in calculus, algebra, and probability and statistics. In contrast, U.S. eighth-grade students performed fairly well (relative to their peers) in both algebra and statistics.

Samples for the seven countries discussed here differed on several points. (The Netherlands and France did not participate at this grade level.) The percentage of the age-group that was still in school at the twelfth-grade level varied from a low of 17 percent in England/Wales to a high of 92 percent in Japan. In the United States, 82 percent of the age-group was still in school by the final year. (See appendix table 1-22.) In fact, only in Japan and the United States did this figure exceed 65 percent. Japan and the United States were also the only two countries in which fewer than 25 percent of students in the last year of school studied mathematics. The figure for Japan was 13 percent; in the United States, it was 15 percent.

Part of the explanation for the relatively low performance by U.S. students at this level may include the low OTL percentages in several subtopics, reflecting past exposure to the test items. (See appendix table 1-23.) For example, the United States had the lowest OTL percentages of all six countries in probability and statistics, calculus, and geometry. In algebra, only England/Wales had a lower OTL percentage than the United States. Only in number systems do the test scores not follow OTL ratings.

Results of the Second IEA Science Study

The relative levels of science achievement of U.S. students compared with those of students in the highest achieving countries were lower for each older age-group tested. Although U.S. 10-year-old students achieved in the middle range, 14-year-old students and final-year secondary students scored near or at the bottom of their respective groups. (See appendix tables 1-24 and 1-25.)

The results reflected student achievement on only the limited number of test items taken by the U.S. students. Postlethwaite and Wiley (1992) note that:

> "Since the United States made a special selection of items from the tests, it is assumed that those responsible selected the items which were thought to be most relevant to the United States. If this were so, then the United States should have an advantage over other countries on both item scores and total scores. However, the restricted number of items does mean that the content coverage is not as large as would be desired."

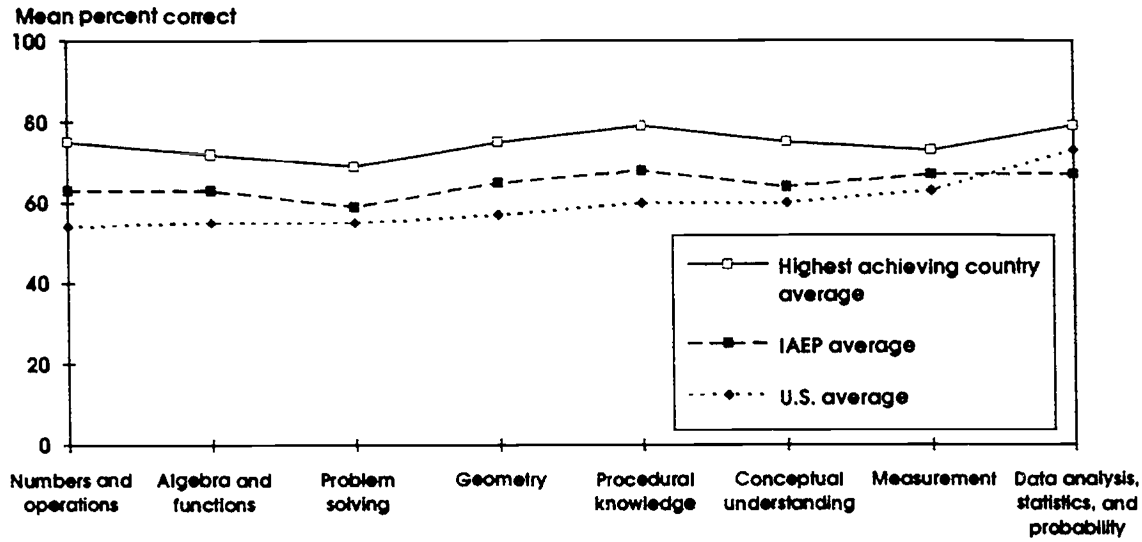
Results of the IAEP

The 1991 IAEP study examined the achievement of 9- and 13-year-old students in a different set of countries from those included in the IEA studies. (See the sidebar, "Countries Compared in This Analysis," for an explanation of which countries among all those surveyed were selected for discussion.) In addition, several of the countries that participated in the IAEP study of 13-year-olds did not participate in the study of 9-year-olds. Thus, although 12 countries (including the United States) are discussed here for the 13-year-old age group, only 9 countries were selected for analysis of the younger age group. The following paragraphs correspondingly refer to U.S. performance vis-à-vis an 11-country international mean for 13-year-olds and an 8-country international mean for 9-year-olds.

Mathematics

In the IAEP study of mathematics achievement, student performance was measured in five topics (geometry, numbers and operations, data analysis/statistics/probability, algebra and functions, and measurement) and three cognitive process areas (conceptual understanding, procedural knowledge, and problem solving). Nine-year-olds in the United States scored above the eight-country international

Figure 1-15
Mean percent of IAEP items correct in mathematics, by topic and process area, age 9: 1991

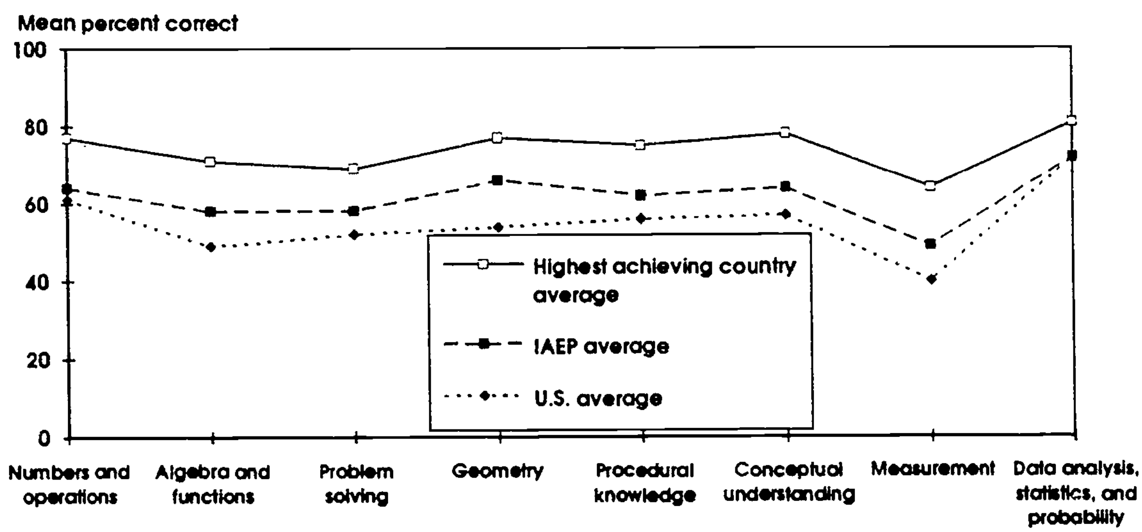


See appendix table 1-28.

NSF Education Indicators—1992

SOURCE: A.E. Lapointe, N.A. Mead, and J.M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992).

Figure 1-16
Mean percent of IAEP items correct in mathematics, by topic and process area, age 13: 1991

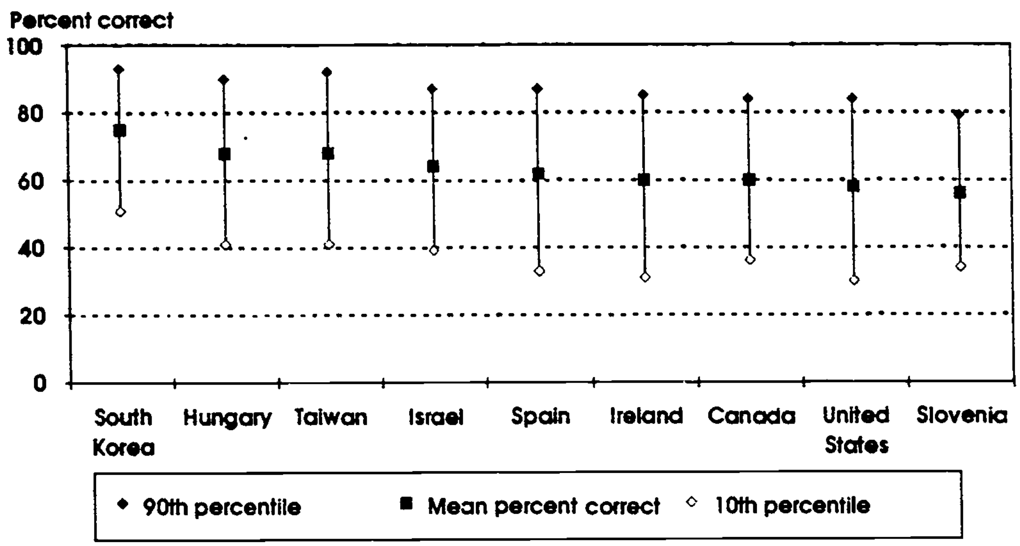


See appendix table 1-28.

NSF Education Indicators—1992

SOURCE: A.E. Lapointe, N.A. Mead, and J.M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992).

Figure 1-17
Percent of IAEP mathematics items correct, by country, age 9: 1991



See appendix table 1-29.

NSF Education Indicators—1992

SOURCE: A.E. Lapointe, N.A. Mead, and J.M. Askew, *Learning Mathematics*. IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992).

mean in only one area: data analysis/statistics/ probability. (See figure 1-15 and appendix table 1-28.)

Thirteen-year-old students in the United States performed no better, again scoring below the international mean in all areas except data analysis/statistics/ probability. (See figure 1-16 and appendix table 1-28.) The mean for the highest achieving country in each topic exceeded the U.S. mean.

In addition to comparing mean scores among countries, it is worth examining the cross-national differences among students at different achievement levels relative to peers in other countries. For example, although the difference between the average mathematics score for all 9-year-old South Korean students and all their U.S. peers was 17 percentage points, the difference narrowed to 9 percentage points for the top 10 percent of students in each country. (See figure 1-17 and appendix table 1-29.) However, this shrinking difference may be a test artifact because IAEP mathematics tests were not adequate to measure the level of achievement for students scoring at the highest end in each country. A 21-percentage-point difference existed between the bottom 10 percent of students in South Korea and in the United States.

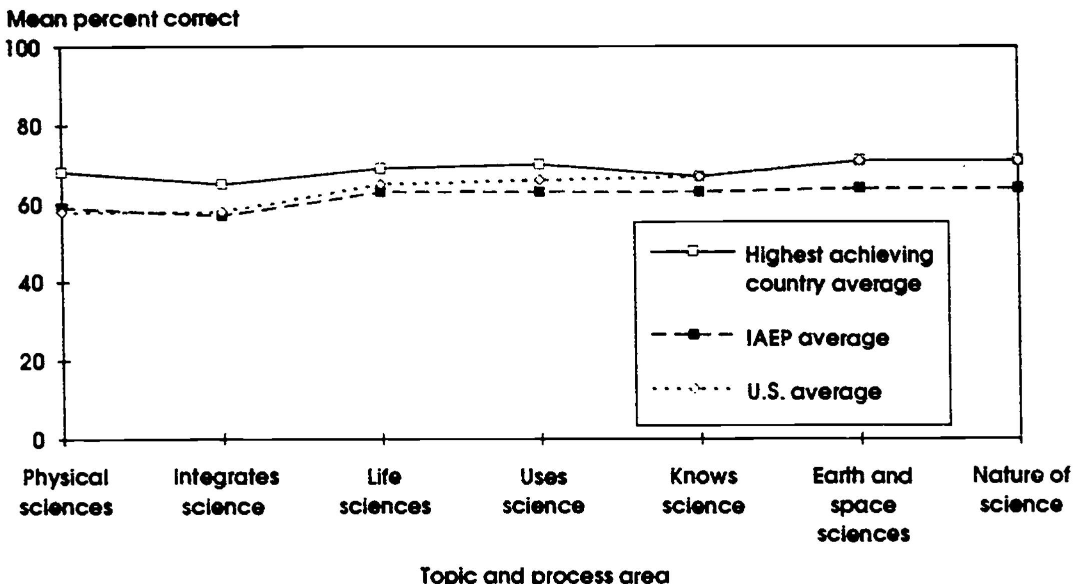
Science

The 1991 IAEP study tested the achievement levels of 9- and 13-year-old students in four topics (life sciences, physical sciences, earth and space sciences, and nature of science) and three cognitive process areas:

- Knows: knowledge of science facts, concepts, and principles.
- Uses: use of knowledge to solve problems.
- Integrates: ability to integrate knowledge to solve more complex problems.

Nine-year-olds in the United States performed about the same as their peers in the eight other countries selected for comparative analysis. Their total average score of 65 percent correct ranked them

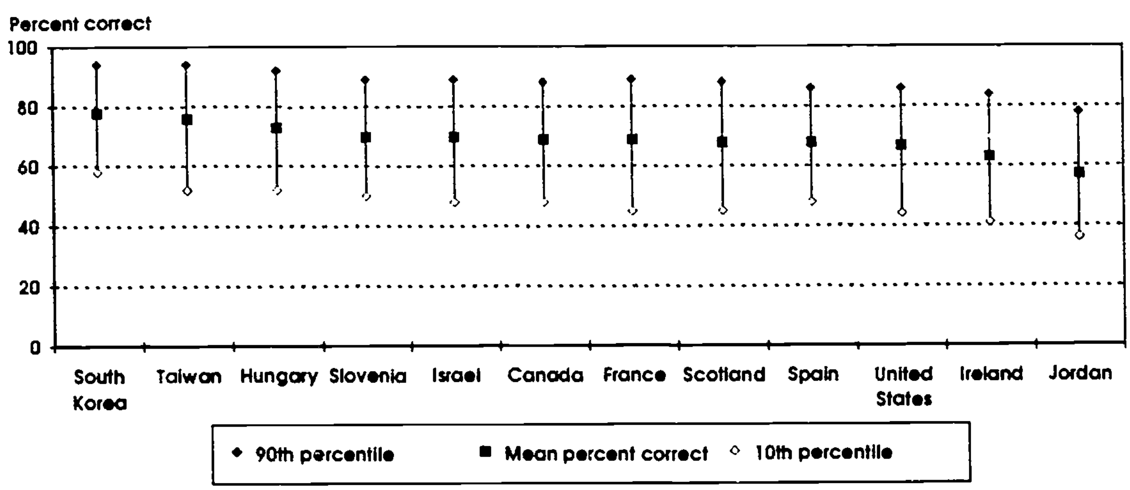
Figure 1-18
Mean percent of IAEP items correct in science, by topic and process area, age 9: 1991



See appendix table 1-30. NSF Education Indicators—1992

SOURCE: A.E. Lapointe, J.M. Askew, and N.A. Mead. *Learning Science.* IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992).

Figure 1-19
Percent of IAEP science items correct, by country, age 13: 1991



See appendix table 1-31. NSF Education Indicators—1992

SOURCE: A.E. Lapointe, J.M. Askew, and N.A. Mead. *Learning Science.* IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992).

59

near the highest achieving students in South Korea and Taiwan, who scored 68 and 67 percent correct, respectively. (See appendix table 1-27.) The United States achieved the highest score in three areas (earth and space sciences; the nature of science; and knowledge of facts, concepts, and principles) and surpassed the international average in all areas except the physical sciences. (See figure 1-18 and appendix table 1-30.)

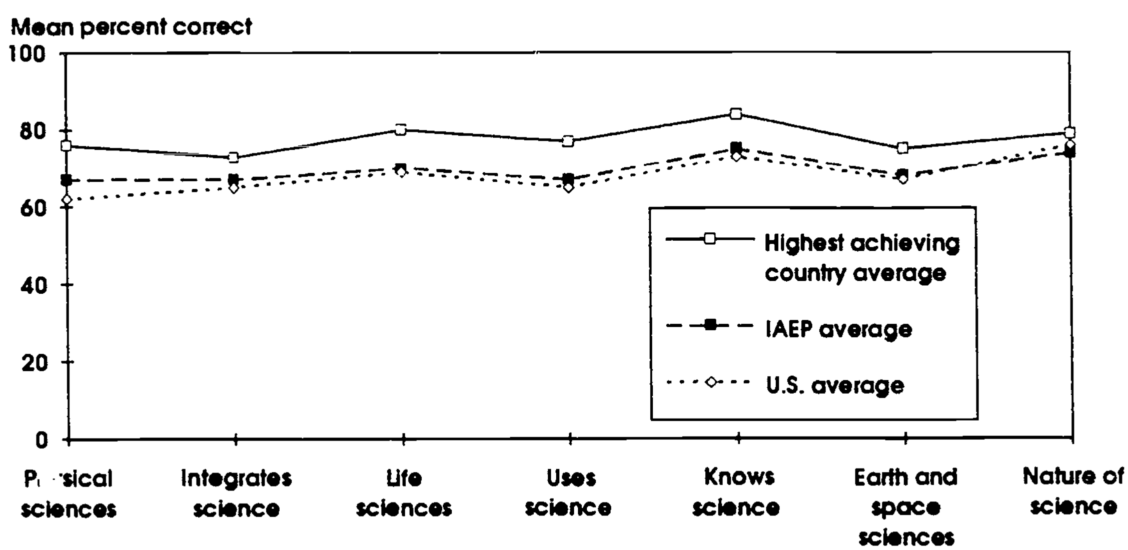
Among the highest achieving students at age 9, those in the United States may have performed on a par with the highest achievers in the highest scoring countries. (See appendix table 1-31.) The top 10 percent of students in the United States, South Korea, and Taiwan scored the same. However, IAEP science tests may not have been difficult enough to measure achievement levels of the best students. Among the lowest achieving students, however, the U.S. average ranked below the averages of South Korea and Taiwan.

The achievement scores of U.S. 13-year-olds exceeded the 11-country international average in one area—nature of science. However, they scored below the international average in each of the other six areas. (See appendix table 1-30.)

Thirteen-year-olds in the United States scored well below students of the same age-group from the country receiving the highest score in each area. (See figure 1-19 and appendix table 1-30.) In four areas (knowledge of science facts, concepts, and principles; life sciences; use of knowledge to solve problems; and physical sciences), this difference was greater than 10 percentage points. Furthermore, in the three areas in which the United States was first among 9-year-olds (knowledge of science facts, concepts, and principles; earth and space sciences; and nature of science), the 13-year-olds performed 11, 8, and 3 percentage points, respectively, below the 13-year-olds of the highest scoring country in each area. (See figure 1-20 and appendix table 1-30.)

The 13-year-olds of nine countries had higher total average scores in science than U.S. 13-year-olds, and the top 10 percent of 13-year-olds in the United States scored below the top students in eight of these

Figure 1-20
Mean percent of IAEP items correct in science, by topic and process area, age 13: 1991



See appendix table 1-30. NSF Education Indicators—1992

SOURCE: A.E. Lapointe, J.M. Askew, and N.A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992).

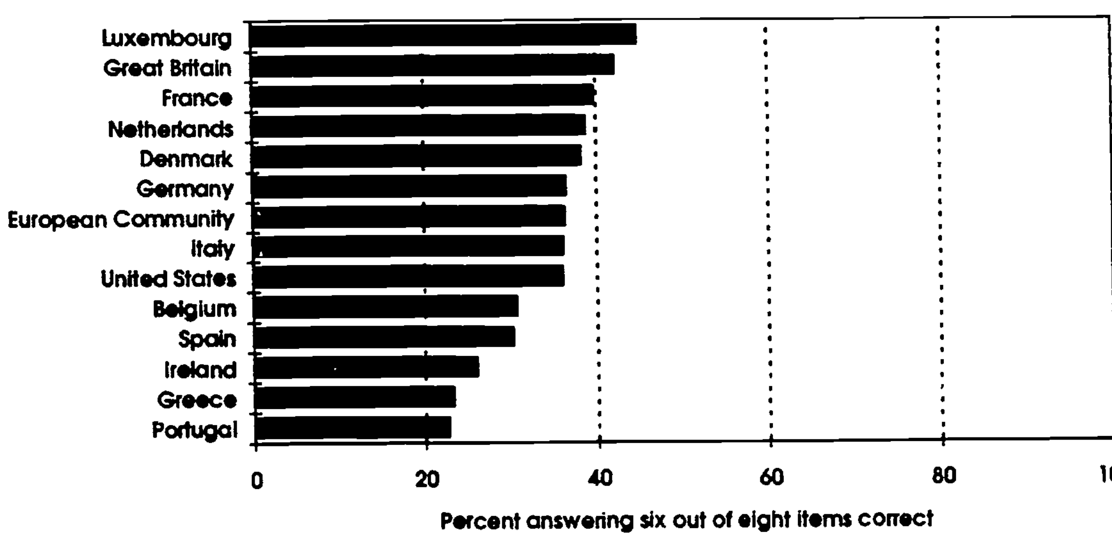
countries. (See figure 1-19 and appendix table 1-31.) The lowest achieving students in the United States performed in the middle range relative to low achievers in the other countries.

International Comparisons of Adult Understanding of Scientific Terms and Concepts

How do American adults compare with adults in other industrial nations in international studies of their understanding of scientific terms and concepts? From 1989 to 1990, a series of national surveys were conducted in the European Community and the United States to examine adult understanding of science and technology, as well as related attitudes. A set of eight identical knowledge items were used in the 13 countries. The items were selected to represent the basic scientific terms and concepts needed by a citizen to read newspaper or magazine reports on current issues or controversies involving science or technology. (See sidebar on test items.) These items reflected the vocabulary dimension of Miller's three-dimensional measure of civic scientific literacy (Miller 1983, 1987, 1991).

Judging by the percent of adults in each country who answered six or more of the eight items correctly, about 40 percent of the adult population of France, the Netherlands, Denmark, and Great Britain possessed a vocabulary of scientific terms and concepts sufficient for them to listen to and comprehend moderately sophisticated public policy debates on issues involving science and technology. (See figure 1-21 and appendix table 1-34.) Slightly more than one-third of adults in West Germany (in 1989, before German unification), Italy, and the United States displayed the same level of vocabulary skill. Approximately 30 percent of adults in Belgium and Spain met this

Figure 1-21
U.S. and European adult knowledge of scientific terms and concepts: 1990



NOTE: Adults were defined as 18 years old or older in the United States and 15 years old or older in Europe.
For eight items asked, see appendix table 1-34.

NSF Education Indicators—1992

SOURCES: J.D. Miller. *Public Attitudes Toward Science and Technology, 1979–1990. Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991) and unpublished tabulations; Commission of the European Communities, unpublished tabulations.

The Measurement of the Public Understanding of Basic Scientific Terms and Concepts

For the purpose of this comparison, eight questions that were used in the same forms in a 1989 survey of the European Community and a 1990 survey of the United States (Miller 1991) have been selected. In other analyses, these eight questions have been used as a part of the vocabulary dimension of the three-dimensional measure of civic scientific literacy, a concept first introduced by Shen (1975) and operationalized by Miller (1983, 1987, 1991).

For reasons of simplicity and clarity, only the vocabulary dimension will be discussed here. The eight questions used to measure this dimension were—

(1) The oxygen we breathe comes from plants. (True)

(2) Electrons are smaller than atoms. (True)

(3) The continents on which we live have been moving for millions of years and will continue to move in the future. (True)

(4) Human beings, as we know them today, developed from earlier species of animals. (True)

(5) Lasers are made up of focused sound waves. (False)

(6) The earliest human beings lived at the same time as the dinosaurs. (False)

(7) Which is faster: light or sound? (Light)

(8) Does the Earth go around the Sun, or does the Sun go around the Earth? And, for those who responded that the Earth goes around the Sun: Does the Earth go around the Sun once a day, once a month, or once a year? (Year)

Although these eight items are not exhaustive of the kinds of information and knowledge that a citizen would need to make sense of conflicting arguments in a contemporary dispute involving science or technology, they represent domains of knowledge that would be basic to understanding various scientific arguments. For example, a citizen who does not understand the composition of a laser or the relative speed of light and sound might have had some difficulty following the debate of recent years about the proposed Strategic Defense Initiative. Similarly, an individual who does not understand the source of oxygen might have some difficulty understanding concerns about the cutting and burning of rain forests.

In the U.S. studies, a wider range of items, including some open-ended questions, has been used to assess public understanding of scientific vocabulary. These eight items are the only questions available for comparison among the 13 countries in this analysis. Although comparisons with a wider array of questions representing more domains of knowledge would be preferable, this short index is a useful point of comparison. It is hoped that the analyses performed with this short index will stimulate increased interest in studying the retained scientific knowledge of adult populations and will lead to a larger core of common questions among participating nations.

standard, and fewer than 30 percent qualified in Ireland, Greece, and Portugal.

When the 12 member states of the European Community were considered as a single unit, the percent of adults able to answer at least six of the eight questions correctly virtually matched that in the United States. These data provide another opportunity to compare the outcomes of the formal educational systems of the 13 countries included in this analysis. When the level of scientific and technical vocabulary knowledge among the 13 countries is compared, it is possible to assess the levels of achievement among those citizens who attended secondary or high school within the last 20 years.

An examination of the age results of all the countries reveals an important pattern. In every country except the United States and Great Britain, the proportion of respondents able to answer six or more of the eight questions correctly was highest among the youngest age-group. Nearly one-half of the younger cohort of citizens in Italy, the Netherlands, West Germany, France, and Denmark answered six or more of the questions correctly, suggesting relatively stronger science education programs in those countries.

Although the surveys were smaller and more focused than the in-school science achievement tests discussed previously, the results from these adult surveys reflect national probability samples of all residents of each country aged 15 or 18 or older.

This kind of comparison of the retained knowledge of the adult population depicts the general state of the science vocabulary of each nation's adult workforce. Viewed in this perspective, these results confirm the previous cross-national findings of a decline in the relative competitive position of U.S. school-leavers and graduates in science knowledge in recent decades.

Chapter Summary

This chapter examined achievement in mathematics and science for elementary and secondary school students. It presented information on the 1990 NAEP and changes over time in national and international student achievement. The 1990 findings revealed that more U.S. students were becoming proficient only in basic mathematical and scientific skills. In mathematics, about one-half of U.S. twelfth-grade students learned skills typically introduced by the seventh grade, while only 5 percent reached the higher level of problem solving and reasoning skills. Similarly, in science, about one-half of twelfth-grade students were proficient in analyzing scientific procedures and data, but only 10 percent acquired advanced scientific skills.

The chapter presented differences in the 1990 achievement levels for student gender, racial and ethnic group, geographic region, and community type. In mathematics, the gender gap did not exist in the lower grades, but a slight difference began to appear in the twelfth grade. In science, the gender gap was observable in lower grades but more visible in the twelfth grade. Without adjusting achievement scores for differences in student socioeconomic background, Asian and white students outperformed other minority students in mathematics and science. No differences existed among students in the Northeast, Central, and West regions in mathematics and science. However, students in the Southeast region scored lower than those in all other regions. Students in large cities—except for those living in poor urban areas—scored higher in mathematics and science than did students in smaller cities or rural areas. Those living in poor urban areas scored the lowest of all community types.

Mathematics and science achievement for U.S. students fluctuated between 1973 and 1990—with declines during the 1970s and gains during the 1980s. Noticeable improvement occurred for different ages, genders, and racial and ethnic minority groups during the 1980s. The largest increase was recorded among 17-year-old African American students in both mathematics and science, far exceeding the level reached in the 1970s. Achievement scores of 17-year-old Hispanic students also improved over the level of the 1970s. In mathematics, male and female students returned to the level of the early 1970s;

but in science, males did not regain the earlier, higher level.

International comparisons of elementary and secondary student achievement in mathematics and science show that U.S. students performed lower than students in most of the countries with similar economic development. This low ranking in achievement has persisted during the past 25 years. According to the most recent international study, IAEP 1991, the mean scores of U.S. 9- and 13-year-old students were below the international mean in seven out of eight mathematics topics and process areas. Of seven science topics and process areas, U.S. 9-year-old students scored above the international mean in six areas, but 13-year-old students scored lower than the international mean in all but one.

Despite the relatively poor performance of U.S. students, U.S. adults appeared to have approximately the same level of scientific knowledge and understanding as adults in the European Community. Differences were observed for age-groups within the United States. The under-35 age-group did not represent the highest scoring group. In contrast, the under-35 age-group accounted for the highest proportion of scientifically knowledgeable adults in all the European nations (except Great Britain). These results seem to reflect the relative standings of U.S. and European students as observed in the international student achievement tests.

Monitoring the progress of U.S. student achievement in mathematics and science will continue as the results of the 1992 national assessment become available. The upcoming international study of mathematics and science, which will be conducted in 1995, will also provide new information on relative performance of U.S. students and enhance understanding of the background factors affecting international differences in academic performance.

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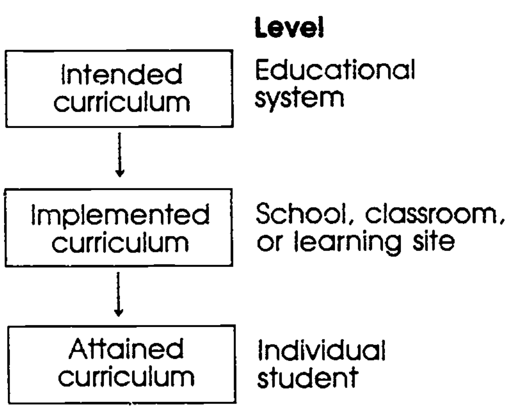
Chapter 2: Science and Mathematics Curricula

Overview: An Organizational Model of Curriculum

Curriculum is defined in a variety of ways. An excellent basis for organizing these definitions is the curriculum model of the IEA[1] Second International Mathematics Study (Travers and Westbury 1989). As used here, this model views curriculum as adopting a different form at each of three separate levels: (1) at the educational system level; (2) at the school, classroom, or learning site level; and (3) at the individual student level. The model proposes three corresponding types of curriculum. (See figure 2-1.)

- **Intended curriculum.** At this level, curriculum relates to the hopes or aspirations of the society served by the educational system. The intended curriculum comprises goals, traditions, standards, frameworks, and expectations—impulses from each involved community that help to shape the character of the curriculum, course outlines, official syllabi, and textbooks.

Figure 2-1
The three curricula



- **Implemented curriculum.** At this level, curriculum deals with the setting in which intentions become implemented or translated into reality through interactions with learners. Learning sites in schools (classrooms and resource centers) or in more informal settings (homes, museums, or zoos) are central to the educational process; it is in these sites, by and large, that children are introduced to the study of subjects. No statement of curricular intentions can by itself adequately describe education. Important questions arise about the coverage of subject matter content—the extent to which the intended curriculum is actually implemented at both formal and informal learning sites. For example, what topics are not discussed because they are perceived by educators to be of little importance? Which topics are seldom covered because of pressures of time? How do out-of-school opportunities that may stimulate student learning differ?

- **Attained curriculum.** At this level, curriculum relates to student attainment. After a given period of time, a student has developed a body of knowledge about and attitudes toward the subject and its use in the world. This knowledge represents the attained curriculum, which also includes learning that is not specifically included in the intended or implemented curriculum. For example, concepts may be learned through their use in other subject matter areas.

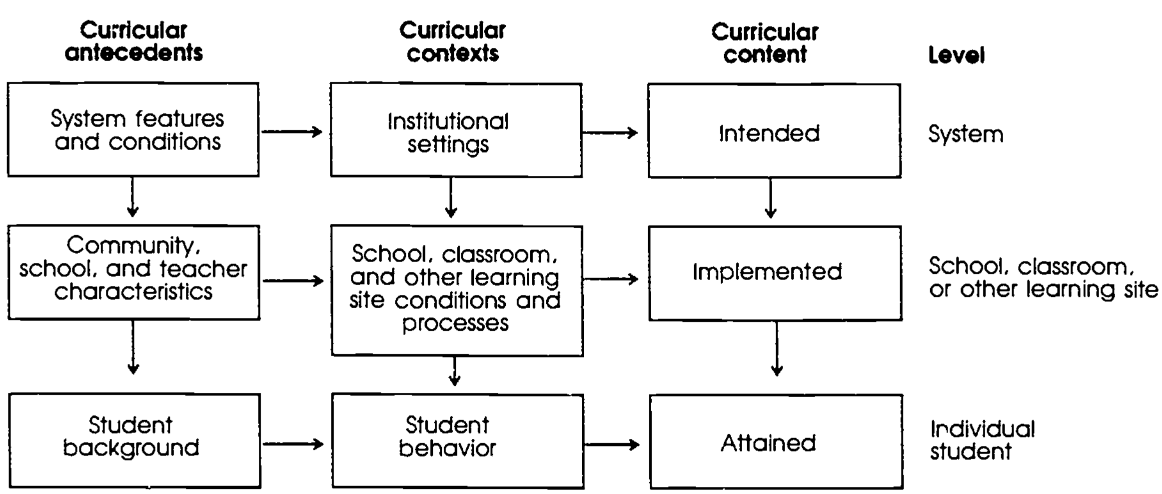
[1]International Association for the Evaluation of Educational Achievement.

These three levels of curricular content exist in a real-world framework, which includes antecedents and contextual variables. (See figure 2-2.) For example, at the system level, the wealth of a society is an antecedent that might affect the context of institutional settings and therefore affect the intended curriculum. Antecedent conditions of the community and home could also affect the learning environment and be expected to relate to what a student learns. The antecedent characteristics that students bring to class, including prior knowledge and attitudes toward a subject, relate to the context variable of student classroom behavior and, therefore, to the attained curriculum.

This chapter describes what has occurred in science and mathematics education in a variety of learning settings and how that is different for different groups. The chapter is organized in accordance with the three-part curriculum model and includes indicators on each aspect. The vision of curriculum implied by this model is quite broad. Consequently, this chapter presents information on a wide variety of indicators from many sources[2] in an attempt to expand understanding of the influences on students' knowledge and skills in science and mathematics wherever learning takes place.

A variety of goals, standards, frameworks, and expectations has been included to describe the **intended curriculum**. These curricular expectations have been compiled from various groups and collectively represent the desired outcomes of science and mathematics education. This chapter's examination of the **implemented curriculum** has been divided into two sections: the available or accessible curriculum components (courses offered or materials available) and the used or accessed curriculum components (courses taken or materials used). The **attained curriculum** is represented mostly by the achievement data described in Chapter 1, although some information on how the attained curriculum relates to the implemented curriculum—for example, the relationship between hours spent on homework and achievement scores—is included here.

Figure 2-2
An expanded model for curriculum



[2]All of the curricular indicators presented in this chapter have limitations. At best, each is only one angle or lens through which to view a complex process, and each has its own measurement and reporting constraints.

The Intended Curriculum

This section describes the goals of several groups for U.S. science and mathematics education—specifically, it describes national perspectives on the intended curriculum. Indicators of state, teacher, and parent goals are also outlined.

National Perspectives on the Intended Curriculum

Federal Goals for Educational Improvement

The educational goals expressed at the national level emphasize science and mathematics education for **all** students, not just for select groups. National concern about the caliber of U.S. science and mathematics education has been growing since the publication of *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education (NCEE) 1983). *By the Year 2000: First in the World* summarizes the significant challenges facing the Nation as it tries to improve the quality of science and mathematics education (Office of Science and Technology Policy (OSTP) 1992). The report states that the responsibility for improving the quality of U.S. schools is shared by Federal, state, and local governments and must involve educators, parents, business and industry, professional associations, and community organizations.

In 1989, President Bush and the state governors established six national goals for education (OSTP 1992). Three of the goals relate to the quality of U.S. science, mathematics, and engineering education:

- By the year 2000, American students will leave grades 4, 8, and 12 having demonstrated competency in challenging subject matter including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.
- By the year 2000, U.S. students will be first in the world in science and mathematics achievement.
- By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

Curriculum Standards in Mathematics

Led by the National Council of Teachers of Mathematics (NCTM), mathematics teachers in the United States have developed standards for mathematics education, published in a report titled *Curriculum and Evaluation Standards for School Mathematics* (1989). The standards focus on two basic principles. First, ". . . all students need to learn more, and often different, mathematics" (NCTM 1989). In other words, students need to learn more than just how to manipulate arithmetic routines; they need to master concepts from algebra, geometry, trigonometry, statistics, probability, discrete mathematics, and even calculus. Second, ". . . instruction in mathematics must be significantly revised" (NCTM 1989). That is, classrooms need to function as "discourse communities" in which conjectures can be made, arguments presented, and strategies discussed.

According to the *Standards*, students should—

- Learn to value mathematics.
- Become confident in their ability to do mathematics.
- Become mathematical problem solvers.
- Learn to communicate mathematically.
- Learn to reason mathematically.

The *Standards* emphasize the concept of "mathematical power":

"This term denotes an individual's abilities to explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems. This notion is based on the recognition of mathematics as more than a collection of concepts and skills to be mastered; it includes methods of investigating and reasoning, means of communication, and notions of context. In addition, for each individual, mathematical power involves the development of personal self-confidence." (NCTM 1989)

Curriculum Standards in Science

The National Research Council (NRC), the principal operating agency of the National Academy of Sciences (NAS) and the National Academy of Engineering, is coordinating the development of national standards for science education from kindergarten through twelfth grade (K–12). By the fall of 1994, National Science Education Standards will be completed and published. The standards will be narrative descriptions of what all students should learn in order to engage and understand the natural world. The standards will address science curriculum, teaching, and assessment and will represent the consensus of teachers and other science educators, scientists, and the general public.

NRC was commissioned in 1991 to lead this undertaking. An advisory committee was established to help plan and advise the enterprise, and 89 individuals representing a wide variety of perspectives and expertise in science, science education, and teaching at all levels were invited to serve on the national committee or on one of the three working groups (on curriculum, teaching, and assessment). Standards for science curriculum, teaching, and assessment will be integrated in a single document. The standards will specify criteria by which to judge the quality of school science and guide the future development of science education.

Concurrent with this standards development effort, and serving as a key input for the effort, are two major science curriculum projects now under way—Project 2061: Science for All Americans, which is being conducted by the American Association for the Advancement of Science (AAAS); and the Scope, Sequence, and Coordination (SS&C) effort of the National Science Teachers Association (NSTA). These two projects are detailed in the following sections. Other projects serving as inputs to the science standards development effort include the curriculum guidelines developed for specific fields of science by the Association of American Geographers (1984), the American Association of Physics Teachers (1988), the Board on Biology (1990), the American Geological Institute (1991), and other organizations.

Project 2061: Science for All Americans. Project 2061 is a three-phase process. Completed in 1990, the first phase created a framework in which to define scientific literacy, which includes mathematics, technology, behavioral and social sciences, and the natural sciences (AAAS 1989). Already under way, the second phase of the project involves six teams of science teachers and district leaders who are constructing curriculum models designed to make all students scientifically literate. The third phase will implement some form of these curriculum models in the country's schools.

In Project 2061, learning goals focus on acquiring knowledge about the world from the perspective of science. More specifically, these goals focus on obtaining an in-depth understanding of major concepts and relationships that organize factual science information. By the end of high school, students are expected to develop an understanding of crosscutting themes—the "big ideas" used by scientists to think about, help explain, and predict phenomena in both the natural and the designed world (in other words, the world as adapted by humans). These themes include models of how things work, the notion of systems and their related parts, stability and change in systems, and the effect of scale on objects and systems. Additional learning goals include acquiring knowledge of the Nation's scientific programs, an understanding of major episodes in the historical development of scientific knowledge, and the mental habits considered necessary for public understanding of science—honesty, curiosity, skepticism, and the ability to collect information accurately, deal with it critically, and communicate it effectively.

Project on Scope, Sequence, and Coordination (SS&C). Like Project 2061, SS&C urges that schools limit the amount of content taught in science classes, but that they teach this content more effectively. According to Aldridge (1989)—

> "The selection of topics and activities for seventh-grade science will be based on relevance of the instruction to the students themselves, their lives, their future, and their immediate environment . . . There will be a minimum of symbolic or mathematical abstractions . . . Students will be presented with experience first, then terms, and then reinforcement with applications. The emphasis at first will be on concrete rather than abstract ideas and on lessons that involve hands-on activities and experience with natural phenomena."

SS&C has published *The Content Core* (1992), a guide for curriculum designers that identifies the science topics to be taught in each discipline at each grade level.

SS&C proposes that—

- All secondary school students study science every year for 6 years.
- The four science disciplines be coordinated so that students see the relationships and applications of important concepts.
- Spaced learning be used—revisiting concepts on a periodic basis, giving students the opportunity for increasingly rich and deep levels of comprehension.

State Course Requirements

State course requirements outline the minimum curricular standards to be met by students for graduation. State-level graduation requirements affect school- and district-level requirement policies and, consequently, student course-enrollment decisions and behaviors. Therefore, it may be important to monitor the status and change of this indicator and to see whether these changes occur equally for all students.

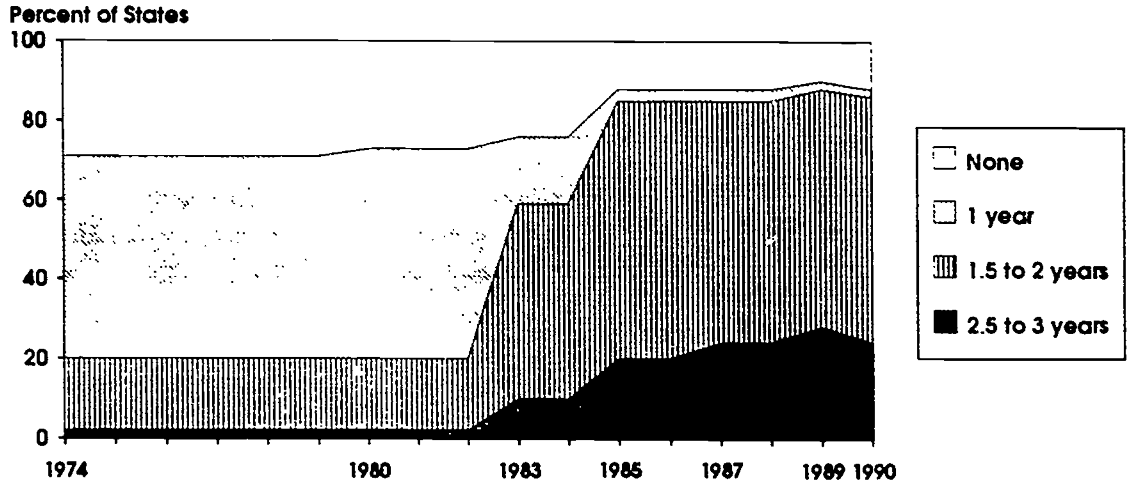
In the wake of repeated calls for educational reforms, course requirements for high school graduation have changed significantly over the years (NCEE 1983; Coleman 1983). In particular, according to information from several national and Federal sources, more states now require completion of more science and mathematics courses. (See appendix table 2-1.) The majority of states, having required 1 year of mathematics in 1974, required 2 years of mathematics in 1990; the number of states requiring 3 years of mathematics also increased. (See figure 2-3.) The pattern for science requirements was similar, although numbers were slightly lower. However, even with these higher standards for science and mathematics course-taking, state requirements as reported in 1990 were still lower than those recommended in *A Nation at Risk* (NCEE 1983).

The 1990 National Assessment of Educational Progress (NAEP) collected from schools information on requirements for graduation. Generally, school course requirements are the same for all students regardless of sex, race and ethnicity, or community type.[3] (See appendix table 2-2.) Despite the general consistency of school course requirements, it appears from this one source that higher percentages of Asian students than students of other racial groups were in schools requiring only 1–3 semesters of science or mathematics, whereas more white students than black or Asian students were in schools requiring 4 semesters of mathematics.[4]

[3]The NAEP community variable was constructed on the basis of the size and urbanicity of the school location and the parent occupational status of students in those schools.

[4]These differences may be a sampling artifact. The sample size of twelfth-grade Asian students was extremely small (N=185).

Figure 2-3
Percent of states imposing regular graduation requirements in mathematics, by number of years required: 1974 to 1990



See appendix table 2-1.

NSF Education Indicators—1992

SOURCES: RAND tabulations of data from the National Association of Secondary School Principals. 1975 and 1980: Education Commission of the States. 1983 and 1990: Center for Education Statistics. 1987: National Center for Education Statistics. 1989: Clune. 1989; as cited in B. Stecher. "Describing Secondary Curriculum in Mathematics and Science: Current Conditions and Future Indicators." a RAND note presented to the National Science Foundation (N-3406-NSF) 1991.

Furthermore, extreme rural and advantaged urban schools seemed more likely to require 4–5 semesters of science and mathematics than did other schools. However, differences between school course requirements for disadvantaged urban schools and those for advantaged urban schools apparently did not exist.

Individual Indicators of the Intended Curriculum

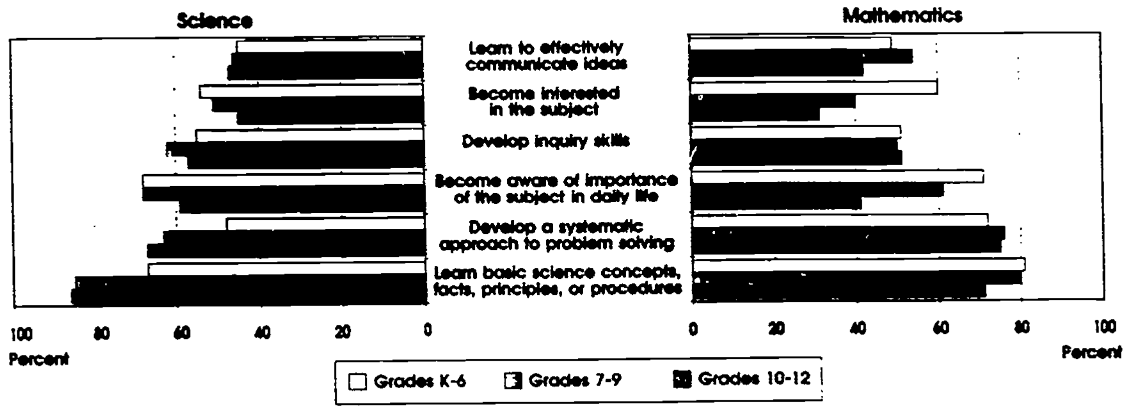
Parent and teacher expectations can also be considered indications of the intended curricula. Two available measures of these are teacher beliefs about what should be emphasized in their classes and parental expectations for their children.

Teacher Emphasis

The 1985–86 National Survey of Science and Mathematics Education conducted by Weiss asked teachers of K–12 students about the instructional objectives they emphasized in their teaching of science and mathematics. (See figure 2-4 and appendix table 2-3.) Although somewhat outdated, these results are the most current ones available on instructional goals of elementary and secondary teachers. A new survey to be carried out in the spring of 1993 will provide updated information on this indicator.

In science, the objective emphasized in the highest percentage of classes was to learn basic science concepts: at least 85 percent of the teachers in grades 7–9 and 10–12 cited this objective. It was second most popular for teachers of grades K–6. At the lower grade levels, the most popular objective was to become aware of the importance of science in daily life. The least emphasized objective for all grades was to learn about the history of science.

Figure 2-4
Percent of science and mathematics classes with selected instructional objectives emphasized by teachers, by grade range: 1986



See appendix table 2-3.

NSF Education Indicators—1992

SOURCE: I.R. Weiss, *Report of the 1985–86 National Survey of Science and Mathematics Education*, RTI/2938/00-FR (Research Triangle Park, NC: Research Triangle Institute, 1987).

In mathematics, knowledge of mathematical facts, principles, algorithms, or procedures was the most popular objective cited by teachers of grades K–6 and 7–9 and the second most popular objective among teachers of grades 10–12. Teachers of older students cited the development of a systematic approach to solving problems as their most emphasized objective. As in science, more emphasis was placed on developing an interest in mathematics and on becoming aware of the importance of mathematics in daily life at the elementary level than at the secondary level (grades 7–12). Like learning about the history of science, learning about the history of mathematics was the objective reported by the fewest teachers of all grades (about 5 percent).

Teacher emphasis on selected science and mathematics objectives reported in figure 2-4 reflects the field's perception of what was appropriate curriculum in 1986 before the NCTM Standards and science curriculum projects were announced. The heavy emphasis on subject matter knowledge and the lesser emphasis on communication of and interest in the subjects diverge from more recent recommendations for mathematics and science curriculum standards. On the other hand, a majority of teachers (about 60 percent) reported emphasizing problem-solving skills and subject importance in daily life, which are part of recent recommendations.

Parental Expectations

Student perceptions of what parents expect for them in terms of academic achievement can affect student learning and attitudes toward learning. The Longitudinal Study of American Youth (LSAY)[5] asked public school students whether their parents expected them to do well in science and mathematics. (See appendix table 2-4.) About 60 percent of the students in the seventh and tenth grades felt that their parents expected them to do well in science, but only 36 percent of the twelfth graders reported this

[5] In the 1987 base year, LSAY sampled about 3,000 public school students each from tenth grade (cohort 1) and seventh grade (cohort 2) and followed them annually from 1988 to 1991. A total of 51 high schools and 52 middle schools were included in the study. Students who moved to another school during the follow-up years were retained in the study, and data were collected. Students who graduated early or dropped out of school were excluded from the study. After cohort 1 students graduated, they were followed, but data are not reported here. LSAY middle schools were selected on the basis of their feeder relationship to the sampled high schools and so do not constitute a representative sample of the national population of middle schools.

expectation. The proportion of students who said their parents expect them to do well in mathematics was about 10 percent higher than those who said their parents expect them to do well in science; but here, too, a pattern of lower expectations for twelfth graders holds. This decrease in perceived parental expectations matched course-taking patterns: fewer students took science and mathematics in twelfth grade. Student-reported parental expectations apparently did not differ by sex or community type; however, a positive relationship existed with parent level of education,[6] especially for twelfth graders. (See figure 2-5.)

Students were also asked whether their parents thought science and mathematics were important subjects. As was the case with the perceived expectations, the perceived importance decreased as students grew older. Students whose parents had higher levels of formal education were more likely than others to think their parents believed science and mathematics to be important subjects. About 30 percent of the students reported that their parents wanted them to learn about computers; this perception, too, positively correlated with parent level of education.

Summary

The information presented in this section shows that different groups had different and somewhat conflicting expectations for science and mathematics curricula. The Federal Government and national professional organizations appear to be the most ambitious in their goals. State requirements may lag behind national recommendations, but state-level reform should narrow that difference. Furthermore, children's perceptions of their parents' expectations for them indicate a view of accomplishment in science and mathematics that is less rigorous than what is desired nationally. Finally, teachers' instructional objectives as reported by Weiss in 1985–86 did not fully match the national recommendations set in 1989.

The Implemented Curriculum: The Accessible Curriculum

The curriculum implemented in schools is often quite different from the intended curriculum. The effects of the intended curriculum are filtered through what is implemented. The new curricular standards in science and mathematics described above are just beginning to be implemented in the Nation's schools. Concurrently, there is a new interest in documenting science and mathematics curricular indicators to allow the changes brought about by the new standards to be tracked, analyzed, and evaluated.

The implemented curriculum has been divided into two components for consideration in this chapter: (1) the available or accessible curriculum and (2) the used or accessed curriculum. The two components are not independent and can overlap in actual practice. The **accessible curriculum** discussed in the section immediately following includes what courses, materials, and facilities are available and how these are delivered. The **accessed curriculum** outlined in a later section includes patterns of course-taking, the amount of time spent with the various components of the curriculum (working with specific topics or materials), taking certain types of courses, using computers or calculators, watching television, visiting museums, fixing things at home, and having discussions with parents.

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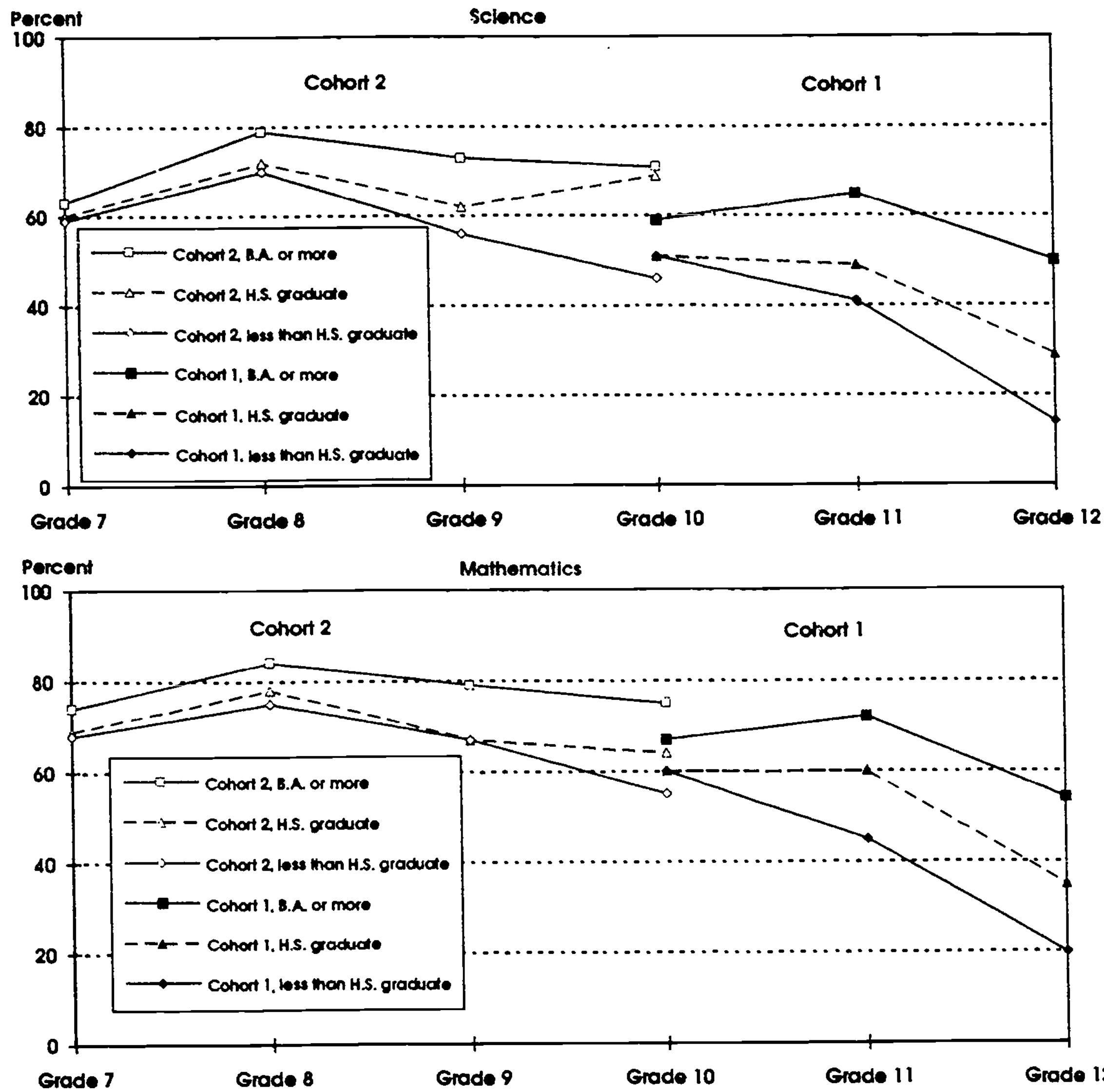
[6] Parent level of education was defined as the highest level of education reported by the students for either parent.

Figure 2-5
Percent of students who report their parents expect them to do well in science and mathematics, by parent's education, grades 7–12: 1987 to 1990



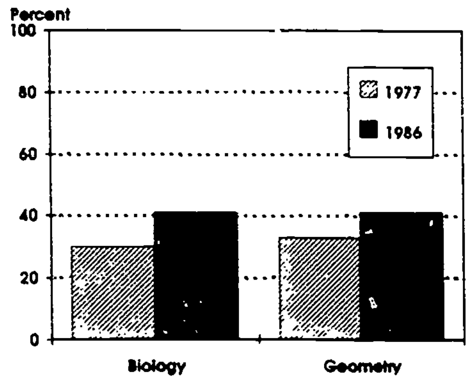
See appendix table 2-4. NSF Education Indicators—1992

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Course Availability

The percentage of secondary schools offering particular science and mathematics courses has varied over the years. (See appendix table 2-5.) Analysis of results from the 1985–86 Weiss study shows that in the United States from 1977 to 1986, the percentage of secondary schools (those having either grades 7–9 or 10–12) offering general science or mathematics courses decreased. By 1986, however, more schools offered specific courses such as biology, earth science, or geometry. An additional change over time is that specific-topic courses traditionally considered "more advanced" appear to have moved into the lower grades. (See figure 2-6.) Overall, less change occurred in school offerings of mathematics courses than in school offerings of science courses.

Figure 2-6
Percent of secondary schools (with grades 7–9) offering biology and geometry: 1977 and 1986



See appendix table 2-5. NSF Education indicators—1992

SOURCE: I.R. Weiss. *Report of the 1985–86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987).

By School Characteristics

Because course offerings vary by school, it is useful to examine course availability by school category (for example, see Stecher 1991). In 1985–86, NAEP[7] compared course availability in terms of the following school characteristics:

- Free lunch participation, defined by the percentage of students participating in a subsidized lunch or nutrition program. This component of school characteristics is used in this chapter as an indicator of the socioeconomic status (SES) of students in schools.
- Minority enrollment, defined as the percentage of non-Asian minority students in the school.[8]
- Size and type of community, a variable constructed by NAEP to reflect a combination of location and parent occupation.
- Size of school, measured as the average student enrollment per grade level.

The 1985–86 NAEP analysis showed that the percentage of schools offering selected science, mathematics, and computer science courses varied slightly across these four characteristics. (See appendix table 2-6.) Moreover, the discrepancies among schools with different characteristics became more marked as course levels rose from basic (for example, first-year biology) to advanced (for example, second-year biology). These differences were more apparent for the science courses than for the mathematics or computer science courses.

On the basis of the four school characteristics studied in 1985–86, differences were fewest in terms of ethnic composition, suggesting that course-offering equity existed among schools with different levels of

[7]The NAEP data have certain quality limitations. First, the sample size of American Indians and Alaskan natives was too small to yield reliable estimates for these subpopulations. Second, some data in the school questionnaire had high nonresponse rates. The free lunch participation rate was not reported by about 20 percent of schools (67 out of 412). Between 10 and 20 percent of schools did not provide information on offering courses in algebra II, physics I and II, and computer programming (Stecher 1991). Data interpretation should take these quality limitations into account.

[8]In this analysis, Asians were not included with other racial and ethnic minority groups because they were not underrepresented in science and mathematics education.

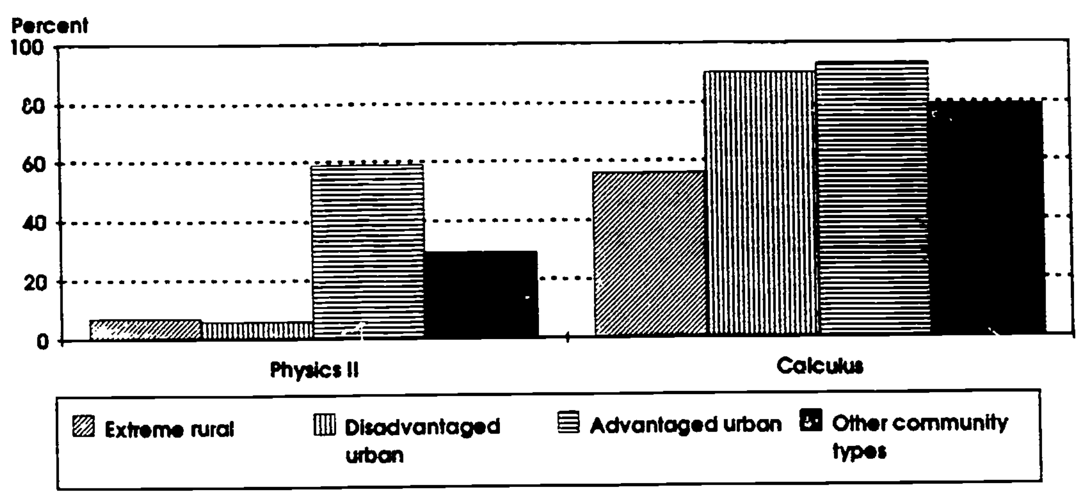
minority enrollment. The greatest differences in course availability occurred between schools in advantaged urban areas and schools in disadvantaged urban areas or big cities, especially for advanced courses such as physics II and precalculus/calculus.

The 1990 NAEP course availability data[9] show that although most science and mathematics courses were offered by a majority of the schools in the United States, they were not offered at all schools. Thus, not all students attended schools at which a particular course, such as calculus, was available. However, as shown by the NAEP analysis of twelfth-grade students, very high percentages (95–100 percent) of U.S. students attended secondary schools that offered the traditional science courses of biology, chemistry, and physics and the traditional mathematics courses of algebra I and II, geometry, and trigonometry. (See appendix table 2-7.) The 1990 patterns were similar to those found in 1985–86. For students in schools offering the various science and mathematics classes, no substantial differences existed for different ethnic groups, and only a few differences existed among community types. Higher percentages of students from advantaged urban communities than students from disadvantaged urban communities were in schools offering second-year physics and introductory algebra. Furthermore, lower percentages of students from extremely rural communities than students from advantaged urban communities were in schools offering calculus or precalculus. (See figure 2-7.) Interestingly, however, high percentages of students in disadvantaged urban communities were in schools offering calculus.

Materials and Facilities

The amount of instructional materials (for example, textbooks) and types of facilities (for example, laboratories) available determine in part the implemented science and mathematics curricula. Many types of resources could contribute to a curriculum, including items available to students in both their schools and their homes; however, national survey results are available for only a few of these resources.

Figure 2-7
Percent of students in schools (with 12th grade) offering physics II and calculus, by community type: 1990



See appendix table 2-7.

NSF Education Indicators—1992

SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

[9]The analysis of course offerings by the four school characteristics is not available for the 1990 NAEP.

The available survey information often reflects only the perceptions of respondents or the combination of discrete observations obtained from several different sources. The information must, therefore, be considered cautiously. This section presents information on teacher perceptions of the availability of mathematics materials, on school reports of the availability of science laboratories and computers, and on student reports of home resources.

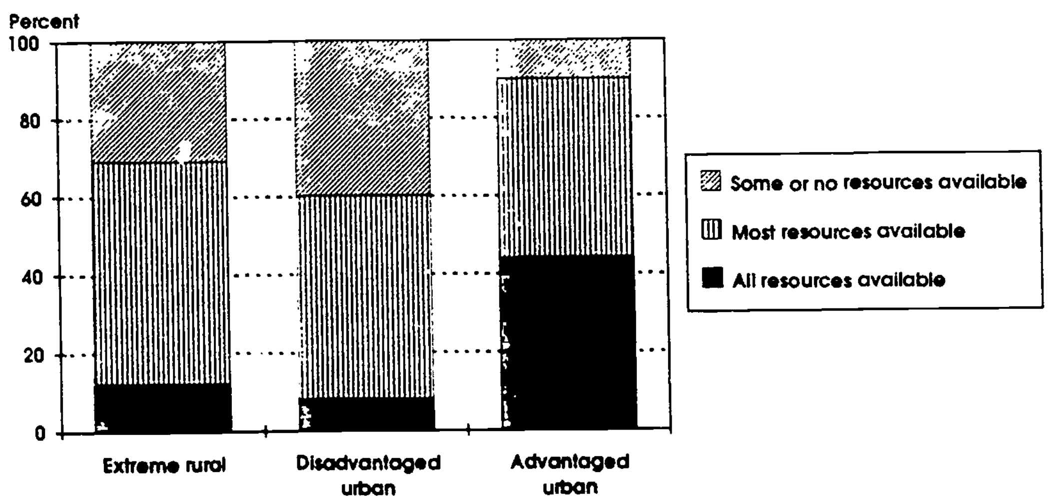
Mathematics Materials

In the 1990 NAEP, fourth- and eighth-grade teachers were asked to report their perceptions of the availability of resources to teach mathematics. Instructional resources available to teachers included basic teaching materials (for example, textbooks or worksheets) and hands-on tools and manipulatives (for example, rulers, counting blocks, or geometric shapes). The teachers rated the availability of the resources on a three-level scale—all, most, and some or none. Overall, few teachers (13 percent of fourth-grade teachers and 19 percent of eighth-grade teachers) felt they had all of the resources they need. (See appendix table 2-8.) More teachers of students in disadvantaged urban schools felt they had "some or no" resources available compared with teachers of students at advantaged urban schools. (See figure 2-8.) Teachers at rural schools also felt as resource poor as teachers at disadvantaged urban schools. These results indicate that it may be difficult for teachers, especially those at disadvantaged urban schools or extreme rural schools, to implement the new mathematics curriculum standards because the standards call for increased use of resources.

Science Laboratories

According to the 1990 NAEP results, most twelfth-grade students were in schools with science laboratories in one or more classrooms. (See appendix table 2-9.) More than 80 percent of the students were in schools with one or more general science laboratories; more than 90 percent were in schools with one or more specialized science laboratories. These patterns remained very similar by sex, race and ethnicity, and

Figure 2-8
Availability of mathematics instructional materials, by community type, as reported by 8th-grade teachers: 1990



See appendix table 2-8.

NSF Education Indicators—1992

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

types of community. Thus, it appears that U.S. schools have the laboratories needed to respond to the new science curricular goals for more use of hands-on science. The existence of laboratories, however, does not imply that class time, supplies, and personnel would be available to use them.

The 1991 International Assessment of Educational Progress (IAEP)[10] of 13-year-old students (about the age of eighth-grade students), conducted by Educational Testing Service, collected information on how many schools in various countries had no science laboratory and how many schools had general or specialized science laboratories in one or more classrooms. Of the 14 countries selected here, Switzerland ranked lowest, with 55 percent of Swiss schools having a laboratory; Taiwan and Scotland ranked highest, with all of the schools having a laboratory. The United States ranked eighth, with 86 percent of its schools having a laboratory. (See appendix table 2-10.) Thus, U.S. schools seem moderately well equipped, compared with the schools of the other countries participating in IAEP.

Computers[11]

Only 10 percent of twelfth-grade students in the 1990 NAEP sample attended schools in which computers were always available in the mathematics classrooms. (See appendix table 2-9.) About 80 percent of the students were in schools with computers available in a computer lab, and about 65 percent were in schools that arranged for computers to be brought to class when needed. These proportions did not differ by sex, racial and ethnic categories, or type of community. Both the national mathematics curricular standards and the science curricular projects recommend greater use of technology in the classroom. NAEP results show that computers were available but were perhaps not as accessible as the new curricular standards might wish. The majority of the computers appeared to be located outside the classrooms and appeared not to be available for ad hoc use by students.

Home Resources

The resources available at students' homes also affect the opportunities they have to learn science and mathematics. LSAY surveyed seventh and tenth graders to determine the availability of six science- and mathematics-related items—a microscope, a computer, an atlas or globe, a pocket calculator, more than 50 books, and a telescope—in their homes. The survey added student responses to these availability questions to yield a six-point resource rating. (See appendix table 2-11.) The findings showed that the level of parent education influenced the availability of home resources: more resources were available in the homes of parents with higher levels of formal education. (See figure 2-9.)

Modes of Instruction

Both the NCTM mathematics standards and the two national science curriculum projects (Project 2061 and SS&C) call for more use of discussion and hands-on procedures and less use of lectures and textbooks. To measure the use of these various modes of instruction at the K–12 grade levels, Weiss (1987) surveyed science and mathematics teachers. Although results from this survey are the latest available, they date from 1985–86 and should, therefore, be used as a broad baseline indicator to judge the future impact of the standards on classroom practices—not taken as a true picture of current practices.

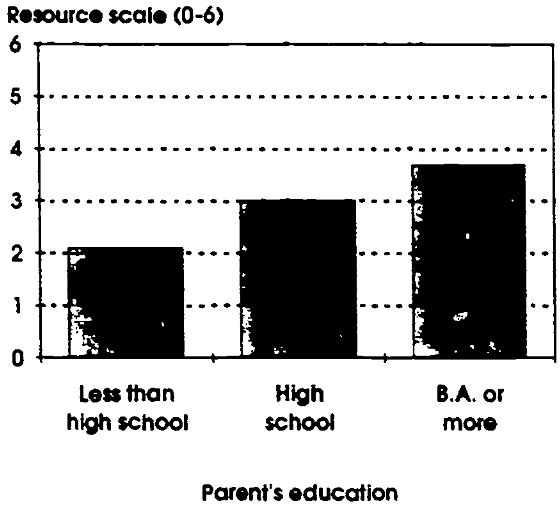
According to the Weiss study, the amount of hands-on activities in the classroom was generally low; these techniques were not being used to the extent endorsed by the new curriculum standards. (See appendix table 2-12.) Moreover, the percentage of science classes using hands-on techniques decreased between 1977 and 1985. Among K–3 teachers in 1985, only 57 percent used these

[10] For a detailed discussion of the study, see Chapter 1 and the Technical Notes in Appendix B to this volume.

[11] For information on actual use of computers, see pp. 74-76.

Figure 2-9

Average home science resources of 7th-grade students, by parent's education: 1987



NOTE: Home resource scale is a composite construct of six resources (a computer. an atlas or globe. a pocket calculator. more than 50 books. a microscope, and a telescope) students report having in their homes.

See appendix table 2-11. NSF Education Indicators—1992

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

techniques: fewer than one-half of the teachers above the third-grade level reported using hands-on activities to teach science in their "most recent" lessons. The proportion for mathematics teachers at the higher grade levels was even lower. Although 63 percent of the K–3 teachers reported using hands-on mathematics activities in their most recent lessons in 1985—an increase of 5 percent from 1977—only 12 percent of the teachers at grade levels 10–12 reported using hands-on techniques in their most recent lessons.

Summary

The information in this section indicates that the availability of science and mathematics curricula has improved but does not yet meet the new national standards. Although a majority of schools offered a wide range of science and mathematics courses. not all schools did. In other words. not all courses were available to all students. The differences in course offerings occurred mostly for advanced-level courses. especially between advantaged urban and disadvantaged urban schools. The availability of instructional materials and school facilities was unequal at different grades. and the inequalities were most visible among schools in different communities. The availability of home resources varied by parent education level. showing that parents with higher levels of formal education provided their children with more learning resources at home than did parents with lower levels of formal education. The Weiss study carried out 7 years ago indicated that lectures and textbooks were the most widely used instructional methods, whereas hands-on activities were used much less often. It also indicated that teachers used discussion almost as much as lecture.

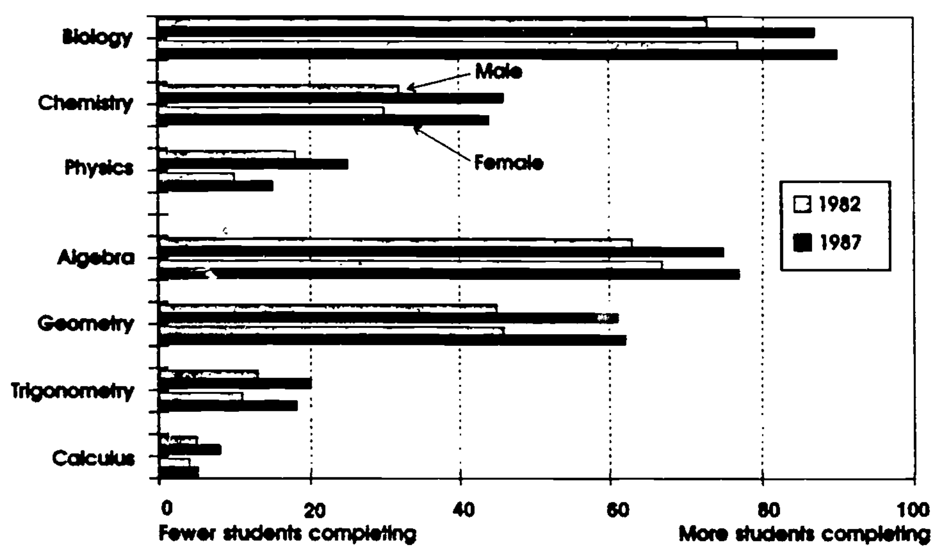
The Implemented Curriculum: The Accessed Curriculum

Extending beyond an examination of the availability of courses and resources, the following section focuses on the "used" curriculum, or the types of courses actually taken by students and the amount of time spent on various topics or devoted to various activities.

Patterns and Trends in Secondary School Course-Taking

According to an analysis of transcripts of 1982 and 1987 high school graduates,[12] even when secondary school science and mathematics courses are available, not all students take them. (See appendix table 2-13.) About 90 percent of 1982 and 1987 high school graduates had taken biology; 45 percent, chemistry; and 20 percent, physics. In mathematics, about 75 percent of the students had taken algebra; 60 percent, geometry; 20 percent, trigonometry; and 5 percent, calculus. A severe drop in both science and mathematics course-taking occurred as courses were perceived to be more difficult or more advanced. In science, at least some of the decline in course-taking was partly caused by the traditional "layer cake" approach, which makes the pool of students available to take certain courses diminish with course

Figure 2-10
Percent of high school graduates completing selected science and mathematics courses, by sex: 1982 and 1987



See appendix table 2-13. NSF Education Indicators—1992

SOURCE: J. Thorne, *High School Transcript Analysis: The 1987 Graduates* (Washington, DC: U.S. Department of Education, 1988).

[12] The high school transcript study examined transcript records of approximately 22,700 high school graduates obtained as part of the 1987 High School Transcript Study and 12,000 transcripts of 1982 graduates who participated in the second follow-up of the High School and Beyond (HS&B) project as the sophomore cohort. For sampling and data collection methods used, see the Technical Notes in Appendix B to this volume.

complexity. That is, biology is offered first, chemistry is offered next, but physics is generally available only to seniors. Even many college-bound students take only two science courses, omitting physics and sometimes chemistry. Also in mathematics, lower level courses must be taken before students can progress to advanced courses such as calculus and trigonometry.

Trends Over Time

According to the analysis of high school transcripts from 1982 and 1987, the percentage of all students taking science and mathematics courses increased. (See figure 2-10 and appendix table 2-13.) The increases among males and females were about equal.

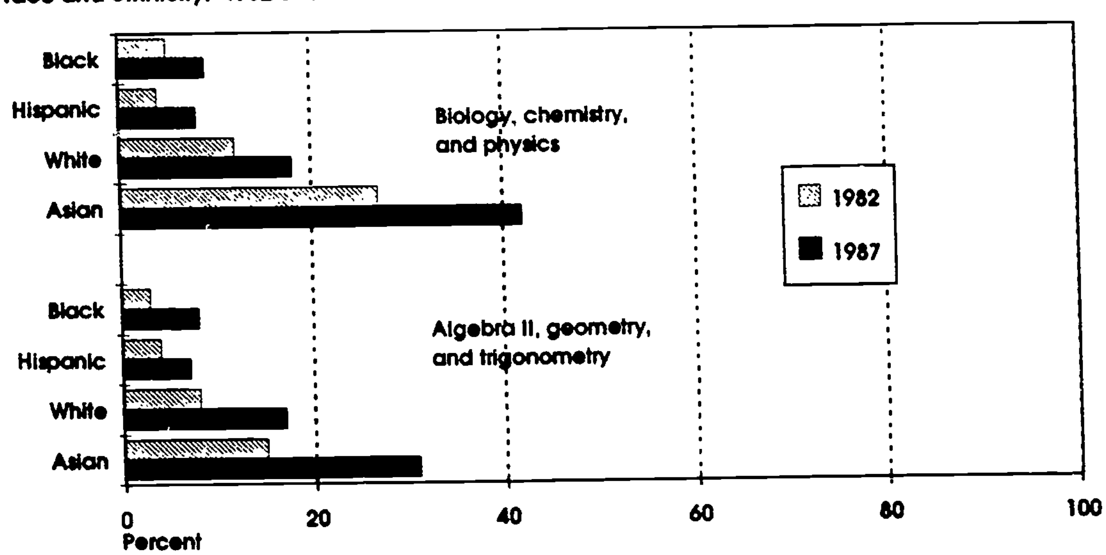
For most science courses, the greatest increase in course-taking occurred among Asian students; in biology, however, Hispanic students recorded the greatest rise. Again, Asian students increased the most in mathematics course-taking, except in algebra, where Hispanic students showed the greatest increase. Hispanic students showed the largest overall increase in taking introductory courses.

The differences between racial and ethnic groups became more profound as the composite number of science or mathematics courses increased. Between 1982 and 1987, Asian students showed the greatest increase in taking the three-course mathematics or science sequences; the lowest increase in course-taking was for African American and Hispanic students. (See figure 2-11.)

By Sex

The transcript analysis showed that males were more likely than females to take physics. In mathematics, course-taking patterns by sex were quite similar, with about an equal percentage of male and female students taking the four traditional mathematics courses. (See figure 2-10.)

Figure 2-11
Percent of high school graduates completing sequences of science and mathematics courses, by race and ethnicity: 1982 and 1987



See appendix table 2-13.

NSF Education Indicators—1992

SOURCE: J. Thorne, *High School Transcript Analysis: The 1987 Graduates* (Washington, DC: U.S. Department of Education, 1988).

84

By Race and Ethnicity

Course-taking patterns varied considerably by race and ethnicity, according to the transcript analysis. Most strikingly, more Asians completed science and mathematics courses than did students of any other racial or ethnic group. In 1987, 70 percent of Asian students took chemistry compared with 48 percent of white students and 30 percent of black and Hispanic students. Only about 5 percent of white, black, and Hispanic students took calculus, while about 30 percent of Asian students did. (See appendix table 2-13.)

By School Characteristics

For students who took science and mathematics courses beyond the first basic course, differences in course-taking patterns emerged by socioeconomic status, ethnic composition, school location and type, and school size, as described below.[13] (See figure 2-12 and appendix table 2-14.)

- **By income level of the parents** (using subsidized lunch participation rates as an indicator of income): The pattern of lower course-taking for students in schools with more low-income families (schools with higher percentages of students participating in the subsidized lunch program) was consistent across all courses.

- **By ethnic composition:** The pattern of course-taking across schools with different ethnic compositions was fairly consistent, with lower percentages of students taking courses as the percentage of non-Asian minority students increased. In a few cases, however—notably chemistry and biology—the schools with the highest proportions of minority students showed a slight advantage over the schools with minority enrollments between 50 and 74 percent.

- **By school community location:** Course-taking was generally lowest for extremely rural schools, followed by disadvantaged urban schools, big city schools, etc., with more students from advantaged urban schools taking courses. Some courses, such as algebra II, geometry, computer literacy, and computer programming, were taken by more students from schools in the extreme rural areas than students in schools in the disadvantaged urban areas. This pattern may result from a lack of other course options at these extreme rural schools.

- **By school size:** It appears that students at midsize schools were more likely to take science and mathematics courses than those in larger or smaller schools. It is interesting that physics I classes and computer classes were more frequently taken by students in smaller schools than those in larger schools. This pattern may exist because the smaller schools have fewer other options, and therefore more students take these two courses.

Tracking

Tracking is the practice of grouping students in courses based on perceived ability. Proponents see tracking as an attempt to help students learn; others believe it prevents students from realizing their full potential (Oakes 1990). Students placed in lower ability tracks early in their school careers may never have the opportunity to complete some science and mathematics courses.

By Student and Community Characteristics

According to the 1990 NAEP survey of schools that contained the eighth grade, school administrators reported that 77 percent of eighth-grade students were grouped by ability in mathematics classes, whereas

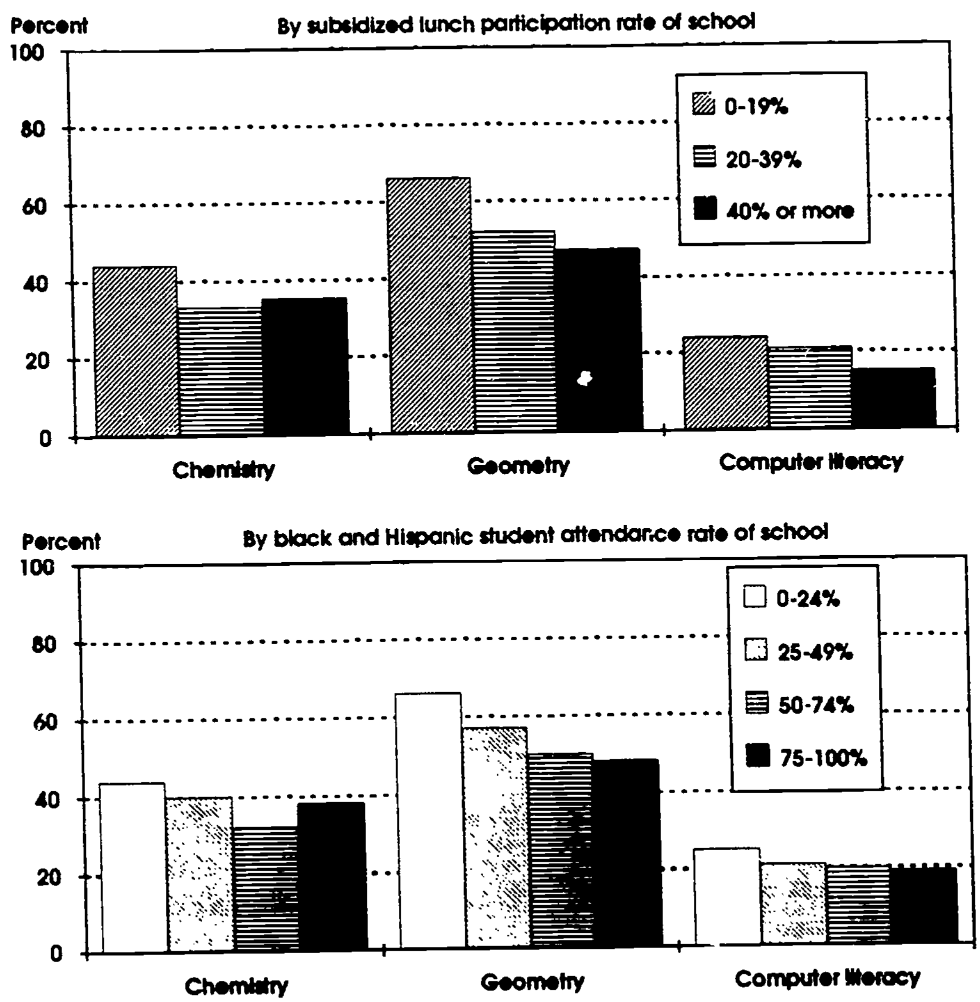
[13]This conclusion is based on data from the 1986 NAEP; limitations of these data are discussed in footnote 3.

only one-third of them were ability grouped in science classes. (See appendix table 2-15.) By twelfth grade, most students were placed in both science and mathematics classes on the basis of ability (74 percent and 80 percent, respectively). No substantial differences existed at eighth and twelfth grades in the percentages of tracked students by sex, race and ethnicity, or type of community.

International Comparisons

The 1991 IAEP collected data from 13-year-old students on international differences in the percentage of schools in which students were assigned to science and mathematics classes on the basis of ability. (See appendix table 2-10.) The percentage of schools using ability grouping ranged from none for both science and mathematics in Hungary, to 57 percent

Figure 2-12
Percent of 12th-grade students taking selected science and mathematics courses through grade 11, by school characteristics: 1985–86



See appendix table 2-14.

NSF Education Indicators—1992

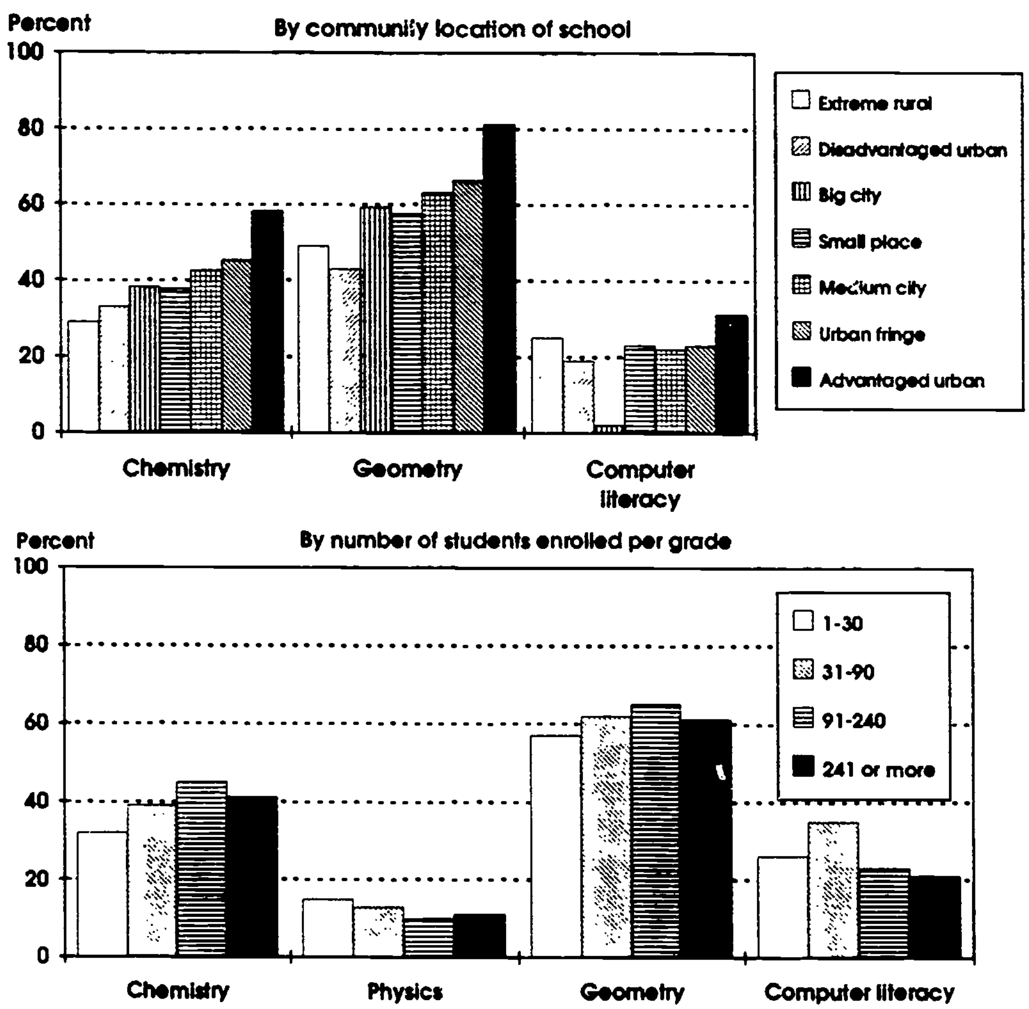
SOURCE: RAND special tabulations of the 1985–86 National Assessment of Educational Progress.

for science in Taiwan, to 74 percent for mathematics in Israel. The United States ranked in the approximate middle of this range of countries in the study: 29 percent of the U.S. schools surveyed reported ability-grouped science classes, and 56 percent reported ability-grouped mathematics classes.

Time Spent on Science and Mathematics

Information on which courses students took and whether these courses were offered to groups of different ability does not completely describe the implemented curriculum. Information on the amount of time spent on specific topics in class helps fill in the picture.

Figure 2-12 (continued)
Percent of 12th-grade students taking selected science and mathematics courses through grade 11, by school characteristics: 1985–86



See appendix table 2-14.

NSF Education Indicators—1992

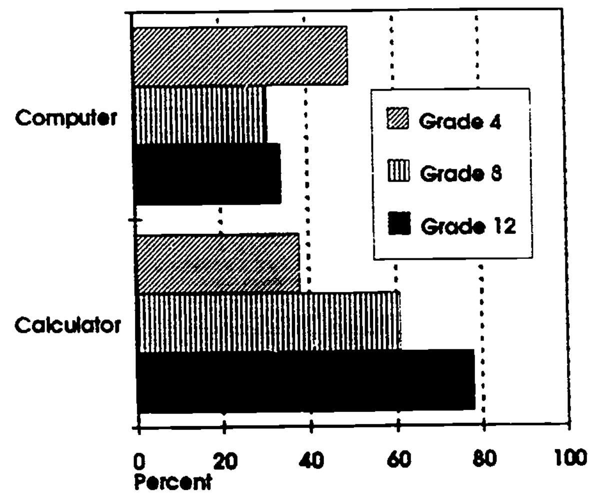
SOURCE: RAND special tabulations of the 1985–86 National Assessment of Educational Progress.

Information from three different studies shows that a wide variety of topics was covered. Because course titles do not always accurately reflect the concepts that the course covers, information on topics covered in eighth-grade mathematics and science courses was provided by the National Education Longitudinal Study for 1988 (NELS:88). These data show that more than two-thirds of public school eighth graders were in classes where fractions, ratios, and percents; problem solving; and integers were taught as major topics. Earth science and weather/astronomy were taught as major topics to more than 50 percent of public school eighth graders. Between 40 and 50 percent studied topics related to environmental science or oceanography, chemistry, various physics subjects, and atomic theory. (See appendix table 2-16.)

Data from the 1990 NAEP supplement these findings. The NAEP data show that "numbers and operations" and "measurement" were popular fourth-grade mathematics topics, whereas "numbers and operations" and "algebra and functions" were emphasized in eighth grade. It is interesting that, in contrast to the recommendations of the mathematics curriculum standards, little emphasis was given to "probability and statistics" at either grade level. (See appendix table 2-17.)

The Second International Mathematics Study (SIMS)[14] conducted by IEA revealed differing emphasis on mathematics topics between eighth and twelfth grades and among countries. Contrary to the 1989 NCTM standards that call for more in-depth coverage of fewer topics at different grade levels, the U.S. results showed less intense coverage across more topics compared with other countries. (See appendix table 2-18.) A new international study of differing emphasis on mathematics and science topics is under way and will be available for indicators in 1994.

Figure 2-13
Percent of students who report ever using a computer or calculator in mathematics class, by grade: 1990



See appendix tables 2-19 and 2-20.
NSF Education Indicators 1992

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Engagement in Activities

The implemented curriculum is partially determined by the type of activities students engage in, both inside and outside of school. Although many different activities may contribute to the implemented curriculum, data are available for only a few. This section presents information on student use of computers and calculators, television viewing, visits to science museums, work around the home, and discussions with parents.

Use of Computers and Calculators

Information from the 1990 NAEP reported by fourth- and eighth-grade teachers reveals an

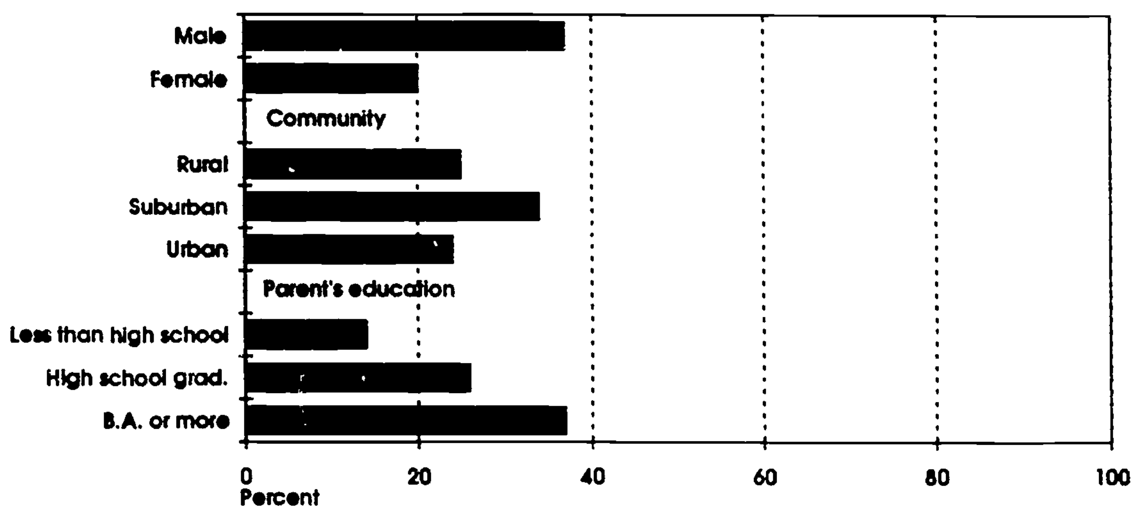
[14]With 19 countries participating, SIMS examined mathematics achievement of students in grades 8 and 12 and conditions of learning mathematics in the international context. For a detailed discussion of the study, see the Technical Notes in Appendix B to this volume.

interesting decline in the use of computers and a concurrent increase in the use of calculators as students grew older. (See figure 2-13 and appendix tables 2-19 and 2-20.) For fourth grade, teachers reported that 41 percent of the students spent 30 minutes or longer each week working with computers; for eighth grade, teachers reported only 12 percent of the students working with computers.[15] Students reported a similar decrease in computer time from the fourth to the eighth grade.

The NAEP statistics also provide a breakdown of computer use by ability level of the students' mathematics class. (See appendix table 2-20.) Teachers rated mathematics classes as high, average, low, or mixed ability and reported how often each class used computers. No major differences in computer use were found at different ability levels; however, both high- and low-ability classes tended to use computers more than the average-ability classes did, indicating that the computers were perhaps used most often in either enrichment or remedial activities.

The 1991 IAEP findings for 13-year-olds show that student use of calculators and computers varied widely by country. (See appendix table 2-10.) South Korea had the lowest percentage of students who reported ever using calculators in school (4 percent); France had the highest (94 percent). The range in percentage of students who ever used computers for school or homework was similarly broad: from 5 percent in Jordan to 61 percent in Slovenia. Students in the United States fell in the upper middle of the range for both indicators, with 54 percent of the students having used calculators and 37 percent, computers. Thus, contrary to public expectations, U.S. students were not the largest users of computers and calculators.

Figure 2-14
Percent of 7th-grade students using computers 10 hours or more other than in class (in the school year), by sex, community type, and parent's education: 1987



See appendix table 2-21.

NSF Education Indicators—1992

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

[15]Obviously, these percentages reflect the context of the elementary and junior high schools. Many elementary classrooms had one computer that students took turns using (or that the teacher used with larger groups), and the computer was used to support learning in almost all subjects. At the eighth-grade level, however, computers were more likely to be in computer labs than individual classrooms, and their use was more restricted to particular subject areas.

LSAY gathered information from public school students in grades 7, 10, and 12 on how much they used computers outside the classroom. The percentage of students who reported using a computer 10 hours or more outside the classroom during the school year was fairly consistent across grade levels, with a range from 29 percent for seventh graders to 24 percent for twelfth graders. Males at all grade levels were more likely than females to report this behavior; so were students in suburban communities and students with parents who received more formal education. The trends are exemplified by the seventh-grade statistics in figure 2-14.

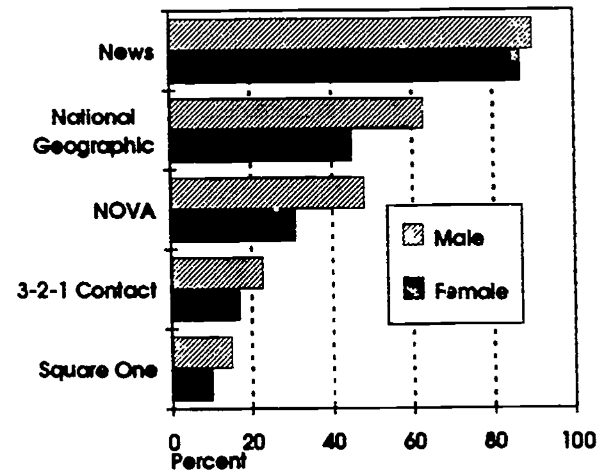
Television Viewing

Television can be educational, depending on the type of program viewed. LSAY gathered information on how often eighth- and eleventh-grade public school students watched selected science and mathematics television programs ("NOVA," the "National Geographic" specials, "3-2-1 Contact," and "Square One") as well as how often they watched the news.[16] (See figure 2-15 and appendix table 2-22.) Students reported whether they watched the programs often, sometimes, or never. Except for the National Geographic specials, which were watched by 53 to 59 percent at least sometimes, only 13 to 39 percent of the students ever watched the science and mathematics programs. Viewing behavior differed by program, student age, and sex. For example, fewer eleventh graders than eighth graders watched the mathematics programs, perhaps because they were directed to younger students. Males were more likely than females at either grade level to watch science programs. These viewing patterns contrast with those for news shows: more than 80 percent of the students reported watching the news at least sometimes.

Visits to Science Museums

According to LSAY, only about 60 percent of seventh and tenth graders in public schools reported ever visiting a science museum. (See appendix table 2-21.) The proportion of positive responses was even lower when, in the LSAY surveys from 1987 to 1990, students in grades 7, 10, and 12 were asked whether they had visited a science museum, natural history museum, or planetarium in the last school year. Responses ranged from 35 percent among seventh graders to 25 percent among twelfth graders. Positive responses did not seem to differ by sex; however, suburban students and students whose parents had more formal education had higher visiting rates. (See figure 2-16.)

Figure 2-15
Percent of 11th-grade students reporting watching various science and mathematics television programs, by sex: 1988



See appendix table 2-22. NSF Education Indicators—1992

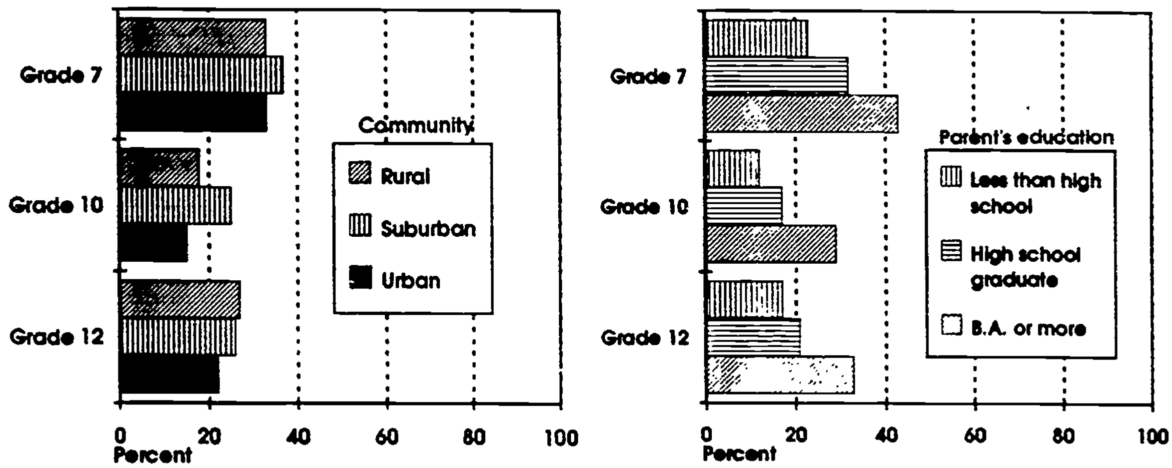
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Fixing Things at Home

About 60 percent of the students in the LSAY survey of public school students in grades 7, 10, and 12 reported helping their parents fix something at home during the past summer. (See appendix table 2-23.) Males reported this behavior slightly more frequently than females. When analyzed by

[16]See p. 80 for a discussion of general television viewing by 9- and 13-year-old students.

Figure 2-16
Percent of students visiting a science museum or planetarium (in the school year), by community type and parent's education, grades 7, 10, and 12: 1987 to 1990



See appendix table 2-21.

NSF Education Indicators—1992

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

community type or level of parent education, no substantial differences were reported.

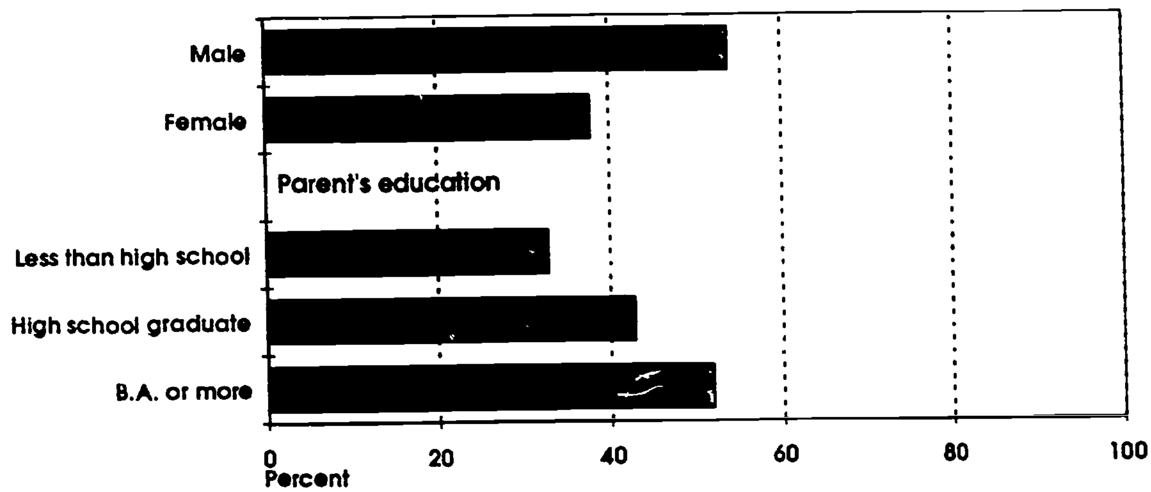
Discussions With Parents

The time that students spend discussing issues with their parents is an important part of the accessed curriculum. LSAY asked public school students in grades 7, 10, and 12 how often they talked to their parents about the space program and issues involving science and technology. (See appendix table 2-24.) About 40 percent of the students in the three grades reported talking to their parents about such issues. Higher percentages of males and students whose parents had more formal education reported talking to their parents about science issues. The trends for all grade levels were similar; the tenth grade is presented in figure 2-17.

Summary

The information on the used curriculum shows that the actual use of the science and mathematics curricula fell short of both the available curriculum and the recommended curriculum. Although a high percentage of students attended schools that offered a variety of science and mathematics courses, few students took advanced courses. One factor that might deter students' use of the available curriculum is tracking—that is, grouping students by ability level and predisposing them to which courses they take. Computer and calculator use differed by grade level and ability level. As students moved up the grade level, the time spent using computers decreased while calculator use increased—which might contradict the usual expectation. High- and low-ability classes tended to use computers more than average-ability classes did. Finally, students' involvement in learning activities at home differed by student gender and level of parent education. More males than females and more students whose parents had higher levels of formal education tended to engage in various informal science and mathematics learning practices such as using computers, visiting museums, and having discussions with parents.

Figure 2-17
Percent of 10th-grade students talking to parents about science and technology issues, by sex and parent's education: 1990



See appendix table 2-24.

NSF Education Indicators—1992

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

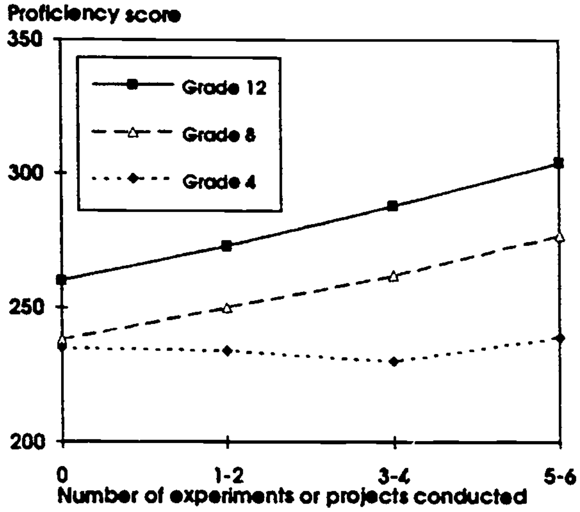
The Attained Curriculum: Relationships of Curricular Components to Student Achievement

The attained curriculum—that is, the conceptual understanding instilled in students through education—is measured through achievement tests. The results of national and international achievement tests are reported in Chapter 1. This section focuses on some of the many elements of the implemented curriculum that could affect student achievement—science laboratory work, participation in science fairs, homework, television viewing, opportunity to learn (OTL), and time spent on science and mathematics—and discusses relationships between each of these elements and student achievement.

Science Laboratory Work

Both Project 2061 and SS&C, among other science curriculum projects, recommend increased use of hands-on science activities. The 1990 NAEP asked students in grades 4, 8, and 12 how many science experiments or projects they conducted. (See appendix table 2-25.) Results showed a positive correlation between student experimentation and achievement. As figure 2-18 reveals, students who were more involved with hands-on science activities showed better performance in science tests than those who were less involved in such activities. Two other studies showed positive relationships between

Figure 2-18
Student participation in science experiments or projects, and science achievement: 1990



See appendix table 2-25. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992).

involvement in hands-on activities and science proficiency. The 1986 NAEP asked third and seventh graders to rate their use of science equipment as low, medium, or high. (See appendix table 2-26.) NELS:88 asked teachers of eighth graders to report the number of science experiments conducted. (See appendix table 2-27.) It must be kept in mind that the existence of the relationship does not necessarily imply that the hands-on activities **caused** the achievement.

Science Fairs

Although NELS:88 showed that only about 30 percent of eighth graders participated in science fairs, a direct relationship existed between science achievement and participation: 34 percent of the students from the highest quartile in achievement participated in science fairs, compared with 22 percent of students from the lowest quartile. (See appendix table 2-28.)

Participation rates did not differ by sex. Among racial and ethnic groups, black students had the highest participation rate at 34 percent, compared with a low of 23 percent for Hispanic students.

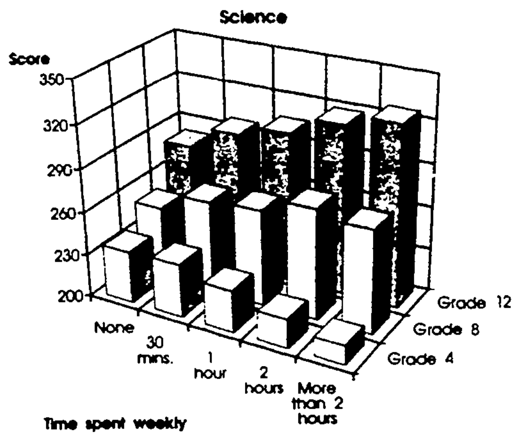
Homework

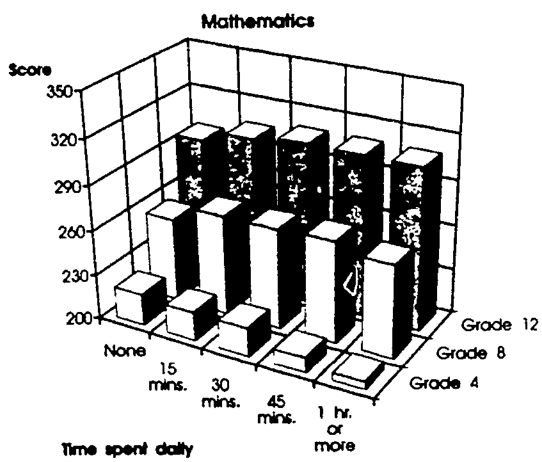
Analysis of the 1990 NAEP showed a positive relationship between time spent doing homework in science and mathematics and achievement in those subjects for eighth and twelfth grades. (See figure 2-19 and appendix table 2-29.) The positive relationship appears clearer in science than in mathematics. In mathematics, students who did any mathematics homework outscored students who did no mathematics homework; however, there are no significant differences in mathematics achievement scores among students who spent varying amounts of time on mathematics homework. In science, differences in science proficiency existed among students who spent varying amounts of time on science homework as well as between students who did any homework and students who did no homework. A similar positive correlation between time spent on science and mathematics homework and subject achievement can be seen in the 1988 and 1991 IAEP results for 13-year-olds. (See appendix tables 2-30 to 2-34.)

In contrast, fourth graders' achievement scores in mathematics and science on the 1990 NAEP declined relative to the time spent on homework. This surprisingly inverse relationship may be the result of either assigning remedial homework to lower achieving students or giving material not completed during class to slower working students for homework. These slower working or lower achieving students might also take much more time to complete the homework given, therefore reporting more time spent on it.

The existence of a relationship between homework and achievement does not necessarily imply that the homework caused the achievement. For example, more motivated students and/or students of higher ability may simply choose to do more homework. Other noncausal relationships may also be at work.

Figure 2-19
Time students report spending on science and mathematics homework and their proficiency scores, by grade: 1990





See appendix table 2-29. NSF Education Indicators—1992

SOURCES: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992); National Center for Education Statistics, *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Television Viewing

IAEP collected information in 1988 and 1991 on the amount of time that 9- and 13-year-olds in 20 countries spent watching television. (See appendix tables 2-30 to 2-34.) In 1991, among 9-year-old students, 8 percent (in Slovenia and Taiwan) to 25 percent (in the United States) reported watching television 5 or more hours each day. Among 13-year-old students, 4 percent (in France and Slovenia) to 24 percent (in Scotland) of students reported 5 or more hours of television watching, as did 21 percent of U.S. students. For each country participating in 1991, the more television the students watched, the lower their overall science and mathematics achievement. Although television viewing may not cause this lower achievement, it may indicate something about the motivation to study at home and attention paid to schooling.

Opportunity to Learn

Opportunity-to-learn (OTL) measures indicate whether students studied in school the material covered in achievement tests. Because differences in achievement results may stem, in part, from the relevance of the international test content to countries' delivered curricula, the international test standards must allow for the curricular differences that exist among countries. The 1988 IAEP collected OTL information to assess the fit between the items tested and the content taught. The OTL ratings indicate the percentage of items from the international test that teachers reported teaching to their students. Among 13-year-olds, the U.S. OTL ratios ranged from 26 for physics to 44 for life sciences, and from 36 for geometry to 69 for numbers and operations. (See appendix table 2-35.) In other words, 26 percent of the items in the physics test were taught to U.S. students. In the United States, the OTL ratings appeared to mirror course-taking patterns, with higher OTL ratings given to topics in courses taken by more students. The relationships between OTL and achievement varied, with correlation coefficients ranging from 0.00 (earth and space sciences) to 0.77 (geometry). The relationships were stronger for mathematics topics than for science topics, perhaps because the science topics were described in more general terms and the relationship was, therefore, less explicit, or perhaps because science concepts can often be encountered in places other than school.

Time Spent on Science and Mathematics

The IAEP data for 13-year-olds show that for 5 of the 14 countries participating in 1991, more time was spent on science than on mathematics. (See appendix table 2-36.) By country, the time per week spent on science ranged from 2.4 hours in South Korea to 6.4 hours in the former Soviet Union. The time spent on mathematics ranged from 3.0 hours (South Korea) to 4.3 hours (the former Soviet Union). The average time spent on these topics in the United States ranked slightly above the middle of this range: 3.9 hours per week for science and 3.8 hours for mathematics. No relationship appeared to exist between students' achievement scores in science and mathematics and the amount of instructional time spent on these subjects for countries participating in the 1991 IAEP.

Summary

In summary, this section shows differing relationships between a variety of curricular indicators and student achievement in science and mathematics. All of the relationships described are correlational, so no causality can be inferred. Several studies showed that time spent engaged in hands-on science activities was positively related to science achievement. Furthermore, higher achieving science students were more likely to participate in science fairs. The relationship between homework and achievement in science and mathematics was mixed, being positive for secondary school students (grades 7–12) but negative for elementary school students. A different process can be inferred to operate at different grade levels for the relationship between homework and achievement. Time spent viewing television was negatively related to achievement in science and mathematics for each country that participated in the 1991 and 1988 IAEP studies. On the other hand, the OTL measure and time spent on science and mathematics showed no consistent relationship to student achievement.

Chapter Summary

This chapter examined science and mathematics curricula from a broad perspective, including not only the traditional definition of curriculum as what is taught in school but also other variables that exist in a real-world framework. These variables include the goals, standards, and expectations of society at large; the interaction of students with educators and materials in informal environments such as museums and zoos as well as in their homes or clubs; and student behavior and attitudes in accessing the curriculum. The chapter thus defined curriculum according to three levels: the intended curriculum, which is the result of society's expectations of the educational system; the implemented curriculum, which involves both accessibility of the curriculum and the degree to which it is accessed; and the attained curriculum, or the development of knowledge in the subject area.

Within this broad view of curriculum, the chapter provided information from a wide range of available indicators. In general, the findings revealed that, although science and mathematics course offerings varied by school characteristics, a high percentage of students attended schools that offered a wide range of science and mathematics courses. However, few students took the more advanced courses. Information on informal and home settings showed differences in expectations and in the accessibility of curriculum materials depending on the parents' level of education. International comparisons showed that the United States lies in the middle range for a variety of curriculum indicators.

These findings by no means present a complete picture of science and mathematics curricula in the United States. Only a limited number of indicators were available, and these indicators may not reflect the most important aspects of the role of curriculum. Development of a new system of indicators could help depict more accurately the existing curriculum. This new system could include more specific information about curriculum and what occurs in the delivery or assessment of science and mathematics topics provided to elementary and secondary school classrooms.

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Chapter 3: Science and Mathematics Teachers

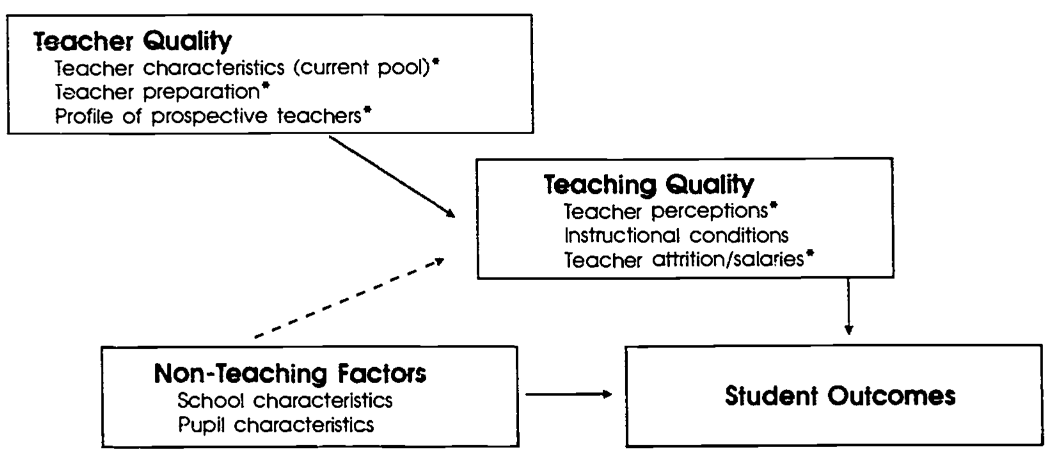
Overview

Teachers hold the key to the quality of science and mathematics education in the Nation's schools. Without effective teachers, students have limited opportunities to learn challenging mathematics and science content and to acquire higher order thinking skills in these areas, no matter how excellent the curriculum. Teachers are effective to the extent that they themselves are well prepared to teach, perceive themselves as competent, and work in a context that enables high-quality teaching.

Figure 3-1 (adapted from Darling-Hammond and Hudson 1989) presents a model of the educational process that illustrates the relationship between the quality of teachers and the quality of their teaching. For purposes of this chapter, "quality of teachers" is defined as encompassing teachers' characteristics, their experience, and their academic preparation—all of which can influence the quality of their instruction. These attributes are important both for teachers currently in the classrooms and for prospective teachers. Moreover, although many factors influence teachers' instructional practices, the quality of teachers creates limiting conditions. For example, even the most favorable teaching environment cannot make up for underprepared teachers.[1]

Teaching quality also is affected by salaries and special incentives; these are part of the context for teaching. Teachers' perceptions of their teaching conditions also influence teaching quality, which is further mediated by such nonteaching factors as school characteristics and pupil characteristics. Instructional conditions materially affect teaching quality as well—for example, class size, time spent on science and mathematics, availability of teaching materials and facilities, authority over instructional resources and methods, opportunities for planning and

Figure 3-1
Model of educational process involving teaching



*Topics covered in this chapter.

Adapted from Darling-Hammond and Hudson (1989).

NSF Education Indicators—1992

[1]In this chapter, "prepared," "underprepared," or "unprepared" refers to teachers' degrees or course-taking. Other aspects of preparation also can influence whether a teacher is prepared to teach.

collegial interaction, and procedures for reviews of teacher performance.

This chapter focuses on four sets of indicators relevant to teacher and teaching quality: teacher characteristics, including age, race and ethnicity, gender, and experience; teachers' preparation, including degrees earned, courses taken, and participation in continuing education; teachers' perceptions of their competence in mathematics and science and of the conditions they face in their teaching; and statistics relevant to the supply of teachers, including age, salary levels, attrition rates, special incentives for mathematics and science teachers, and career plans of college freshmen.[2] Information is also provided on how teacher characteristics and teacher preparation vary by grade levels taught, type of assignment, and characteristics of students taught. Factors related to curriculum and instructional conditions are discussed in Chapter 2.

Teacher Quality

This section deals with the attributes of the teachers responsible for teaching science and mathematics in the Nation's schools—the number of teachers with such responsibility at the elementary and secondary levels; breakdowns within the science and mathematics teacher corps by teacher age, sex, and race and ethnicity; and the number of years of teaching experience. Also discussed is the preparation of teachers, specifically, the types of degrees earned, courses taken during preparation, and in-service or continuing education. This part of the chapter includes a review of the distribution of teachers with various levels of preparation among different types of student groups; it also provides information on teachers' own views of their preparation for teaching different subjects. The section concludes with a look at trends in college students' choices to prepare for the teaching profession and current procedures by which states certify prospective teachers.

Characteristics of the Current Teaching Pool

Numbers of Science and Mathematics Teachers

Who should be considered a science or mathematics teacher? Someone who teaches science or mathematics exclusively? primarily? occasionally?[3] According to the 1987–88 Schools and Staffing Survey (SASS) conducted by the National Center for Education Statistics (NCES), some 1.5 million professionals were teaching science and mathematics in grades K–12, two-thirds of them teaching in grades K–6.[4] (See appendix table 3-1.) Thus, even small percentages of all science and mathematics teachers corresponded to thousands of professionals.

Survey results provide the following statistics on science and mathematics teachers:

- Almost all elementary teachers (1,025,000) had responsibilities for science and mathematics instruction.

[2] The data on teacher supply provided in this chapter primarily concern the current pool of adequately qualified science and mathematics teachers; dealing with future demands for science and mathematics teachers is beyond the scope of this chapter. For discussions of teacher supply and demand issues, see Murnane et al. (1991), National Research Council (1987), and Gilford and Tenenbaum (1990).

[3] Researchers use varying definitions to determine which teachers will be included in their studies. Definitions of teachers used by the Schools and Staffing Survey (SASS) appear at the end of this chapter. In Appendix B to this volume, a brief description of the teacher sample is provided for each of the major national studies used in this chapter. Where necessary, definitions applicable to specific data are provided in the text.

[4] Analysis of SASS data to generate statistics that describe science and mathematics teachers was performed by Elliott Medrich and associates of Management Planning Research Associates, Inc., under an NCES grant.

- Some 50,000 elementary teachers specialized in teaching science or mathematics.[5]
- Almost half a million (480,000) secondary teachers (grades 7–12) were teaching some science and mathematics.
- About 330,000 secondary teachers were providing science or mathematics instruction as their main or second assignment.[6] (See appendix tables 3-1 and 3-2 and sidebar.)
- Many secondary teachers with main assignments in one field of science were teaching other sciences as well. For example, 63 percent of high school physics teachers primarily taught other subjects, most often chemistry or mathematics (Neuschatz and Covalt 1988).

Teachers With Minor Science or Mathematics Assignments

SASS findings show that 150,000 secondary teachers (namely, teachers of grades 7–12) with language, arts, social science, etc., as their main or second assignment taught some science or mathematics courses. (See appendix tables 3-1 and 3-2.) Data indicate that teachers with second assignments for science or mathematics instruction were less prepared than teachers whose main assignment was science or mathematics. (See appendix table 3-4.) Teachers with less than second assignments for science or mathematics were even less prepared. Even if each of these teachers conducted only one science or mathematics class, this means that secondary students in 150,000 classes had teachers whose main or second assignment was neither science nor mathematics. This situation probably will always exist, given the administrative task of matching the available science and mathematics teachers to the number of classes needed in a school. Nevertheless, this indicator should be monitored.

Sex

On the basis of concern for role model appropriateness, arguments about the need for more male teachers at the elementary level and more female teachers in the physical sciences have been put forward. But SASS results show that elementary teaching continued to be dominated by females: 90 percent of all elementary teachers in 1987–88 were female.[7] (See figure 3-2.) It is interesting that only 82 percent of elementary mathematics specialists and 66 percent of science specialists were female. Thus, there is a greater percentage of males among the few elementary teachers who specialize in science or mathematics than among the large pool of general elementary teachers.

Representation by sex varied by grade level. (See figure 3-3.) The female-to-male ratio of all secondary teachers (grades 7–12) was close to 1; females constituted 46 percent of these teachers. The ratio varied, however, by subject area. (See figure 3-2.) Women accounted for only 32 percent of secondary instructors teaching chemistry or physics. In other science fields, the underrepresentation of females is less pronounced.

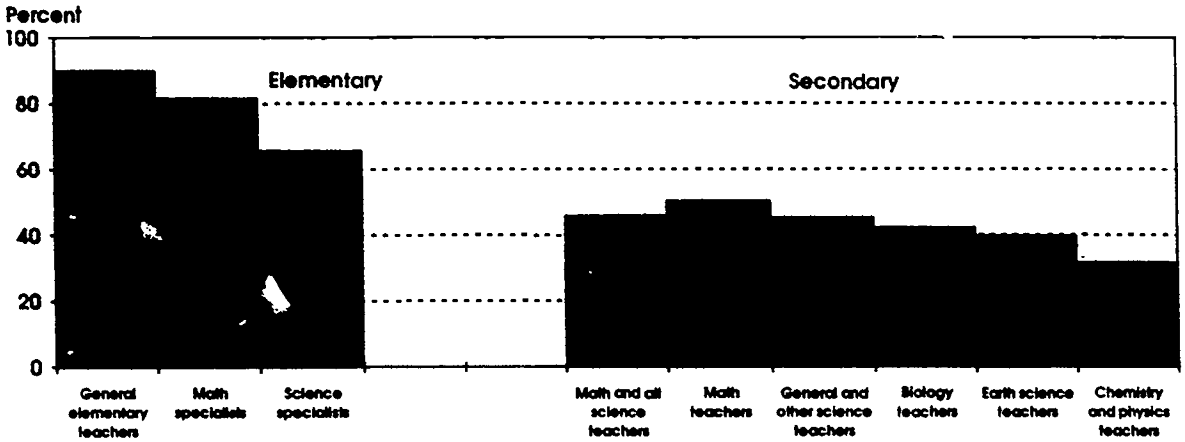
The relative proportions of male and female high school teachers in science and mathematics have changed over time—more so among mathematics teachers than science teachers. (See appendix table 3-6.) Analysis of results from the 1977 National Survey of Science and Mathematics Education (NSSME) shows that two-thirds of the mathematics teachers in high school were male; in 1985–86, nearly one-half of the high school mathematics teachers were female (Weiss 1989). However, a large gender gap

[5]Throughout this chapter, these teachers are referred to as "elementary science specialists" or "elementary mathematics specialists."

[6] "Main assignment" teachers are those who listed mathematics or science as the field in which they teach the most classes. "Second assignment" teachers are those who listed mathematics or science as the field in which they teach the second most classes. Of the 330,000 teachers cited above, 90 percent were main assignment and 10 percent were second assignment.

[7]National data on teacher characteristics, such as sex, mask considerable differences among states. See the following discussion on age as an example.

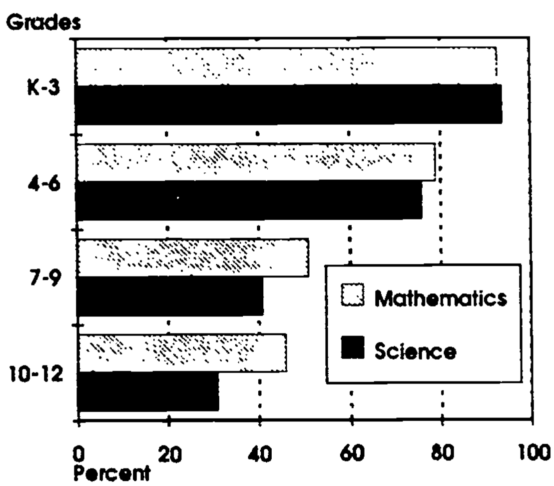
Figure 3-2
Percent female of all teachers of mathematics or science who teach those subjects as a main or second assignment: 1987–88



See appendix tables 3-1 and 3-5. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987–88, Teacher Questionnaire, special tabulations created by Elliott Medrich, MPR Associates, Inc.

Figure 3-3
Percent female of all teachers of mathematics or science at different grades: 1985–86



See appendix table 3-6. NSF Education Indicators—1992

SOURCE: I.R. Weiss. Report of the 1985–86 National Survey of Science and Mathematics Education (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume II* (Washington, DC: National Science Teachers Association, 1990).

still existed among high school science teachers: 68 percent were male in 1985–86, compared with 74 percent in 1977. The results for 1985–86 are consistent with the SASS findings cited previously for grades 7–12.

Age

In 1987–88, the group of teachers closest to retirement—those age 50 or older—made up a slightly higher percentage of elementary teachers (21 percent) than of secondary teachers (17 percent). (See text table 3-1.) The size of this group among secondary teachers varied by subject area. In mathematics, the proportion of teachers who fall into the 50+ age range matched that of all secondary teachers (17 percent). At the extremes, the 50+ group constituted 23 percent of teachers instructing in chemistry or physics but only 12 percent of earth science teachers.[8] By the same token, there were more young earth science teachers than young chemistry or physics teachers. Thus, chemistry and physics teachers are more likely to be in short supply in the

[8]The SASS questionnaire used to obtain these data does not allow for separate reporting of data on chemistry and physics teachers.

Text table 3 .

Age distribution of science or mathematics teachers who teach those subjects as a main or second assignment, by teaching level and course taught: 1987–88

Level and course taught	Percent of total	20–29 years old	30–49 years old	50 years or older
Elementary teachers	100.0	13.7	65.7	20.6
Mathematics specialists	100.0	13.3	64.9	21.8
Science specialists	100.0	14.3	67.3	18.4
Secondary teachers	100.0	16.1	67.3	16.6
Mathematics	100.0	16.3	67.7	16.1
Biology	99.9	14.7	68.9	16.3
Chemistry/physics	100.0	12.5	64.9	22.6
Earth science	100.1	20.4	68.1	11.6
General/other science	100.1	16.9	65.5	17.7

See appendix table 3-5.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. U.S. Department of Education. Schools and Staffing Survey, 1987–88. Teacher Questionnaire, special tabulations created by Elliott Medrich. MPR Inc.

next decade if age (and associated retirement) is assumed to be the main determinant of attrition for this group.

National statistics often mask wide differences in state-by-state statistics. For example, the national SASS results shown in text table 3-1 indicate that the proportion of secondary mathematics teachers over age 50 was 16 percent. State data collected by the Council of Chief State School Officers (Blank and Dalkilic 1990) show values ranging from about 10 percent for Kentucky and North Carolina to about 29 percent for Minnesota and Delaware among the 36 states that reported. (See appendix table 3-7.) Because labor markets for teachers are more likely to be regional than national (Grissmer and Kirby 1987), generalizing the national findings cited here to individual states may not be useful.

National Education Association (NEA) data for 1991 show that the mean age of the current teaching pool is close to what it was in 1961. (See appendix table 3-8.) However, when considering teachers' age distribution, one should not rely on the mean as an indicator. For instance, a rather lower percentage of younger teachers made up the 1991 pool than was the case 20 years ago. (See figure 3-4.) Moreover, about two-thirds of the 1991 teaching pool was aged 30 to 49, compared with about 40 percent in 1966.[9] Because many of the large group of middle-aged teachers will enter the 50+ age-group in the near future, schools can expect a significant increase in the retirement rate in about a decade.

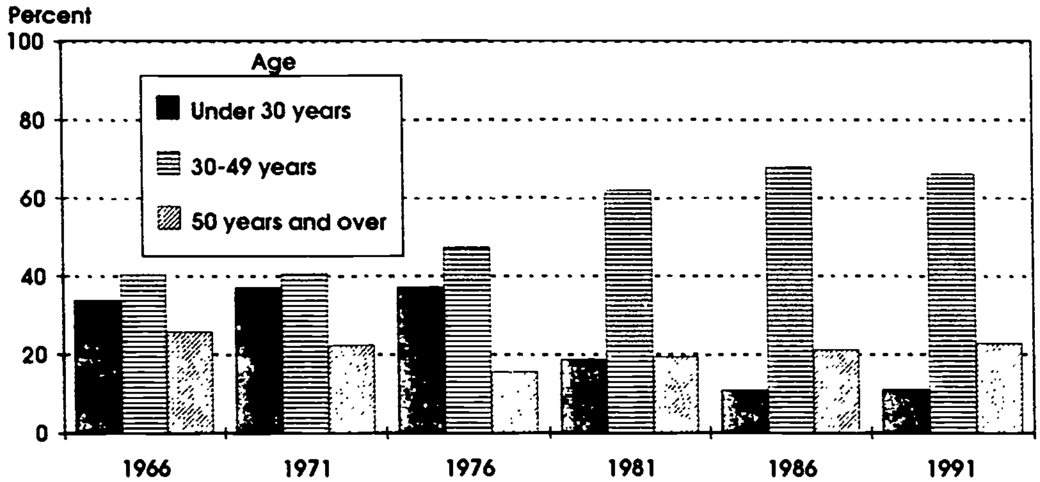
Race and Ethnicity

The proportions of teachers by race in 1987–88 were virtually the same for elementary teachers and secondary science and mathematics teachers: white, 88 percent; black, 6 percent; other races, 6 percent.[10] (See appendix table 3-1.) The corresponding

[9]The NEA time series does not specifically include trend data on age for science and mathematics teachers.

[10]The SASS teacher questionnaire did not clearly distinguish among Asians, Hispanics, and Native Americans.

Figure 3-4
Percent of all public school teachers, by age-group: 1966 to 1991



See appendix table 3-8.

NSF Education Indicators—1992

SOURCE: National Education Association. *Status of the American Public School Teacher.* 1990–1991 (Washington. DC. 1992).

percentages of minority students were significantly higher: minorities accounted for 29 percent of students in 1987–88; 15 percent of students were black (Alsalam et al. 1992).

Because a gap exists between the percentages of minority teachers and students, it is not surprising that most minority students do not have minority teachers. The paucity of minority teachers is doubly unfortunate: minority teachers act as role models for minority students and, in an increasingly heterogeneous society, all students need to see effective teachers who come from different backgrounds, ethnic groups, and races.

Student race and ethnicity correlates to the student's likelihood of having a teacher of the same race or ethnicity. (See text table 3-2.) NAEP collected race and ethnicity data on mathematics students in the fourth and eighth grades in 1990. This study showed that an overwhelming proportion of white students had white teachers: 93 percent of white students in fourth grade, 95 percent of white students in eighth grade. In contrast, 40 percent of black students in fourth grade and 21 percent of black students in eighth grade had black teachers in mathematics. Very few Hispanic children had Hispanic teachers in mathematics: 8 percent of fourth graders and 13 percent of eighth graders.

Years of Teaching Experience

The SASS findings reveal that teachers' years of experience teaching science and mathematics may be fewer than their total years of teaching experience. (See text table 3-3.) For example, while only 13 percent of secondary teachers who teach mathematics or science as their main or second assignment had 3 years or less of **total** teaching experience, 33 percent had 3 years or less of experience teaching in their **main** fields. These findings are supported by results from the National Assessment of Educational Progress (NAEP), presented in appendix table 3-11.[11]

[11]The NAEP reports group together all teachers with 5 or fewer years of experience. Murnane and Phillips (1981) report that the highest difference in effectiveness is between teachers in their first and second years of teaching and those with more than 2 years of experience.

Text table 3-2
Percent of students with mathematics teachers of different races and ethnicities, by student characteristics, grades 4 and 8: 1990

Grade and student characteristic	Percent of Total	Percent with White teacher	Percent with Black teacher	Percent with Hispanic teacher	Teacher's race not reported
Grade 4	100	85	11	2	2
Male	100	85	11	2	2
Female	100	85	11	2	2
White	100	93	5	1	1
Black	100	57	40	2	1
Hispanic	100	75	13	8	4
Grade 8	100	91	5	3	1
Male	100	91	5	3	1
Female	100	91	6	2	1
White	100	95	3	2	0
Black	100	77	21	2	0
Hispanic	100	80	5	13	2

See appendix table 3-9.

NSF Education Indicators—1992

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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991).

Preparation of Teachers in the Current Teaching Pool

To provide effective science or mathematics instruction, teachers need an adequate grounding in the subject matter and an understanding of how students at the relevant grade levels learn these subjects. Teachers may acquire this knowledge both through formal preparation and through experience and in-service education. Analysis of teacher preparation, therefore, should include data on degrees earned (both undergraduate and graduate), undergraduate majors, graduate degree fields, types of courses taken, and the amount of in-service work. Recency of courses taken or in-service participation in relevant subjects also is of interest, particularly in scientific and mathematical fields.

Unfortunately, statistics on majors and numbers of courses taken do not provide sufficient information about the depth of science or mathematics preparation. Listings of courses taken—either reported by teachers or taken from college transcripts—provide somewhat better information. None of these sources, however, notes how adequate the courses were—for example, whether the science courses included any laboratory investigations or how thoroughly the teacher mastered the material.

Degrees Earned

Almost one-half of the pool of science and mathematics teachers surveyed in 1987–88 held a degree beyond the bachelor's degree; this was true of both elementary specialists and secondary teachers. (See

Text table 3-3
Teaching experience for elementary and secondary mathematics and science teachers who teach those subjects as a main assignment: 1987–88

Teaching level	Percent of total	Years of overall teaching experience			Percent of total	Years of teaching experience in main field		
		3 or less	4-19	20 or more		3 or less	4-19	20 or more
Elementary specialists	100.0	11.4	62.0	26.6	100.0	34.1	58.8	7.1
Secondary teachers	100.0	12.5	57.9	29.6	100.0	33.3	57.7	9.0

See appendix table 3-10. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics. U.S. Department of Education. Schools and Staffing Survey. 1987–88. Teacher Questionnaire. special tabulations created by Elliott Medrich. MPR Associates. Inc.

appendix table 3-12.) The most common advanced degree earned by teachers was the master's degree.[12] However. about 8 percent of science and mathematics teachers had earned an education specialist or doctoral degree (6 and 2 percent. respectively).[13]

A somewhat larger percentage of secondary teachers than elementary specialists obtained master's degrees (44 percent versus 36 percent). The information in text table 3-4 indicates that a considerably higher proportion of teachers with 4 or more years of experience held master's degrees than did teachers with less experience. More male than female teachers earned master's degrees: the difference in percentages of degrees between males and females was similar for both elementary specialists and secondary teachers (9 and 8 percentage points. respectively).

Most elementary teachers who specialized in teaching science or mathematics did not have bachelor's degrees in science or science education or in mathematics or mathematics education. (See figure 3-5.) Rather. like the entire pool of elementary teachers. most of these teachers earned degrees in elementary education.

Text table 3-4
Percent of teachers holding M.A. or M.S. degrees as their highest degree, by sex, teaching experience, and level: 1987–88

Teacher characteristic	Elementary specialists	Secondary teachers
Total	36.1	43.9
Sex		
Male	43.1	47.3
Female	33.8	39.7
Years of teaching experience		
0 to 3	7.1	11.8
4 to 19	36.9	44.0
20 or more	46.6	57.4

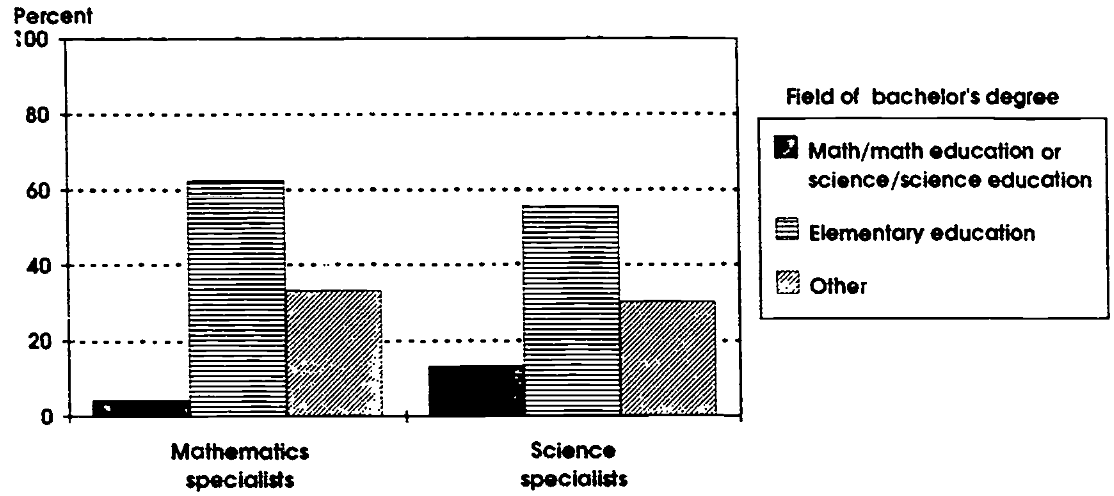
See appendix table 3-12. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education. Schools and Staffing Survey. 1987–88, Teacher Questionnaire. special tabulations created by Elliott Medrich. MPR Associates, Inc.

[12]Because a number of states are now mandating or will soon require teachers to earn master's degrees. care will be needed in tracking this indicator in the future.

[13]The education specialist degree is unique to the education field: it requires a level of coursework and research between those of master's and doctoral degrees.

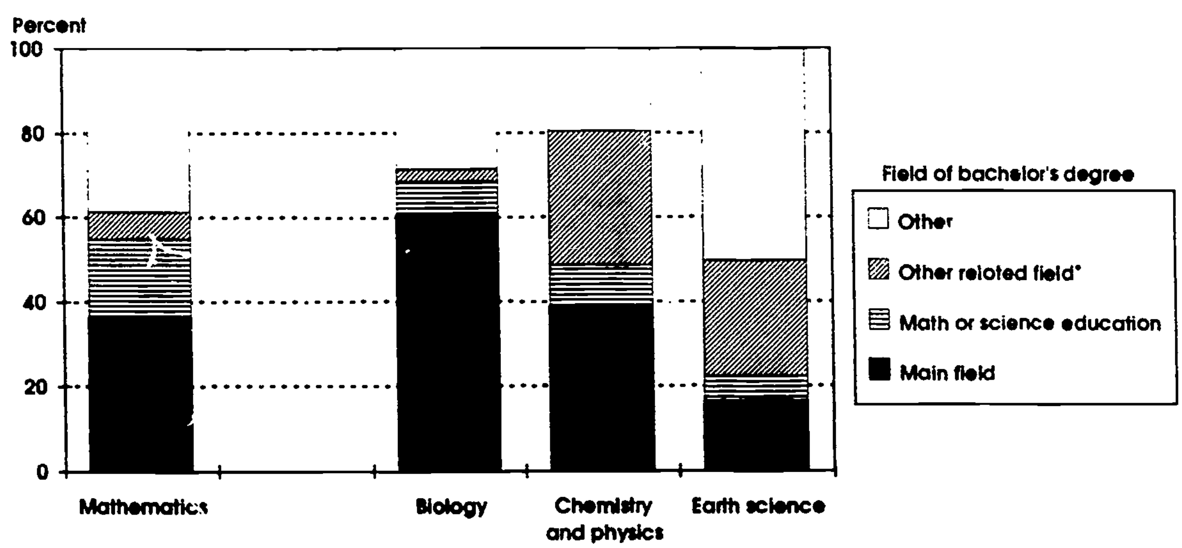
Figure 3-5
Percent of elementary specialists in mathematics or science, by field of bachelor's degree: 1987–88



See appendix table 3-13. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987–88, Teacher Questionnaire, special tabulations created by Elliott Medrich, MPR Associates, Inc.

Figure 3-6
Percent of secondary mathematics or science teachers who teach those subjects as a main assignment, by field of bachelor's degree: 1987–88



*For mathematics, teachers holding science degrees; for science, teachers holding degrees in other science or in mathematics.

See appendix table 3-4. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987–88, Teacher Questionnaire, special tabulations created by Elliott Medrich, MPR Associates, Inc.

108

The percentage of secondary teachers who earned subject matter degrees in the fields they teach varied by subject area. (See figure 3-6.) A larger proportion of biology teachers held subject matter degrees (60 percent) than did teachers in any other science. area, while far fewer earth science teachers earned degrees in earth science fields (16 percent). The percentage of mathematics teachers earning degrees in mathematics education was greater than the percentage of science teachers holding science education degrees (18 percent versus 6 to 9 percent).

Not surprisingly, among teachers of grades 7–12 whose **second** (rather than main) assignment was science or mathematics instruction, the percentage who earned subject matter degrees was much lower. For example, only 8 percent of the second assignment instructors teaching mathematics held mathematics degrees; only 6 percent of these teachers teaching biology held biology degrees. (See appendix table 3-4.)

Some middle school science and mathematics teachers are less prepared than high school teachers because they complete different programs of study. Few teacher training institutions offer programs entirely devoted to the preparation of middle school teachers; instead, many institutions prepare these teachers by adding a few courses to the elementary teacher preparation program. Thus, the science and mathematics preparation of some middle school teachers may not be any greater than that of elementary teachers, who may be required to complete between zero and three courses each in science and mathematics.

In 1987–88, teachers of grades 9–12 were better prepared than were teachers of grades 7–8; more of the teachers at the higher grade levels had science or mathematics degrees. (See figure 3-7.) However, a higher percentage of science teachers at both levels had degrees in science compared with mathematics teachers holding degrees in mathematics. Especially noteworthy is the small number of seventh- and eighth-grade mathematics teachers who held mathematics degrees and the relatively large number who held elementary education degrees.

As gauged by majors in the field, the preparation of science teachers for their main or second science assignments varied considerably by discipline.[14] (See figure 3-8.) Fewer than 10 percent of the teachers responsible for instruction in earth sciences in seventh and eighth grade (grades in which the subject is frequently taught) had bachelor's degrees in earth science.[15] More of these teachers had degrees in

Student Achievement Related to Teacher Preparation

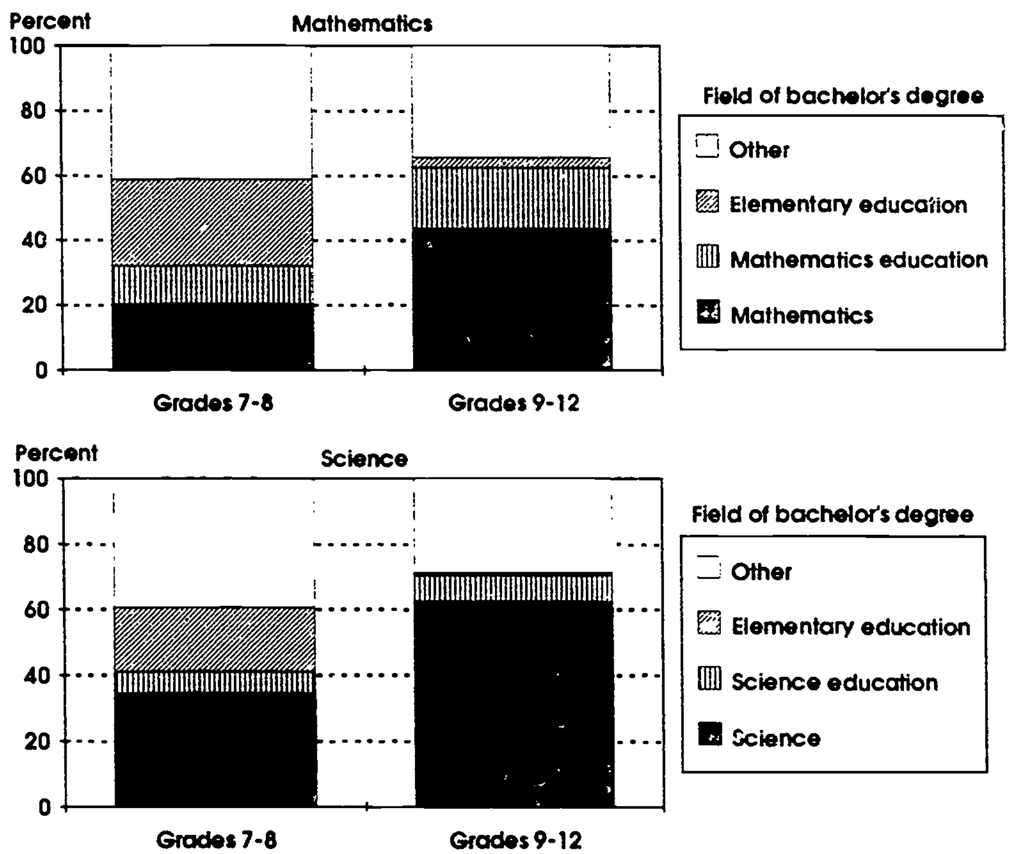
Results of NELS:88 indicate that eighth-grade students' mathematics achievement was related to their teachers' preparation and experience. Specifically, students whose teachers had majored in mathematics (or mathematics education) performed slightly better than those whose teachers had majored in education only. Also, students whose teachers had 3 or fewer years of experience scored slightly lower than students whose teachers had 10 or more years of experience. (See appendix table 3-18.) No statistically significant relationship was found for science.

Other national studies (NCES 1991, 1992) sometimes have failed to show relationships between teacher preparation and student achievement, possibly because of the cross-sectional nature of the studies. Because students are tested only at one point, their performance is a product of the skills of all previous teachers, not just the effectiveness of their current teachers. Also, the types of test items used often inadequately capture the higher learning that mathematics and science educators believe are most affected by teacher preparation (Madaus et al. 1992).

[14]Because chemistry and physics are not taught as specific fields in grades 7 and 8, and the SASS data do not address the status of teachers assigned to "physical science" courses, these fields are not represented in the analysis.

[15]The SASS question that elicits information on "earth science" degrees provided a range of choices, all of which could reasonably be so classified.

Figure 3-7
Percent of secondary mathematics or science teachers who teach those subjects as a main or second assignment, by field of bachelor's degree and grade range: 1987–88



See appendix table 3-14.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987–88, Teacher Questionnaire, special tabulations created by Elliott Medrich, MPR Associates, Inc.

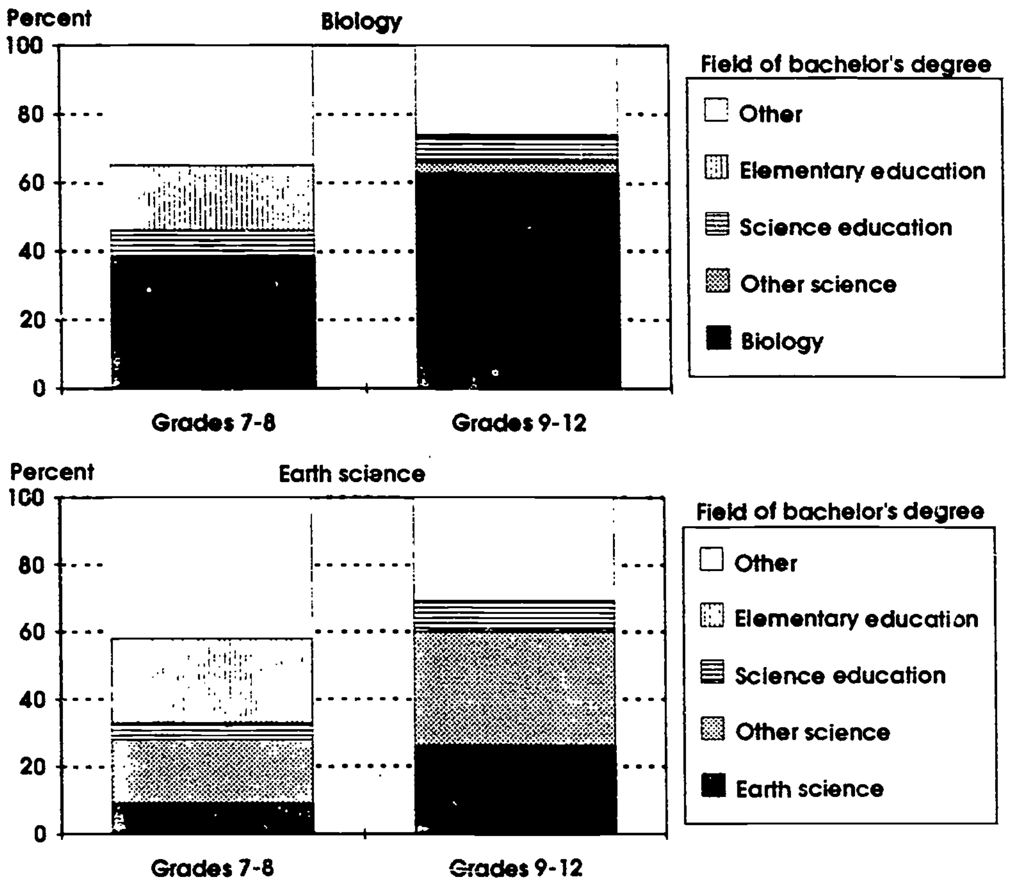
biology than in the field that they were teaching. Even for grades 9–12, the proportion of earth science teachers with bachelor's degrees in earth science was only 25 percent. In biology, on the other hand, 38 percent of the teachers in grades 7–8 had bachelor's degrees in this subject; this proportion increased to 63 percent in grades 9–12.

Inequitable Distribution of the Most Qualified Teachers

The distribution of teachers with relevant majors across students' racial, ethnic, and income groups is an important equity issue. The information presented in appendix table 3-16 and text table 3-5 demonstrates that students in poor schools tended to have less well-prepared teachers—namely, teachers with majors in education rather than in a subject matter field—compared with students in wealthy schools.

Figure 3-6

Percent of secondary biology and earth science teachers who teach those subjects as a main or second assignment, by field of bachelor's degree and grade range: 1987–88



See appendix table 3-15. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987–88, Teacher Questionnaire, special tabulations created by Elliott Medrich, MPR Associates, Inc.

NELS:88 found a relationship between teachers' majors and students' socioeconomic status (SES).[16] Low-SES students were less likely to have mathematics teachers who majored in mathematics or mathematics education. (See text table 3-5.) Also, more mathematics teachers of low-SES students majored only in education than did teachers of middle- or high-SES students. Analogously, appendix table 3-16 indicates that fewer science teachers of socially and economically disadvantaged children in the eighth grade had majors in science or science education than did teachers of middle- or high-SES students.

Another gauge of the poverty level of schools—the percent of students who receive free lunches—yielded similar findings in NELS:88. In impoverished schools—those in which more than 50 percent of the students receive free lunches—mathematics teachers

[16]NELS:88 based student SES on the following background variables: parents' educational levels, parents' occupations, and family income. Socioeconomic groups were defined as follows: the "low" SES group refers to the lowest 25 percent of a composite of these variables; "middle" refers to the middle 50 percent; and highest 25 percent comprises the "high" SES group.

Text table 3-5

Percent of public school 8th-grade students whose mathematics teachers had different bachelor's degrees, by student and school characteristics: 1988

Student and school characteristic	Percent of total	Teacher: Majored in mathematics/ math ed.	Minored in mathematics/ math ed.	Majored in education only	Majored in other subject
Total	100.0	43.3	27.1	18.2	11.4
Socioeconomic status					
Low	100.1	38.5	25.9	23.1	12.6
Middle	100.0	43.2	27.7	17.7	11.4
High	100.0	49.8	26.2	13.2	9.8
Race and ethnicity					
Asian/Pacific Islander	100.1	44.1	23.5	15.0	17.5
Hispanic	100.1	33.3	28.5	17.5	20.8
Black	100.0	40.0	26.6	21.5	12.9
White	100.0	45.7	27.2	17.7	9.4
Native American	100.0	30.5	23.5	23.4	22.6
Percent free lunch					
5 or less	100.0	45.7	26.6	15.6	12.1
6–20	100.0	49.7	26.2	14.0	10.1
21–50	99.9	40.3	27.8	20.3	11.5
more than 50	100.2	31.8	26.1	24.1	18.2

See appendix table 3-17.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, National Education Longitudinal Study of 1988 (NELS:88): "Base Year Student and Teacher" surveys as cited by L. Horn, A. Hafner, and J. Owings, *A Profile of American Eighth-Grade Mathematics and Science Instruction*, NCES 92-486 (Washington, DC: 1992).

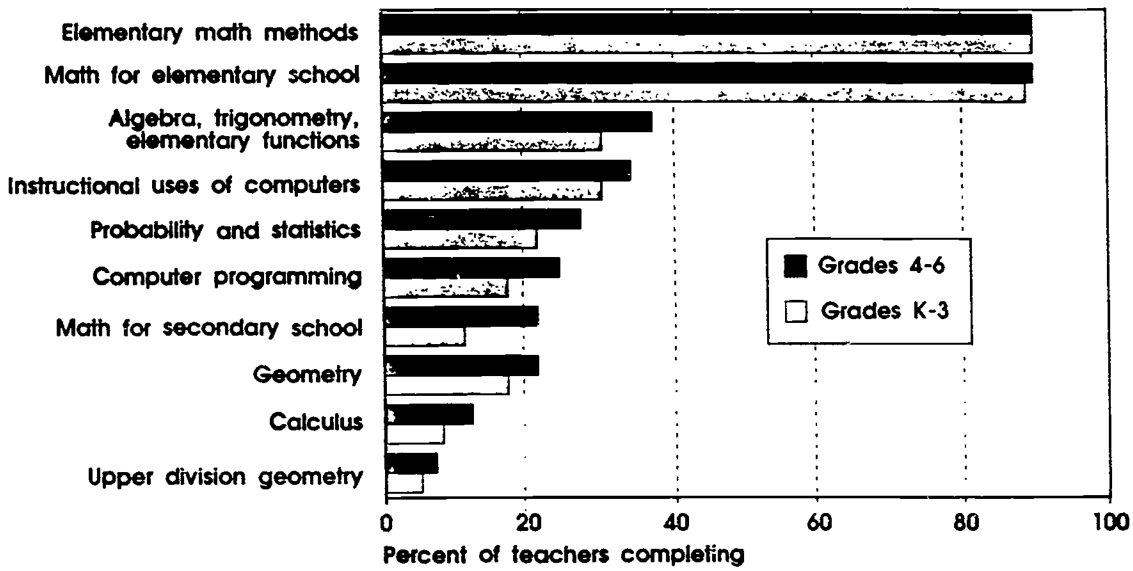
were less likely to have majored in mathematics or mathematics education.[17]

NELS:88 also found an inequitable distribution of the most qualified mathematics teachers among students belonging to different racial or ethnic groups. (See text table 3-5.) White students in eighth grade were somewhat more likely to have teachers who majored in mathematics or mathematics education (46 percent) than were black students (40 percent). Hispanic students were less likely than white or black students to have teachers with the most subject matter preparation (33 percent).

Oakes (1990) obtained similar findings using data collected by the National Survey of Science and Mathematics Education. Teachers at secondary schools serving minority or disadvantaged students were less likely to hold bachelor's or master's degrees in science or mathematics. In sum, students attending predominantly white, high-SES, and suburban schools had greater access to well-qualified science and mathematics teachers.

[17]SASS measures of socioeconomic status are inadequate for making comparisons similar to those made using NELS:88 data.

Figure 3-9
College courses completed by elementary teachers: 1985–86



See appendix table 3-19. NSF Education Indicators—1992

SOURCE: I.R. Weiss. Report of the 1985–86 National Survey of Science and Mathematics Education (Research Triangle Park. NC: Research Triangle Institute. 1987). as cited in *Science and Mathematics Education Briefing Book. Volume I* (Washington. DC: National Science Teachers Association. 1989).

Courses Taken During Preparation

The 1985–86 NSSME is the source of the most current statistics on course-taking patterns of elementary and secondary teachers of science and mathematics. (See figures 3-9 and 3-10.) Results show that most elementary school teachers took college courses in elementary mathematics methods and in mathematics for elementary school: few had any preparation in geometry or in instructional uses of computers. For secondary mathematics teachers. calculus and methods of teaching mathematics were the most commonly taken courses: surprisingly. even in grades 7–9. fewer than one-half of the teachers had taken courses in computer programming.

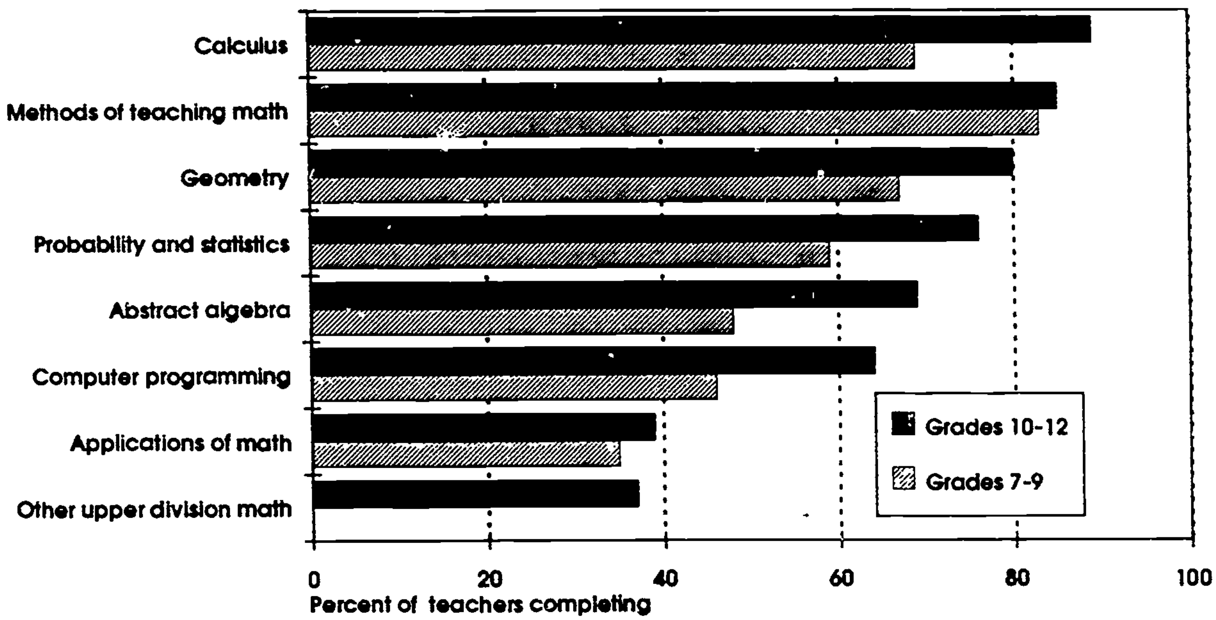
Figure 3-11 provides corroborating evidence that earth science teachers in middle school had less preparation for teaching their subject than have either physical science or life science teachers. The NSSME results show that 50 percent of earth science teachers in grades 7–9 had only two or fewer courses in the earth sciences.

Continuing Education

Unfortunately. the least prepared teachers also were least involved in recent continuing education. Figure 3-12 shows that in 1985–1986 the majority of elementary teachers' coursework in science was completed 5 or more years earlier: fewer than 30 percent took coursework in the 5 years before the survey.[18] In contrast. the majority of secondary science teachers took courses less than 5 years prior to the survey: 61 percent of teachers of grades 7–9 and 57 percent of teachers of grades 10–12. A

[18]Nelson et al. (1990) as well as other researchers report that teachers perceive other forms of continuing education—such as observing classrooms. reading professional journals. and meeting informally with other teachers—to be as useful or more useful than courses.

Figure 3-10
College courses completed by middle school or high school mathematics teachers: 1985–86



See appendix tables 3-20 and 3-21.

NSF Education Indicators—1992

SOURCE: I.R. Weiss, Course Background Preparation of Science and Mathematics Teachers in the United States (Chapel Hill, NC: Horizon Research, Inc., 1988), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1989).

similar pattern, although not as pronounced, was evident in mathematics.

There may be fewer opportunities for in-service education in science and mathematics for elementary school teachers than for secondary school teachers. This hypothesis is strengthened by the NSSME findings on in-service participation by teachers at different grade levels. (See appendix table 3-24.) NAEP findings for mathematics teachers (NCES 1991) also indicate that nearly one-third of fourth-grade teachers reported no mathematics in-service education during the previous year, compared with 13 percent for eighth-grade teachers.

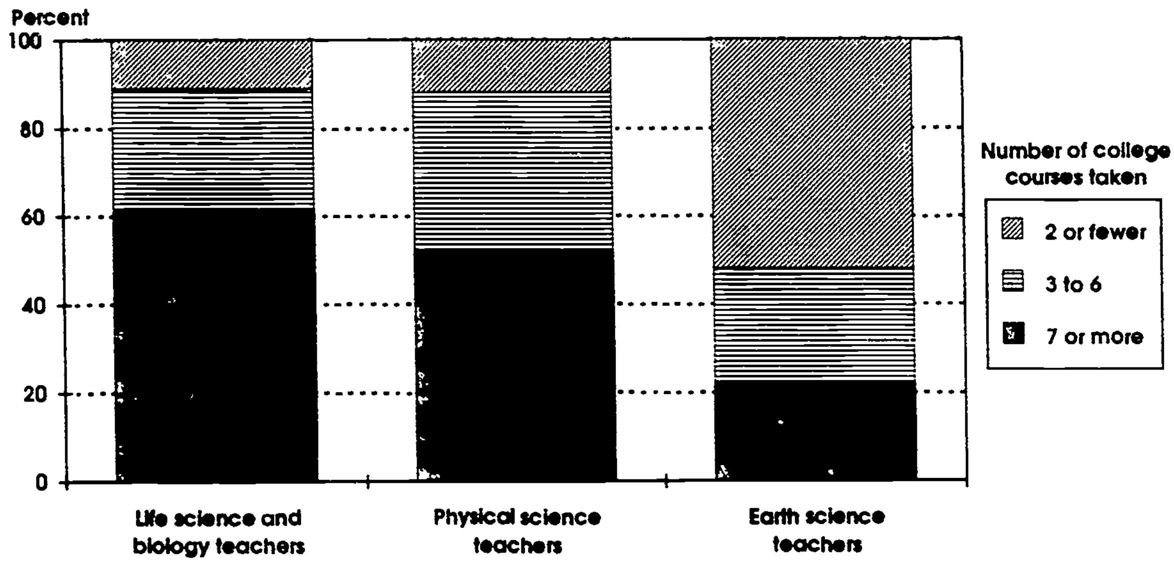
Teachers' Perceptions of Their Preparation

NELS:88 collected data on teachers' own perceptions of their ability to teach various subjects and their preparation in those subjects. The results differ by subject and indicate that teachers' views of their ability to teach science may be influenced by the amount of their science preparation. For example, the NELS:88 data indicate that eighth-grade teachers with 40 or fewer science course credits were less likely to feel very well prepared to teach science than those with more than 40 credits. (See appendix table 3-25.)

A majority of elementary teachers felt well qualified to teach reading and mathematics but only adequately qualified to teach science. (See figure 3-13.) Only 1 percent of the teachers perceived themselves as not well qualified to provide instruction in reading or mathematics, compared with 22 and 23 percent of the teachers who reported they were not well qualified to provide instruction in earth/space

114

Figure 3-11
Percent of science teachers of grades 7–9, by number of college courses taken in their teaching field: 1985–86



See appendix table 3-22.

NSF Education Indicators—1992

SOURCE: I.R. Weiss, Course Background Preparation of Science and Mathematics Teachers in the United States (Chapel Hill, NC: Horizon Research, Inc., 1988), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1989).

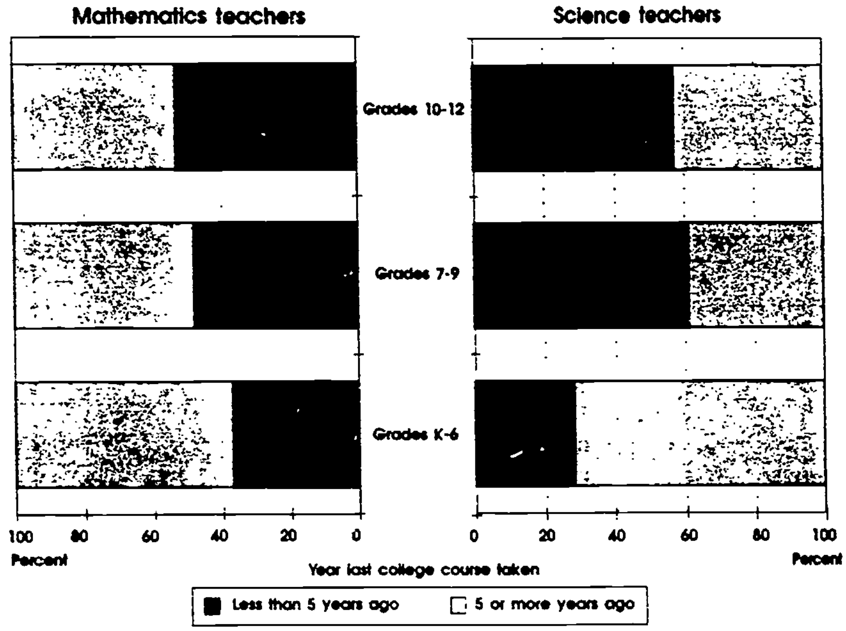
science and physical science, respectively. NELS:88 yields similar findings for eighth-grade science and mathematics teachers. Most perceived themselves to be very well or well prepared to teach their subject, but more mathematics teachers had this perception than did science teachers (96 percent versus 82 percent, respectively).

Profile of Prospective Teachers

The number of new entrants available to the teaching pool depends on both the number of undergraduate students deciding to go into teaching and formal requirements for entering the profession, such as certification and testing, which are generally imposed at the state level.[19] In the short run, neither certification nor required tests generally keep otherwise qualified individuals from entering the teaching profession (for example, teachers can be granted temporary certificates). Most jurisdictions, however, require teachers to pass tests and become fully certified within a given period of time (2 to 3 years) in order to continue teaching. Recently, an additional source of incoming teachers has been alternative certification (career shifts). The decision to enter traditional teacher training programs or alternative certification programs is driven in part by market conditions.

[19]The actual number of teachers entering the pool is smaller than the number potentially available because some individuals who are fully prepared and certified decide to enter other careers.

Figure 3-12
Percent of mathematics and science teachers completing their last college course less than 5 years ago, by grade: 1985–86



See appendix table 3-23.

NSF Education Indicators—1992

SOURCE: I.R. Weiss. Report of the 1985–86 National Survey of Science and Mathematics Education (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1989).

Career Choices

Since 1982, a steady increase has occurred in the percentage of college freshmen planning to pursue a career in teaching.[20] (See figure 3-14.) Heightened interest in education as a career has been accompanied by an increase in SAT scores of prospective education majors. (See sidebar on page 104 and Figure 3-17.) This directly contrasts with declines in health- and science-related career choices, such as engineering and nursing. Interest in education at the secondary level increased at about the same rate among both males and females. However, the increases among males choosing elementary education as a career have been very small. (See figure 3-15.) Furthermore, for most minorities, the percentage of freshmen interested in teaching careers continued to be lower than the percentage of white students pursuing teaching, especially among prospective secondary teachers. (See figure 3-16.) Murnane et al. (1991) suggest that the decreasing proportion of blacks actually entering teaching might be the result of testing requirements for licensure[21] and the opening up of more opportunities in nonteaching careers.

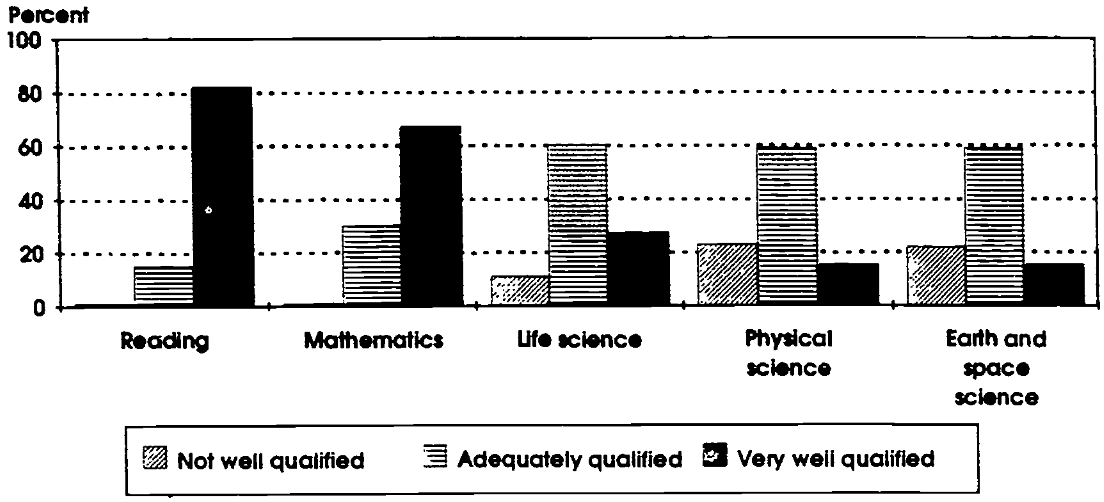
State Certification and Testing

State certification of science and mathematics teachers is a poor national indicator of teacher quality. For one thing, the range in course

[20]These data come from an annual survey of college freshmen (Astin et al. 1991). Optimism spurred by the upward trend in numbers of prospective teachers must be tempered by these facts: (1) many college students change their majors, and (2) the survey only has categories for elementary or secondary education, not science or mathematics teaching.

[21]A disproportionate number of black teaching applicants score below the cutoffs on standardized tests required for state licensure (Smith 1987).

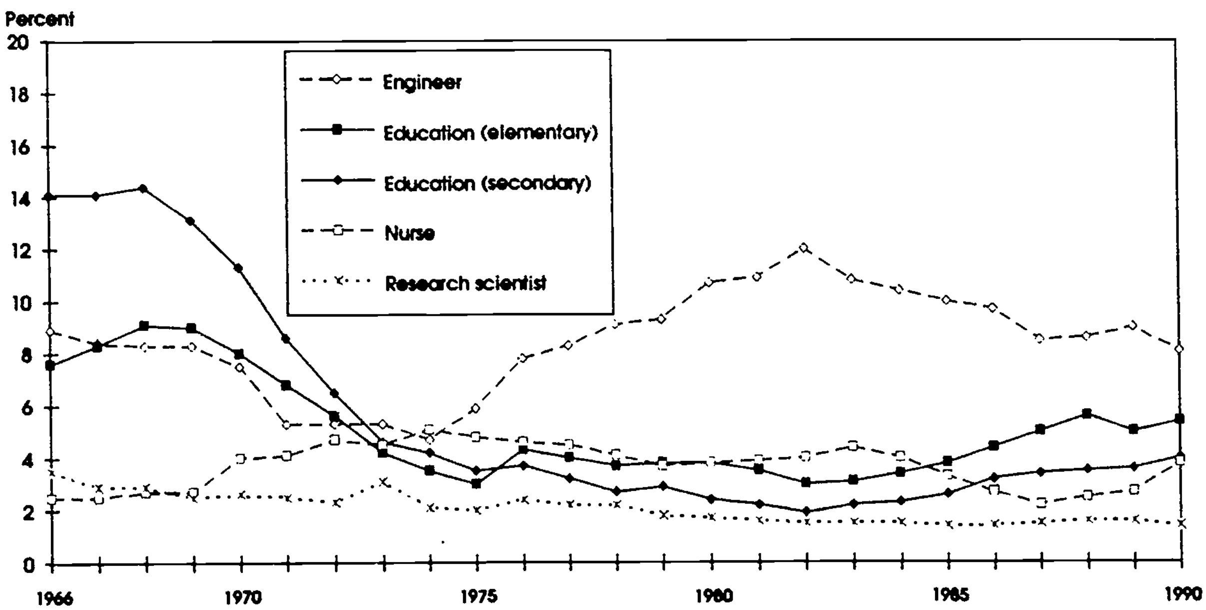
Figure 3-13
Percent of elementary teachers with different perceptions of their qualifications to teach selected courses: 1985–86



See appendix table 3-26. NSF Education Indicators—1992

SOURCE: I.R. Weiss, Report of the 1985–86 National Survey of Science and Mathematics Education (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1989).

Figure 3-14
Percent of college freshmen choosing selected careers: 1966 to 1990

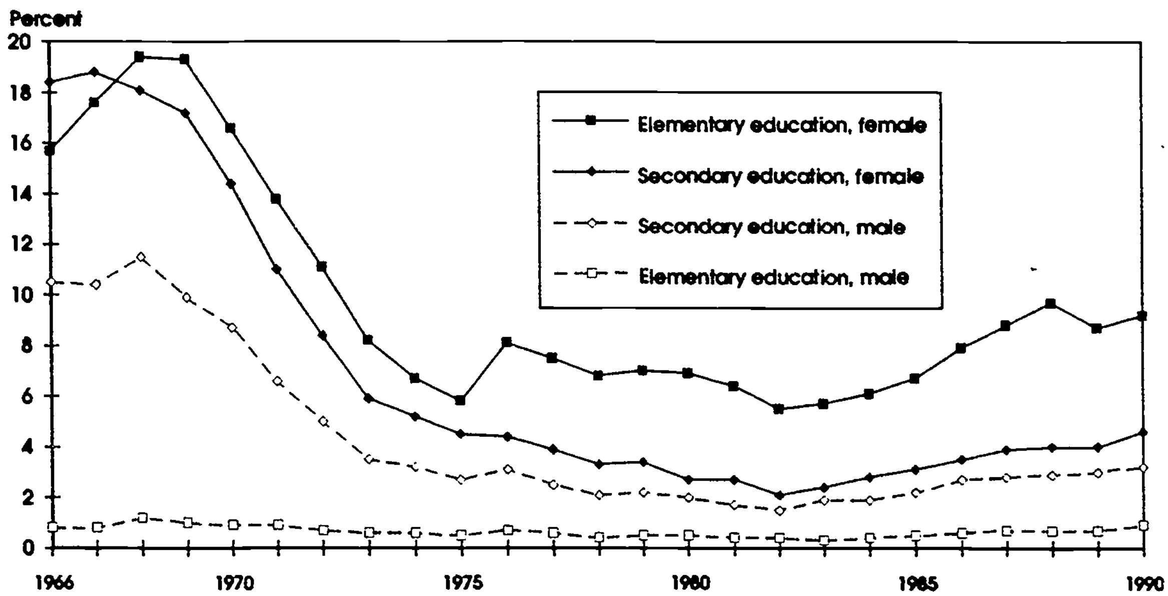


See appendix table 3-27. NSF Education Indicators—1992

SOURCE: E.L. Dey, A.A. Astin, and W.S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966–1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991).

117

Figure 3-15
Percent of college freshmen choosing education careers, by teaching level and sex: 1966 to 1990



See appendix table 3-27. NSF Education Indicators—1992

SOURCE: E.L. Dey, A.A. Astin, and W.S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966–1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991).

requirements for certification among states is very large. (See appendix table 3-30.) At the extremes. one state requires 16 course credits for secondary certification in mathematics. while another mandates 45 credits. Fifteen states have no science or mathematics course requirements for elementary certification (Blank and Dalkilic 1992). The percentage of teachers who are certified is, at best, a **state-level** indicator of teacher quality.

States are experimenting with alternative certification—which waives some of the traditional requirements—to attract teachers with strong science or mathematics backgrounds. Feistritzer and Chester (1991) report that 11 states now have alternative certification programs that—

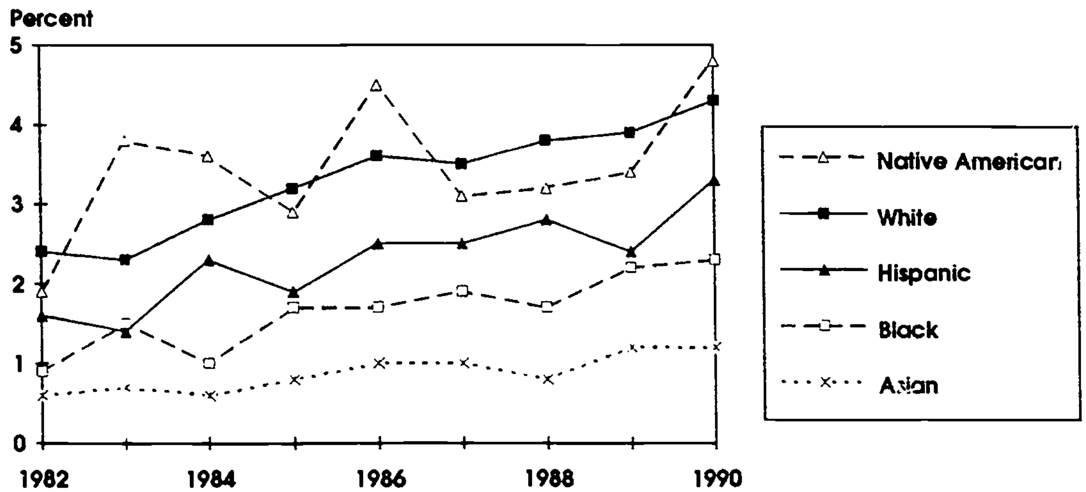
- Are designed to attract talented individuals holding bachelor's degrees in fields other than education.

SAT Scores of Prospective Teachers

During the past decade, increases in the Scholastic Aptitude Test (SAT) scores of students choosing education have been greater than the average changes in the scores of students in all fields, although scores for prospective education majors have still been lower than the scores averaged from those of all majors. The 1991 average verbal scores for all students were four points lower than 1982 scores, whereas verbal scores for students choosing education were 12 points higher than their 1982 scores. (See figure 3-17.) Math scores for students choosing education increased 22 points, compared with their earlier performance; math scores for students in all fields increased only 7 points.

Figure 3-16

Percent of college freshmen choosing secondary school teaching careers, by race and ethnicity: 1982 to 1990

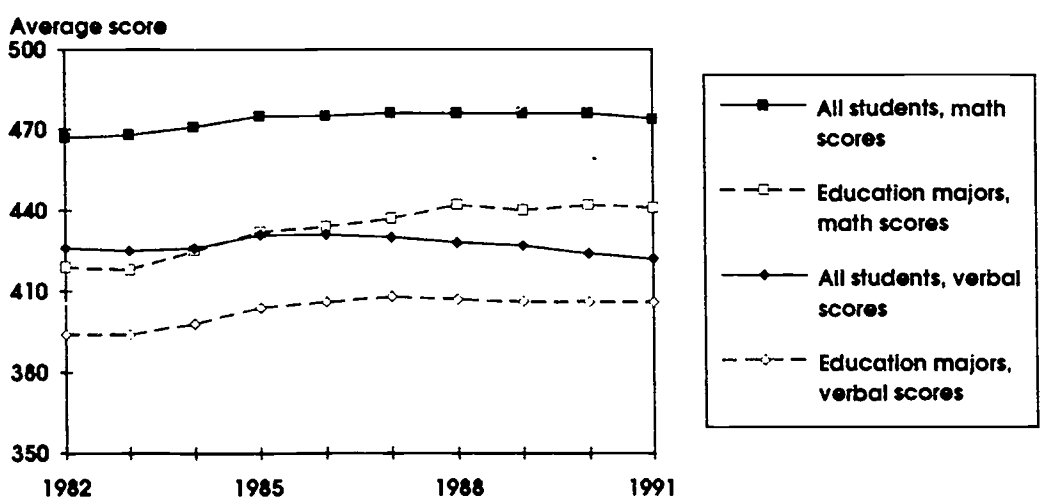


See appendix table 3-28. NSF Education Indicators—1992

SOURCE: E.L. Dey, A.A. Astin, and W.S. Korn, *The American Freshman. Twenty-Five Year Trends. 1966–1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), as cited in printouts that accompanied the source document.

Figure 3-17

Average SAT scores for all college-bound seniors and for those designating education as their first-choice intended field of study: 1982 to 1991



See appendix table 3-29. NSF Education Indicators—1992

SOURCE: College-Bound Seniors reports from the College Board.

- Involve formal instruction in the content and practice of teaching, although often less than that found in traditional teacher preparation programs.
- Require that prospective teachers teach with a trained mentor.
- Are intended to be permanent, unlike emergency and provisional certification measures that usually are short term.

This kind of alternative certification route is a recent phenomenon: of the 11 states that have created them, 8 initiated such programs during 1990–91.

Coley and Goertz (1990) report that many states are instituting tests to gauge the quality of teachers.

- In 21 states, teachers must pass a test to enter teacher training programs.
- Thirty-six states require testing for certification in areas of professional knowledge, basic skills, general knowledge, or specialty areas.
- Twenty-three states require tests in specialty areas as part of the certification process; most of these states use the specialty area tests of the National Teachers Exam.

Only 11 states have no testing requirements either for entrance to teacher training or for certification. (See appendix table 3-31 for the individual testing requirements of the 42 states reported in the Coley and Goertz study.)

Teaching Quality

The single most important determinant of **teaching** quality is **teacher** quality—the characteristics[22] and preparation of the current and incoming pool of teachers as discussed in the preceding sections of this chapter. However, other factors also are involved in teaching quality. Some of these, such as curriculum quality and teaching conditions, are discussed in Chapter 2. Two factors influencing teaching quality that are direct teacher variables germane to this chapter are (1) teacher perceptions of the teaching conditions that they face and (2) teacher attrition and salaries.

Perceptions of Teaching Conditions

NSSME (Weiss 1989) asked science and mathematics teachers of K–12 students what factors affected science and mathematics teaching in their school as a whole. In considering 19 possible problem areas, a greater percentage of science teachers cited several of these as serious than did teachers of mathematics. One-fifth to one-quarter or more of the science teachers said that facilities were inadequate, funds were insufficient for purchasing equipment and supplies, and materials were lacking for individualizing instruction. (See appendix table 3-32.) Science teachers' next most frequent complaints were inadequate access to computers and inadequate student reading abilities—the two factors cited most often by mathematics teachers. For 9 of the 19 NSSME survey items, less than 10 percent of teachers reported them to be a serious problem (for example, belief that science or mathematics is less important than other subjects, teachers inadequately prepared to teach the subject, and poor quality of textbooks).

Different factors affect teaching at different grade levels. At the elementary level, one-fifth of the teachers stated that they did not have enough time to teach science; a similar proportion of middle school and high school science teachers complained that class sizes were too large. Among mathematics

[22] This chapter does not discuss teachers' characteristics such as motivation, enthusiasm, and the like. Although they undoubtedly affect teaching quality, such characteristics are difficult to measure and few data about them exist.

teachers, lack of student interest was noted as a problem by 22 percent of the middle and high school teachers; this was somewhat less of a problem for science teachers at these levels (14 and 16 percent, respectively). Student absences troubled almost one-quarter of the mathematics teachers in grades 10–12.

Some of these findings are echoed in the results of the 1990 NAEP science assessment, which surveyed teachers of eighth-grade students. (See appendix table 3-33.) In this study, however, a somewhat greater percentage of science teachers felt that their facilities for teaching laboratory science were inadequate (teachers of 39 percent of the students) and that they were not well supplied with instructional materials and resources (teachers of 35 percent of the students). Other findings from NAEP provide additional information about teacher perceptions of teaching conditions. For example—

- Science teachers of 91 percent of the students reported that they had a great deal of freedom in deciding how to teach their classes.
- In contrast, teachers of 29 percent of the students felt they had little freedom in deciding on the curriculum.
- Teachers of nearly one-half of the students reported that they relied primarily on the textbook to determine what they taught.

Teacher Attrition and Salaries

It is generally held that science teachers—particularly those in the physical sciences—have alternative career options that offer higher compensation than teaching, both at the entry level and at the mid-level.[23] For this reason, teacher attrition and salaries are discussed here as linked phenomena.

Attrition

The 1988–89 follow-up to SASS showed that, during a 1-year period, an equally low percentage—about 6 percent—of science and mathematics teachers left the profession as did teachers of all other subjects. (See appendix table 3-34.) At the elementary level, the attrition rate for teachers specializing in science and mathematics was lower than that for all elementary teachers—4.9 percent versus 6.3 percent.

Weiss and Boyd (1990) examined attrition during a 3-year period and found the attrition rate of mathematics and science teachers to be 4.5 percent, considerably lower than the 6.1-percent rate reported by SASS. Measuring attrition rates over a 1-year period, as did SASS, is not a reliable indicator in and of itself because the rates are subject to the vagaries of the economy and teachers' opportunities to find other employment. Murnane et al. (1991), in their study of teacher attrition in three states, found that chemistry and physics teachers were most likely to leave teaching in each of the first 10 years, and elementary teachers were least likely to do so.

Information on attrition from the 1980s may not be a good basis for predicting attrition patterns in the 1990s because of changes in teachers' age distribution (see figure 3-4), possible changes in the economy, and greater demand due to an increasing student population and changing curricula.

Salary and Salary Incentives

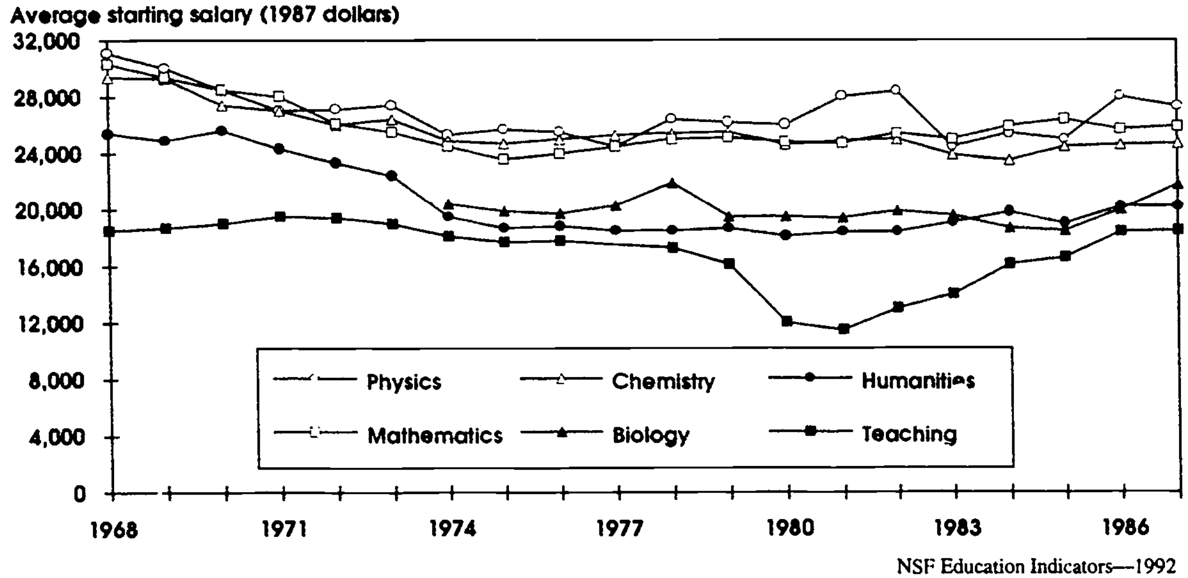
The average 1990 salary for teachers ($32,700)[24] fell below salaries for accountants ($37,100) and engineers ($51,600), even though teachers have approximately the same amount of formal education as these other professionals.[25] (See appendix table 3-35.) It is noteworthy, however, that assistant professors in institutions of higher education earned only marginally more ($34,200 on average) than precollege teachers. The difference between teachers'

[23]See Murnane et al. (1991) and Grissmer and Kirby (1987) for effects of salary levels on teacher attrition, particularly at the beginning of teaching careers.

[24]Salaries for teachers and college professors are given on a 9-month basis, compared with a 12-month basis for other professions.

[25]Great variation exists across districts in teacher salaries.

Figure 3-18
Starting salaries for teaching and other professions: 1968 to 1987



SOURCE: College Placement Council (1988) and National Education Association (1987a), as cited by D. Gilford and E. Tenenbaum, *Precollege Science and Mathematics Teachers: Monitoring Supply, Demand, and Quality* (Washington, DC: National Academy Press, 1990).

salaries and those of other professionals exists not only for average salaries but also for entering salaries: entry-level salaries for teachers (see footnote 24) are barely competitive with entry-level salaries in biology and the humanities; they are considerably lower than those in chemistry, physics, or mathematics. (See figure 3-18.)

One approach to attracting well-qualified teachers to critical fields is to offer incentive pay. The SASS results indicate that a slightly larger proportion of secondary school teachers in private schools (5 percent) received incentive pay than did their counterparts in public schools (3 percent), but the total of all teachers receiving such pay was very small. (See appendix table 3-36.) There is little evidence that science and mathematics teachers at either the elementary or secondary level receive extra incentives to teach, even in such fields as the physical sciences, where qualified teachers are deemed to be in short supply (Murnane et al. 1991).

Chapter Summary

This chapter examined factors affecting the quality of the Nation's science and mathematics teachers and the quality of their teaching. Indicators were presented for specific teacher characteristics, professional preparation and the distribution of teachers with different types of preparation across various population groups of students, teachers' perceptions of teaching conditions, and financial remuneration. Survey findings from the late 1980s revealed that, although only 10 percent of teachers at the elementary level were male, the proportion of males specialized in mathematics and science teaching was somewhat greater, particularly in science. At the secondary level, genders were more evenly represented in the teaching of mathematics and science. Studies reveal that teachers as a group were not as ethnically mixed as the student body. Only 12 percent of the Nation's science and mathematics teachers were from minority racial or ethnic groups, compared with 29 percent of the student body.

In terms of professional preparation, most specialist science or mathematics teachers in elementary school did not have bachelor's degrees in science or science education or in mathematics or mathematics education; their degrees were in elementary education only. A majority of elementary teachers felt well qualified to teach mathematics but only adequately qualified to teach science. Perhaps of more concern are the findings that, at the middle-school level, a large number of seventh- and eighth-grade mathematics teachers held only elementary education degrees. In the sciences, the percentage of secondary teachers who earned subject matter degrees in the field they teach varied by subject area, from 60 percent in biology to 16 percent in earth sciences. Of the nearly one-half million secondary teachers (grades 7–12), only two-thirds taught mathematics or science as their main or second assignment. Teachers with more preparation in their degree fields were not equitably distributed throughout the country's schools, that is, students with higher socioeconomic status had greater access to better prepared science and mathematics teachers.

Although there has been a small, steady increase in the number of college freshmen indicating education as a career choice since 1982, the proportion of teachers under 30 years of age was considerably lower in 1991 than it was in the mid-1960s. The current abundance of middle-aged teachers (ages 30–49) may portend a teacher shortage within the next two decades.

Improving Indicators of Teacher Quality

Better indicators of teacher quality are needed and could be developed through three means: (1) adjusting important sets of questions and standardizing them among different surveys, (2) adding new measures, and (3) strengthening the linkage between teacher attributes and student outcomes. Regarding the adjustment and standardization of questions, some data from different surveys that pertain to the same indicator are difficult to compare because questions are not standardized. For example—

- Race and ethnicity data from different surveys could not be compared regarding white, black, and Hispanic teachers because surveys defined race and ethnicity categories somewhat differently.
- Extent of preparation could not be compared because differences between semester- and quarter-length courses were inadequately specified.
- Data about teachers at some grades were not comparable because surveys did not use the same grade ranges to categorize teachers.
- Recency of teachers' in-service was not comparable because surveys used different time intervals.[26]
- The number of years of experience was not comparable because surveys used different time intervals when reporting this indicator.[27]

[26]Because few experts would expect teachers to participate in science in-service every year—particularly elementary teachers who must stay abreast of all subjects—it is probably too stringent to ask whether teachers have had in-service during the past year, as one survey did. Recency of in-service probably would be gauged more appropriately by using an interval of 3 years.

[27]Because teachers' effectiveness grows more during the first few years of teaching, surveys should consider grouping teachers with 1–3 years of experience instead of using categories of 1–5 or 1–10 years of experience, as does one of the surveys.

Regarding new measures, indicators of teacher quality would be improved if existing data collections were augmented.

- More data about teachers' courses in relevant fields are needed to track the depth of their preparation.
- No information is available on the extent of teachers' knowledge in the subject matter they teach or on the way to teach it effectively. The National Research Council's Committee on Indicators of Precollege Science and Mathematics Education advocated tests of teachers' subject matter knowledge as a key indicator of teacher quality (Murnane and Raizen 1988). If information from teacher tests continues to remain unavailable, surveys might use some indirect probes of teachers' knowledge. For example, researchers currently are experimenting with instrumentation that asks teachers to write and explain the optimal solution they would expect students to provide for an open-ended problem and then discuss their strategies for teaching the underlying concept.

Regarding relationships between teacher attributes and student achievement, most attempts to relate existing student achievement measures to teacher quality indicators have not yielded statistically significant results, let alone educationally meaningful results. Indicators of teachers' knowledge are critical in this respect. Also needed are improved measures of student outcomes.

- Tests used in national surveys of student achievement generally probe only certain kinds of science and mathematics learning and do not address those likely to be most contingent

Terms for SASS Data

The SASS study sampled teachers for all subjects in all grades. The SASS data reported in Chapter 3 about science and mathematics teachers was analyzed by Management Planning Research Associates, Inc. (MPR) specifically for purposes of this publication. Because this is the first time these data have appeared, some terms are specified below. Information about the entire SASS study, 1987–88, and its follow-up study, 1988–89, is provided in Appendix B to this volume.

The SASS study identified teachers' assignments for science and mathematics through the following questions, or combinations of questions:

> What is your current primary teaching assignment, that is, the field in which you teach the most classes? This question yielded teachers whose "main" assignment is science or mathematics.
>
> In what field do you teach the second most classes? This question yielded teachers whose "second" assignment is science or mathematics.
>
> Does your teaching assignment include any classes in mathematics, computer science, biological/life science, earth science, or physical science in grades 7–12? Using all three questions, SASS determined secondary teachers who do teach some mathematics or science classes but not as a main or second assignment.

"Elementary" refers to grades K–6. "Secondary" refers to grades 7–12. Elementary teachers who declared their main or second assignment was science or mathematics are termed "elementary science specialists" or "elementary mathematics specialists." General elementary teachers were defined to be those who teach multiple subjects to the same class of students all or most of the day. Special analyses were done for teachers who taught grades 9–12 only and grades 7–8 only.

Detailed NCES Definitions for SASS Data

An "elementary" (K–6) teacher was one who, when asked for the grades taught, filled out the SASS survey in one of the following ways:

- Only "ungraded" and was designated as an elementary teacher on the list of teachers provided by the school; or
- sixth grade or lower, or ungraded and no grade higher than grade 6; or
- sixth grade or lower, and seventh grade or higher, and reported a primary assignment of prekindergarten, kindergarten, or general elementary; or
- seventh and eighth grades only, and a reported primary assignment of prekindergarten, kindergarten, or general elementary; or
- sixth grade or lower and seventh grade or higher, and reported a primary assignment of special education and was designated as an elementary teacher on the list of teachers provided by the school; or
- seventh or eighth grades only, and reported a primary assignment of special education and was designated as an elementary teacher on the list of teachers provided by the school.

A "secondary" (7–12) teacher was one who, when asked for the grades taught, completed the survey in one of the following ways:

- Ungraded and was designated as a secondary teacher on the list of teachers provided by the school; or
- sixth grade or lower and seventh grade or higher, and reported a primary assignment other than prekindergarten, kindergarten, or general elementary; or
- ninth grade or higher, or ninth grade or higher and ungraded; or
- seventh and eighth grades only, and reported a primary assignment other than prekindergarten, kindergarten, general elementary, or special education; or
- seventh and eighth grades only, and reported a primary assignment of special education and was designated as a secondary teacher on the list of teachers provided by the school; or
- sixth grade or lower and seventh grade or higher, or seventh and eighth grades only, and were not categorized above as either elementary or secondary.

In other data sets used in this chapter, grade and school levels are specified, e.g., middle school (grades 7–8) or high school (grades 10–12).

on teacher quality. Student achievement tests that more adequately address all the learning goals of science and mathematics education must be developed.

- Cross-sectional studies actually assess students' cumulative learning from many teachers, not just learning acquired through their current teachers. Longitudinal studies using tests administered at both the beginning and the end of the school year are more appropriate for establishing relationships between teacher quality and student achievement.

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Chapter 4: Course Persistence and Career Choice

Overview

The public education system in the United States is unique among the systems of industrial nations in the degree of choice accorded students in their study of mathematics and science at the secondary level. Course selection may be viewed in terms of student **persistence** in mathematics and science. Students' decisions may provide, or block, access to careers in science, mathematics, or engineering. Persistence in the study of science and mathematics may also help an individual become a more informed citizen and a more perceptive consumer as well as more aware of technological and scientific issues. Thus, persistence influences a person's range of career choices and level of **scientific understanding**.

The first section of this chapter examines the patterns of public school student persistence in mathematics and science courses during the last decade, using the results from three national longitudinal studies. The influence of student gender and parent education on persistence decisions is explored, as are student assessments of the difficulty and future career utility of high school courses in mathematics, science, English, and social studies.

The second section of this chapter focuses on the development during the middle school and high school years of student expectations concerning careers in science, mathematics, or engineering. The influence of student gender, parent education, and other factors on these expectations is examined.

Persistence in the Study of Science and Mathematics

The issue of persistence in the study of science and mathematics is a problem primarily for the United States. In the public school systems of most major industrial countries, students who continue in full-time secondary schooling are required to take science and mathematics every year. In Japan and most European countries, for example, students are expected to complete at least trigonometry before they graduate. In contrast, the U.S. system optimizes student choice; it does not require all students to develop basic competence in science and mathematics. Most states in the United States require students to take at least 2 years of science and 2 years of mathematics to complete high school, but many states do not specify which courses must be taken.

There has been a growing recognition at the state level that the present system of voluntary enrollment in mathematics and science has not functioned satisfactorily. Since 1980, 45 states have enacted new laws raising the minimum course requirements in mathematics, and 40 states have increased their requirements in science. Only 10 states, however, require 3 years of high school mathematics, and only 3 states require 3 years of high school science. No state requires 4 years of high school mathematics and 4 years of science.

Enrollment in Mathematics and Science Courses

In 1990, only 8 percent of public high school seniors attempted a calculus course, and only 26 percent took trigonometry and analytic geometry (usually labeled precalculus) during high school. (See figure 4-1 and text table 4-1.) Although 86 percent of high school seniors in 1990 had completed at least

1 year of algebra, only one-half of this senior cohort had completed geometry and second-year algebra. Clearly, most U.S. high school students have elected minimal mathematics programs.

Compared with high school seniors in 1980, high school seniors in 1990 were slightly more likely to have completed 2 years of mathematics (excluding arithmetic), with 71 percent reporting that they had completed either geometry or second-year algebra. (See figure 4-1.) During the same period, the percentage of students who reported completing both geometry **and** second-year algebra increased from 42 percent to 51 percent. The proportion of high school seniors who never attempted algebra decreased from 21 percent in 1980 to 14 percent in 1990. Data from 1982 suggest that student persistence in mathematics declined in the early 1980s, then increased in the last half of the decade. These findings suggest that the increased public and parental awareness of the relatively poor performance of U.S. students in mathematics and the reform efforts of the National Council of Teachers of Mathematics have had some

Text table 4-1
Percent of public high school seniors who completed selected mathematics courses: 1980 to 1990

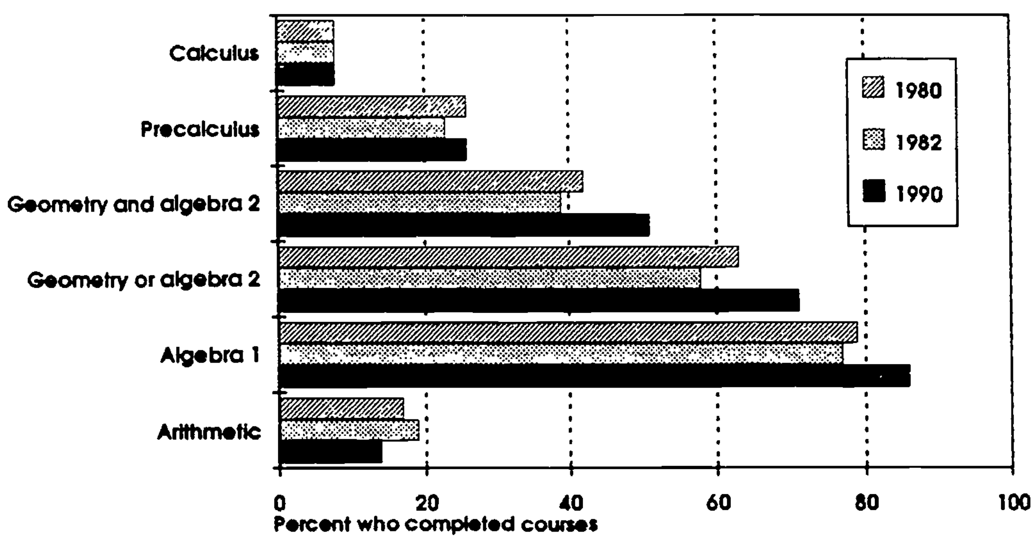
Course	1980	1982	1990
Arithmetic	17*	19*	14
Algebra 1	79	77	86
Geometry or Algebra 2	63	58	71
Geometry and Algebra 2	42	39	51
Precalculus	26	23	26
Calculus	8	8	8
Sample size	10,026	8,693	2,600

*Indicates some mathematics.

See appendix tables 4-1, 4-2, and 4-3.
NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B); and unpublished tabulations.

Figure 4-1
Percent of public high school seniors who completed selected mathematics courses: 1980 to 1990



See appendix tables 4-1, 4-2, and 4-3.
NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B); and unpublished tabulations.

effect on school requirements in mathematics and on parental and school pressure for student persistence in the study of mathematics.

An examination of the same studies points to a similar pattern of student avoidance of advanced science courses during high school. Only one in five high school seniors took a physics course during high school; this proportion was stable during the 1980s. (See figure 4-2 and text table 4-2.) Between 1980 and 1990, the proportion of high school seniors who reported taking a chemistry course increased from 37 to 42 percent; however, one-half of all high school students graduated without taking a laboratory-based chemistry course. During the same period, the proportion of high school seniors who had taken a laboratory-based biology course increased substantially, as fewer students enrolled in nonlaboratory biology courses. The proportion of students who completed high school without experiencing any laboratory-based science course decreased substantially between 1980 and 1990.

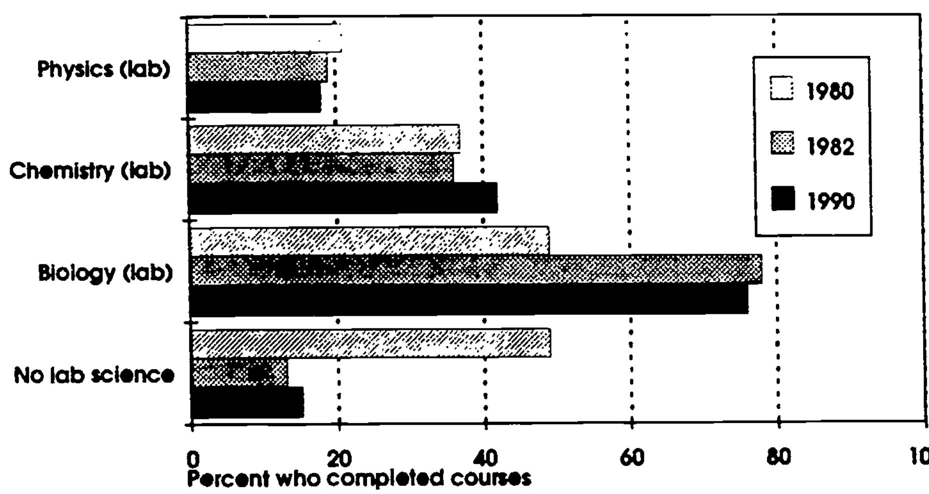
Text table 4-2
Percent of public high school seniors who completed selected science courses: 1980 to 1990

Course	1980	1982	1990
Nonlaboratory science only	49	13	15
Biology (with lab)	49	78	76
Chemistry (with lab)	37	36	42
Physics (with lab)	21	19	18
Sample size	9,501	8,605	2,826

See appendix tables 4-4, 4-5, and 4-6.
NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B); and unpublished tabulations.

Figure 4-2
Percent of public high school seniors who completed selected science courses: 1980 to 1990



See appendix tables 4-4, 4-5, and 4-6.
NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B); and unpublished tabulations.

Student, Family, and Community Characteristics

The patterns of persistence in the study of science and mathematics vary significantly by the personal characteristics of a student and the educational backgrounds of a student's parents. Although some differences exist in the persistence patterns of central city and suburban students, most of these differences can be fully accounted for in multivariate analyses by variables in parental background.

Comparing student persistence in mathematics and science among high school males and females shows a narrowing of the gender difference in trigonometry (precalculus) and chemistry between 1980 and 1990. (See appendix tables 4-1 to 4-6.) It appears that most of the total increase in student enrollments in precalculus and chemistry during this period reflected increased female enrollment in these subjects. A small narrowing of the gender difference in physics enrollment occurred, but virtually all of this reflected a decline in the rate of male enrollment in physics courses. No change in the proportions of male and female students taking calculus took place between 1980 and 1990—about 6 percent of female seniors and 10 percent of male seniors took a calculus course.

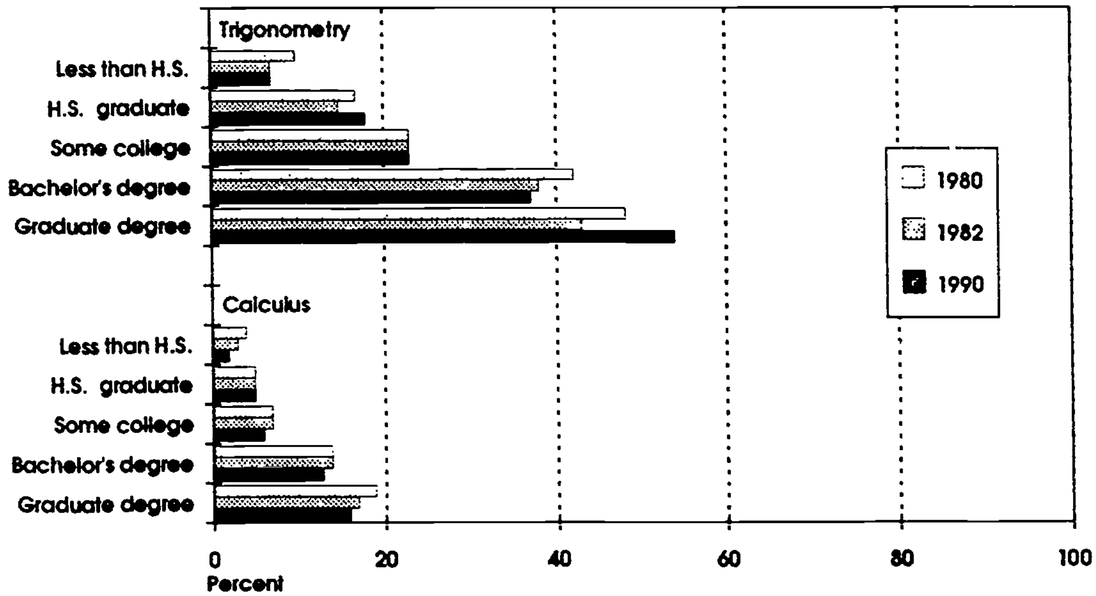
When analyzed in terms of family and community characteristics, student persistence in public high school science and mathematics courses shows clear patterns of accumulated advantage, driven largely by differences in levels of parental education. Parents with higher levels of formal education were significantly more likely to encourage their children to study science and mathematics, to provide learning toys like microscopes and calculators in the home, and to take their children to museums and use other informal learning resources to stimulate their interest and enhance their skills. Parents with college degrees were significantly more likely to encourage their children to plan to attend college and to talk about the kinds of courses and experiences that will be necessary for college enrollment and success. The advantage is substantial and cumulative.

The contrast is clearest in regard to student persistence in mathematics. In 1990, fewer than 10 percent of students whose parents did not graduate from high school reached precalculus; among high school seniors only 2 percent of this group attempted calculus. (See figure 4-3.) In the same senior class, 54 percent of students whose parents held graduate degrees had taken a trigonometry course, and 16 percent had taken or were enrolled in calculus in 1990. The difference between the mathematics persistence of students whose parents had more formal education and those whose parents completed fewer years of schooling increased between 1980 and 1990.

A similar pattern appears in student persistence in high school science courses. In 1990, only 17 percent of senior students whose parents had not graduated from high school had taken a chemistry course, compared to 66 percent of the students whose parents had graduate degrees. (See figure 4-4.) Among the same senior class, only 4 percent of the students whose parents had not graduated from high school had taken or were enrolled in a physics class, compared with 36 percent of the students whose parents had graduate degrees. This pattern of educational differentiation appears to have remained relatively stable during the 1980s.

The levels of education that students expect to complete were strongly associated with the levels of their parents' education. A student's expected level of educational attainment appears to influence student persistence in the study of mathematics and science. Data from three national longitudinal studies show that, during the 1980s, approximately 30 percent of high school students expecting to complete a bachelor's degree enroll in high school physics, compared with fewer than 10 percent of students expecting to discontinue schooling after high school graduation. During the same period, students with higher educational expectations tended to take more higher level mathematics courses than students with lower expectations, but no similar pattern of increased

Figure 4-3
Percent of public high school seniors completing trigonometry (precalculus) and calculus, by parent's education: 1980 to 1990



See appendix tables 4-1, 4-2, and 4-3.

NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B), and unpublished tabulations.

persistence in high school science courses occurred. (See appendix tables 4-1 to 4-6.)

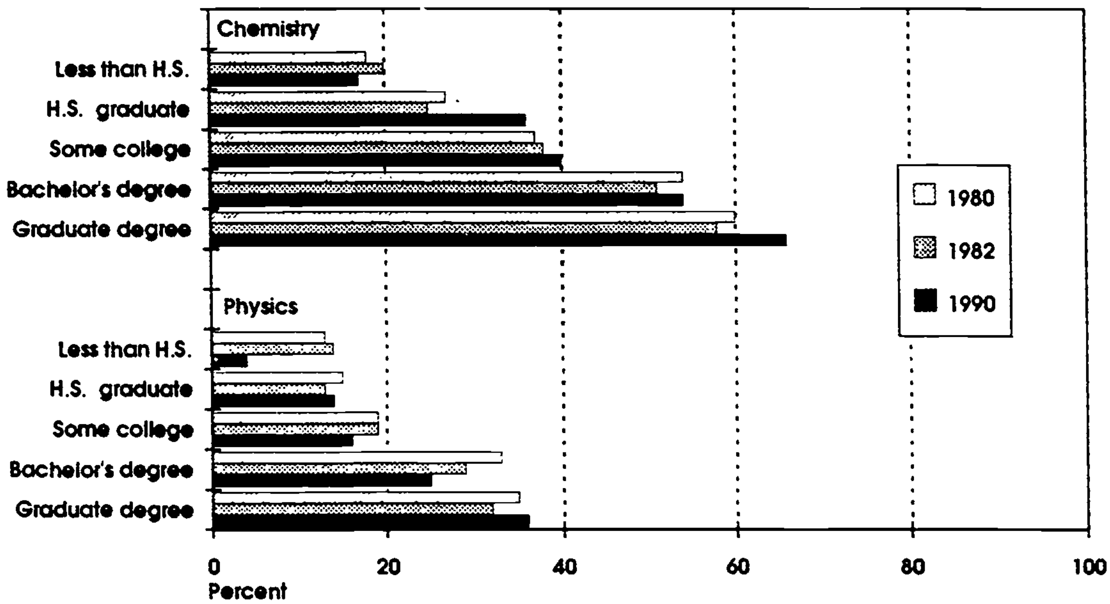
Student Attitudes Toward Science and Mathematics Courses

Why do U.S. public high school students avoid advanced courses in mathematics and science? Although the gender and family background factors described in the previous section partly explain this behavior, another key is understanding student attitudes and assessments of the utility of mathematics and science courses. The Longitudinal Study of American Youth (LSAY), a national longitudinal study of two 3,000-student cohorts, has surveyed public school students twice each year since 1987 regarding—among other items—student perceptions of subject matter, course challenge, and course utility.

Despite the popular stereotype that students prefer studying subjects other than mathematics and science, evidence suggests that most students enjoyed the study of mathematics, science, English, and social studies almost equally. (See figure 4-5.) Moreover, this level of enjoyment was relatively high. When asked to indicate how much they liked each of the subjects they were studying in school, a national sample of public high school students rated all four subjects in the range of 2.8 to 3.0, on a scale of 0 to 4.0. Students were asked to evaluate several aspects of each course, using the letter grades A through F, which were assigned values of 4.0 through 0 respectively—as would be used in computing grade-point averages in school.

When examining student assessments of courses, it is important to recognize the de facto achievement grouping—or tracking—in high school courses,

Figure 4-4
Percent of public high school seniors completing chemistry and physics, by parent's education: 1980 to 1990



See appendix tables 4-4, 4-5, and 4-6. NSF Education Indicators—1992

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B), and unpublished tabulations.

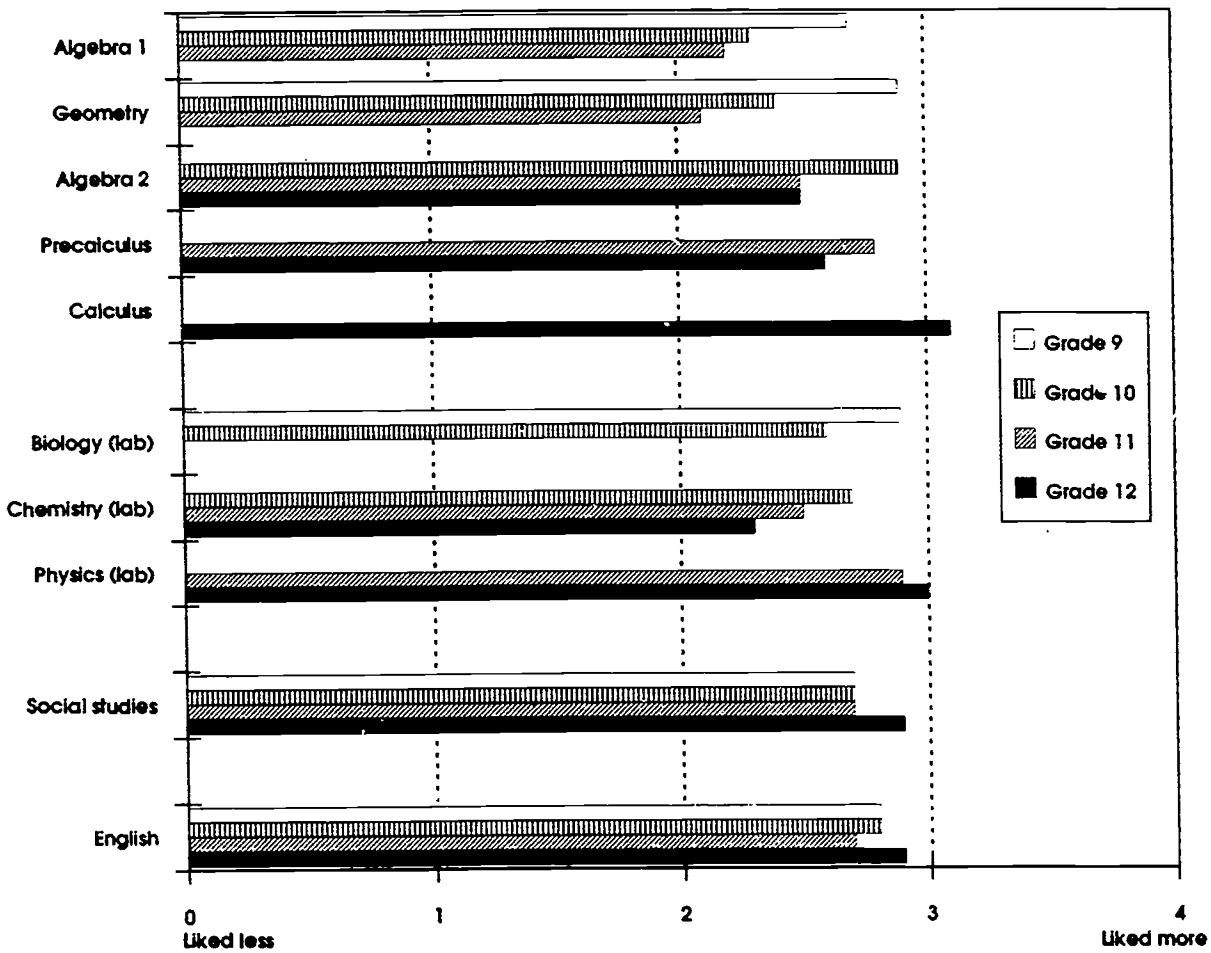
especially mathematics. Students in the top achievement track usually took geometry in the ninth grade, second-year algebra in the tenth grade, precalculus in the eleventh grade, and calculus in the twelfth grade. Although some minor variations occur in individual schools, the pattern generally holds for public high schools in the United States. Students in this top track liked mathematics more than other students did, giving mean scores of 2.9, 2.9, 2.8, and 3.1 to the four courses in the sequence mentioned above. (See figure 4-5.)

Students in other mathematics achievement tracks reported somewhat less positive feelings about mathematics as a subject. For example, high school students in the modal track usually took first-year algebra in the ninth grade, geometry in the tenth grade, and second-year algebra in the eleventh grade; some of these students persist into precalculus in the twelfth grade. These modal students assigned scores of 2.7, 2.4, 2.5, and 2.6 to liking mathematics.

Student attitudes toward science paralleled their feelings toward mathematics. (See figure 4-5.) Although a less distinct pattern of achievement grouping emerged for science, the fact that only one-half of high school students ever took a chemistry course and that only one in five ever took a physics course represents a de facto stratification. Even within this selective enrollment environment, public high school students reported slightly less positive attitudes toward chemistry than either biology or physics.

High school students in the LSAY study were also asked to assess the level of challenge posed by various courses. Again, using the traditional A-to-F grading system, students were asked to rate the degree to which each course challenged them intellectually.

Figure 4-5
Mean student assessment of how much they like selected public high school courses: 1987 to 1991



See appendix tables 4-7, 4-8, and 4-9.

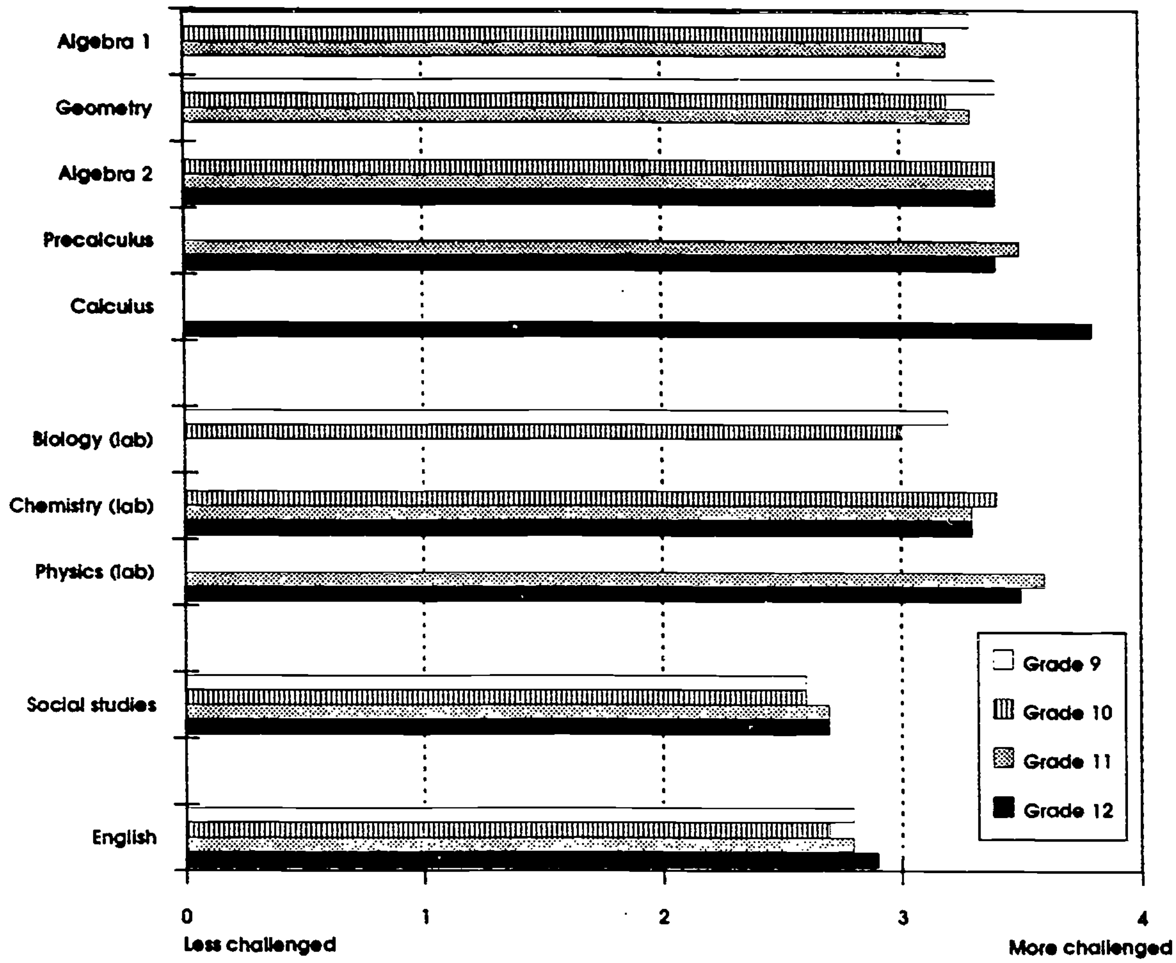
NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

The responses indicate that mathematics and science courses were significantly more challenging for students at all grade and achievement levels than were English or social studies courses. (See figure 4-6.) Generally, higher level mathematics and science courses were rated as slightly more challenging than more basic courses. The level of challenge appears to be largely unrelated to the achievement tracking of the student for both mathematics and science courses.

An important factor in student persistence in mathematics and science courses is the student's perception of the future utility of each course for his or her career objectives. Using the same grading scale of 0 to 4.0, high school students were asked to assess how useful each course they were taking would be for their expected careers. Students generally rated mathematics courses as being the most useful to their expected careers, followed by English and then

Figure 4-6
Mean student assessment of how much they are challenged by selected public high school courses: 1987 to 1991



See appendix tables 4-7, 4-8, and 4-9.

NSF Education Indicators—1992

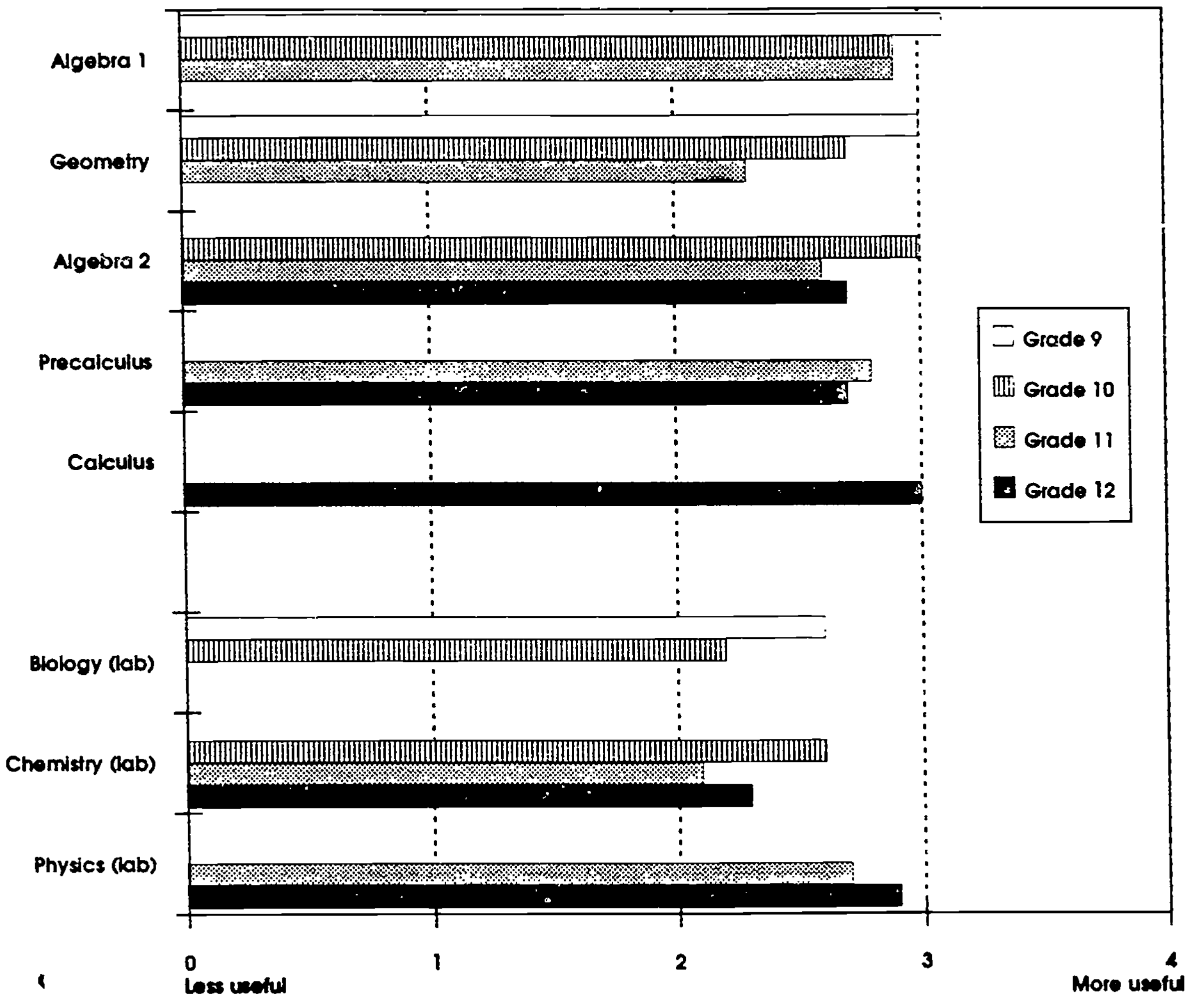
SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

science courses. Social studies courses were rated least useful. (See figure 4-7 and appendix tables 4-7 to 4-9.)

The top achievement group in mathematics rated the career utility of their courses high, with scores of 3.0, 3.0, 2.8, and 3.0. (See appendix table 4-7.) Among the 20 percent of students enrolled in physics, the mean career utility rating was approximately 2.8 on a 4.0 scale. The career utility rating of biology and chemistry among students taking those subjects relatively later in their program was approximately 2.6 on the same scale. (See appendix table 4-8.)

In summary, a significant proportion of students liked mathematics and science courses as much as their English or social studies courses; moreover, they found them more challenging. Mathematics courses were generally viewed by students as useful to their expected careers, but the career utility of science

Figure 4-7
Mean student assessment of how useful selected public high school courses will be for their expected career: 1987 to 1991



See appendix tables 4-7 and 4-8. NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

courses ranked below that of English. The absence of a strong link between science courses and career needs was apparently felt to about the same degree by all students, regardless of academic track.

Student Choices in Course-Taking

A second perspective on why students avoid advanced mathematics and science courses was gained in a series of direct inquiries by LSAY. In 1989–90, all seniors who were not enrolled in a mathematics or science course were presented with a list of possible reasons for not taking mathematics or science and were asked to select all that applied. Their answers point to a complex and overlapping set of explanations.

Reasons Given for Avoidance of Science and Mathematics Courses

The most common explanation given for avoiding either mathematics or science courses was the student's need for another course and the implied pressures of schedule, time, and place. Approximately 37 percent of the high school seniors surveyed in 1990 reported that they elected not to take a mathematics or science course so they could enroll in a course in another area. (See figure 4-8.) Reflecting the career utility perceptions noted previously, nearly 40 percent of high school seniors not enrolled in a science course said that they did not think that an additional science course would be helpful to their expected careers. In comparison, 28 percent of seniors not enrolled in a mathematics course cited the same reason.

About one-third of seniors not enrolled in a mathematics course reported that they did not like the subject matter, compared with a similar report by 29 percent of seniors not enrolled in a science course. (See figure 4-8.) About 30 percent of high school seniors not taking mathematics or science reported that they had been advised by teachers or counselors that they did not need an additional course in that area. Slightly more than 30 percent of seniors not enrolled in mathematics thought that they would not do well in an additional mathematics course, compared with a similar report by 24 percent of seniors not enrolled in a science course. Approximately one-quarter of seniors indicated that they did not want to work hard during their senior year and elected to avoid more difficult or challenging courses like mathematics or science. From these responses, it is clear that no single, simple reason explains student course selections and the decision not to persist in the study of science and mathematics.

Influences of Student, Family, and Community Characteristics

Males and females differed somewhat in their explanations for not taking a mathematics or science course during their senior years. Senior females were significantly more likely than males to report that they did not like mathematics; they were also slightly more likely to report that they wanted to take another course or had been advised that they did not need to take more mathematics. (See figure 4-8.) Senior males were more likely than females to report that they did not need an additional mathematics course for their expected occupation. However, one-quarter of both males and females reported that they did not take a mathematics course to avoid having to work hard during their last year in high school.

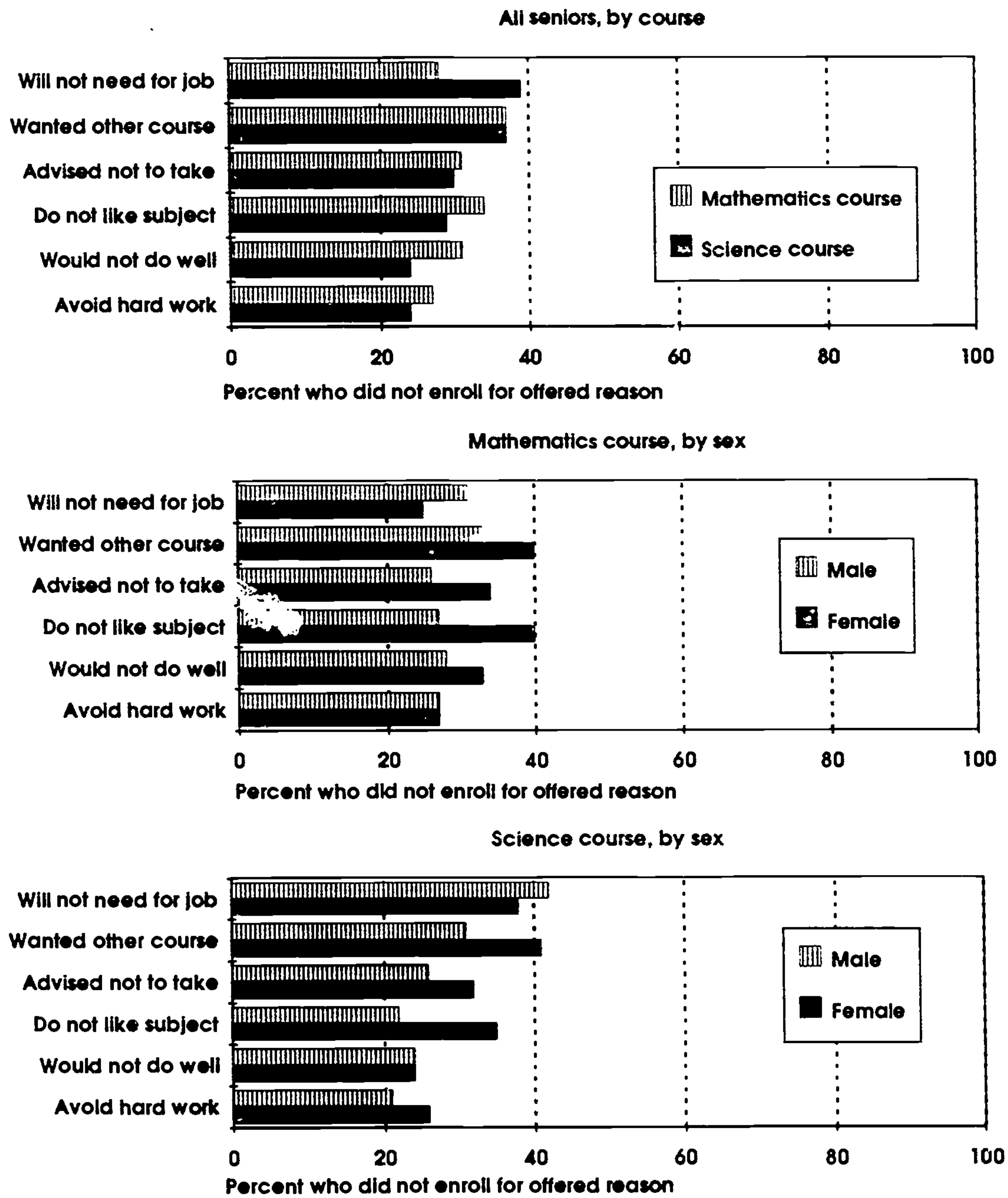
Similar gender differences were found in seniors' explanations of their failure to enroll in a science course during their last year of high school. Senior females were significantly more likely than males to report that they wanted to enroll in another course or that they did not like science. Senior females were also slightly more likely to report that they had been advised that they did not need to take more science and that they did not want to take an additional hard course during their last year of high school. (See figure 4-8.) Senior males were slightly more likely than females to report that they did not need an additional science course for their expected career. One-quarter of both males and females thought that they would not do well in an additional science course.

In contrast to numerous other studies of parental background and influence, results from LSAY show few differences either by level of parent education or by level of student-expected educational attainment in reasons for not taking a mathematics course. Findings show, however, that students from families with fewer years of formal education were significantly more likely to report that they had been advised by teachers or counselors not to take an additional mathematics course, whereas students from families with more years of formal education were significantly more likely to report that they simply did not like mathematics. (See appendix table 4-10.)

No significant differences appeared in the patterns of explanations among students in central city, suburban, and nonmetropolitan public schools.

Figure 4-8

Percent of public high school seniors citing selected explanations of non-enrollment in a mathematics or science course in their senior year, by sex: 1990



See appendix tables 4-10 and 4-11. NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

139

Career Considerations

A central assumption of the present student choice system is that students, with the assistance of parents and teachers, will understand the system sufficiently to make informed decisions about persisting or desisting in the study of science and mathematics. However, evidence suggests that many middle and high school students are misinformed about the level of mathematics and science needed for careers in science, mathematics, or engineering.

Future Scientists. LSAY asked middle and high school students who had reported that they expected to become scientists which science and mathematics courses they would need for that profession.[1] A substantial portion of the sample provided incorrect responses. For example, fewer than half of the seventh-grade students surveyed thought that they would need to take trigonometry or calculus in high school. (See figure 4-9 and appendix table 4-12.) Even among the seniors surveyed, only 52 percent thought that it would be important for them to take calculus in high school to prepare for a scientific career, and 34 percent did not think that high school trigonometry would be necessary.

The results from the survey item regarding the relationship between high school science courses and a career in science were equally disappointing.[2] Only 47 percent of seventh-grade students who expected to become scientists thought that high school chemistry would be needed for a scientific career, and only 56 percent indicated that high school physics would be needed. (See figure 4-9 and appendix table 4-13.) Although the proportion recognizing the need for high school chemistry and physics increased slightly in subsequent years, it never exceeded 72 percent. Nearly one-third of high school students planning careers as scientists did not know that high school chemistry or physics would be needed for that career.

The high level of misinformation among seventh-grade students is disturbing because this is the point in the course sequence when students are separated into prealgebra and arithmetic tracks. Only 18 percent of public school students take algebra in the eighth grade, and it is largely students from this group who reach twelfth-grade calculus. Unfortunately, most middle schools mask this mathematics tracking decision, and many students and parents do not understand the implications of this decision for subsequent college admissions and career choice decisions. Because a majority of seventh-grade students who say that they expect to pursue a career in science do not understand the high school mathematics and science course requirements for this career, they are unable to participate effectively in this decision-making process.

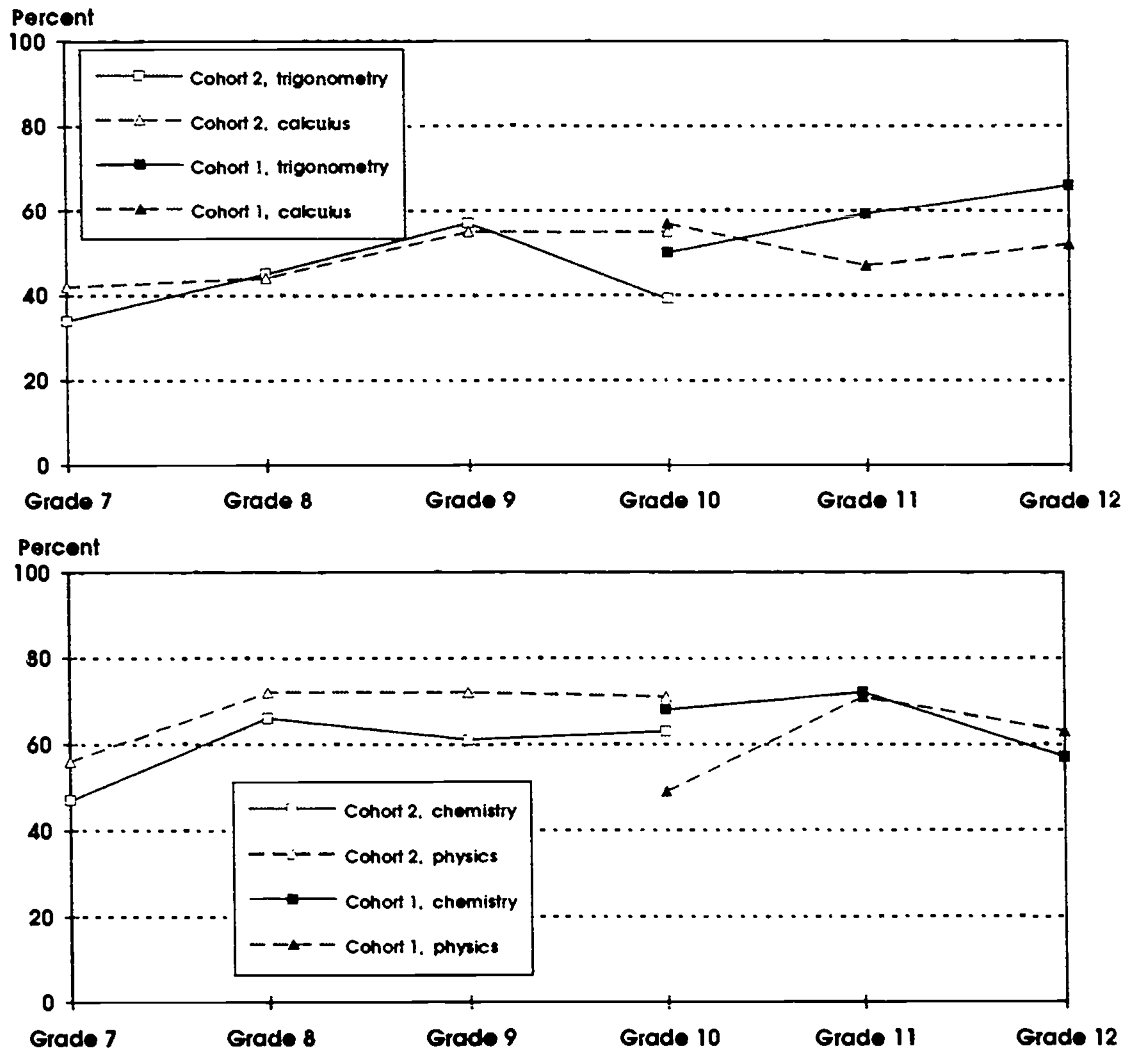
Future Engineers. Prospective engineers were slightly better informed about high school course requirements than future scientists, but a substantial proportion remained misinformed. During the critical decision-making years in mathematics, a majority of seventh- and eighth-grade students who reported that they expected to become engineers responded that high school trigonometry and calculus were not necessary for their chosen career. (See figure 4-10 and appendix table 4-12.) The proportion recognizing the relationship between the study of high school mathematics and an engineering career increased steadily throughout the middle and high school years, reaching nearly 80 percent in the senior year. However, fully one in five prospective engineers among seniors did not know that taking high school trigonometry and calculus would be important to a future engineering career.

A similar pattern was found with regard to understanding the need for certain high school science courses by prospective engineers. Among

[1]The exact wording of the question was "Which of the following high school math courses will you need to take to qualify for your FIRST CHOICE of job?" The answers from which the respondents chose were "none, I don't need any for this job"; "geometry"; "algebra"; "trigonometry"; "calculus"; and "I am not sure."

[2]The exact wording of the question was "Which of the following high school science courses will you need to take to qualify for your FIRST CHOICE of job?" The answers from which the respondents chose were "none, I don't need any for this job"; "biology"; "chemistry"; "physics"; and "I am not sure."

Figure 4-9
Percent of public middle school and high school students who understand that mathematics and science courses are needed for a career as a scientist: 1987 to 1991



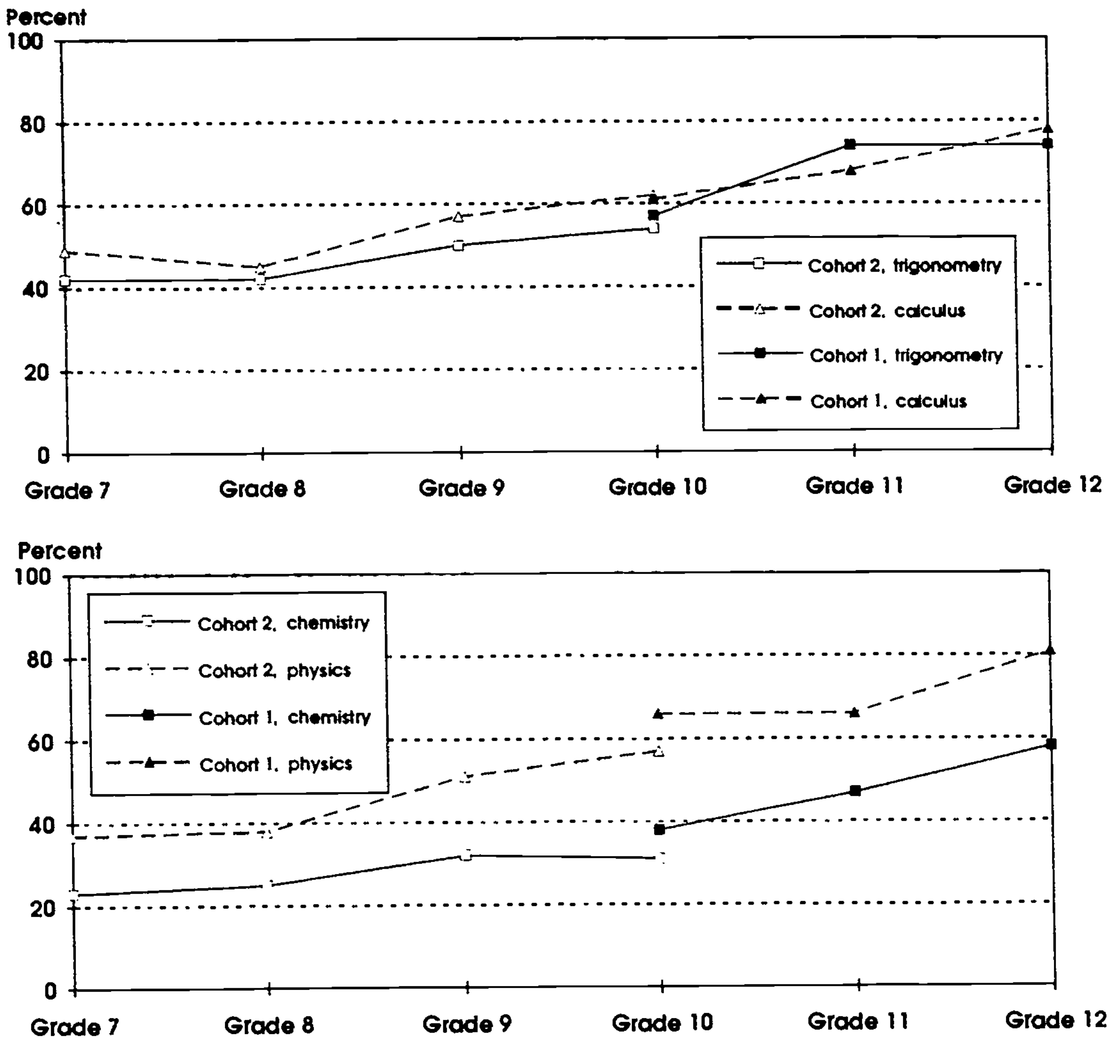
NOTE: Cohort 1 included a national sample of 3,000 public school tenth-grade students in the fall semester, 1987. Cohort 2 included a national sample of 3,000 public school seventh-grade students in the fall semester, 1987.

See appendix tables 4-12 and 4-13. NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

seventh-grade students who reported that they expected to become engineers, only 23 percent thought that chemistry would be necessary, and only 37 percent believed that high school physics would be needed. (See figure 4-10 and appendix table 4-13.) Again, these longitudinal data show a pattern of improvement in student understanding of science course requirements for an engineering career.

Figure 4-10
Percent of public middle school and high school students who understand that mathematics and science courses are needed for a career as an engineer: 1987 to 1991



NOTE: Cohort 1 included a national sample of 3,000 public school tenth-grade students in the fall semester, 1987. Cohort 2 included a national sample of 3,000 public school seventh-grade students in the fall semester, 1987.

See appendix tables 4-12 and 4-13.

NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

However, even by the senior year, 20 percent of students expecting to become engineers did not think that high school physics was necessary, and 40 percent did not think that high school chemistry was necessary. These results raise serious questions about the effectiveness of school counseling services and about the kind of career information provided by science and mathematics teachers themselves.

Summary

The results are clear. A significant portion of U.S. public high school students avoided advanced courses in mathematics and science when offered a choice in course selection. Student persistence in mathematics and science related positively and significantly to levels of parent education. By 1990, high school males and females persisted in the study of mathematics and science at nearly equal levels through trigonometry (precalculus) and chemistry, but a significant difference by sex in persistence in calculus and physics continued throughout the 1980s.

Students made persistence decisions about the study of mathematics and science for a complex set of reasons based on a combination of parental influence, personal attitudes toward course subject matter, and perceptions of course difficulty and career utility. Evidence suggests, however, that a portion of these student judgments may have been based on misunderstandings of the need for mathematics and science courses for various occupations. Although a rigorous examination of the relative influence of parents, teachers, counselors, and peers on this student decision-making process is beyond the scope of this chapter, the findings cited here argue for increased analysis of the dynamics of the present elective science and mathematics education system in the United States.

The Expectation of a Career in Science, Mathematics, or Engineering

In the present global marketplace, it appears that those nations with the best trained and most adaptable workforces will be the most successful. Virtually all major industrial nations have expressed concern about the flow of young people into careers in science, mathematics, and engineering, often initiating studies of the career choices of their youth and programs to stimulate increased student interest in science, mathematics, and engineering (S&E) careers. This issue of a sustained flow of young people into these careers has been a major concern of the National Science Foundation from its origins.

Although the following analysis and discussion focus primarily on professional-level careers in science, mathematics, and engineering (see sidebar for definitions), there is broad agreement that it is important to understand the attraction of capable young people to a wide range of technologist and technician careers at the associate and bachelor's degree levels. While limitations of space and time prohibit a full discussion of the issues related to these semiprofessional occupations, it is anticipated that future editions of *Indicators of Science and Mathematics Education* will include more analysis and discussion of these occupations.

General Patterns of Career Expectations

A comparison of public high school seniors in 1972, 1980, and 1990 reveals an insignificant increase in student interest in S&E careers. During this 18-year period, the proportion of seniors expecting careers in science or mathematics remained relatively stable, while the proportion of seniors expecting careers in engineering increased significantly. Student expectations of careers in science or mathematics—here defined as graduate-level careers in research, industry, or university teaching—dropped from 1.7 percent in 1972 to 1.1 percent in 1980, before climbing back to 1.3 percent in 1990. (See appendix table 4-14.) All of these changes, however, were small enough that they could be accounted for by sampling error, given the size of the

143

samples. Expectations for engineering careers increased from 3.4 to 5.0 percent over the 18-year period, with all of the increase occurring between 1972 and 1980. The difference in student preference for engineering careers in 1980 and 1990 was not statistically significant.

LSAY participants have been asked each fall and spring to report what career they expect to be in when they are 40 years old. A companion question asks students how certain they are about their expected careers, and two additional questions located in a different section of the questionnaire also probe the level of certainty about career expectations. To a large extent, the proportion of middle and high school students expecting to pursue a career in science, mathematics, or engineering increases as students begin high school but then gradually declines as students encounter advanced courses and are exposed to alternative career choices. About 3.2 percent of LSAY high school seniors in 1990 reported a high

Longitudinal Study Databases

Three national longitudinal studies have accumulated extensive data regarding student academic achievement, attitudes, interests, and career choice—including career interest and attainment in science, mathematics, and engineering—during the last two decades:[3]

- The **National Longitudinal Study of 1972** (NLS-72), conducted by the National Center for Education Statistics (NCES), selected a national sample of approximately 17,000 high school seniors and has been following these individuals through periodic surveys. The most recent survey was conducted in 1987, 15 years after high school graduation, and included data on career attainment. This data set includes extensive measures of vocational training, college-level experiences, and career changes. Because this study began with high school seniors, it has relatively fewer school and family variables than other data sets that include younger students.
- NCES's **High School and Beyond Study** (HS&B) was initiated in 1980 with large national samples of approximately 35,000 high school seniors and 36,000 high school sophomores. Follow-up surveys of these students have been conducted about every 2 years. This two-cohort study included a wider range of school, family, and career preference variables than did NLS-72.
- The **Longitudinal Study of American Youth** (LSAY), sponsored by the National Science Foundation, selected national probability samples of approximately 3,000 public school seventh-grade students and 3,000 tenth-grade students in 1987 and has been following these students twice yearly since that time. Each fall semester, students complete a mathematics achievement test and a science achievement test. Students also complete two questionnaires each year, providing information such as the courses they are taking, the activities in which they are engaged, what job they expect to be doing when they are 40 years old, and how sure they are about their career choice. This comprehensive study also collects data from parents, teachers, and principals.

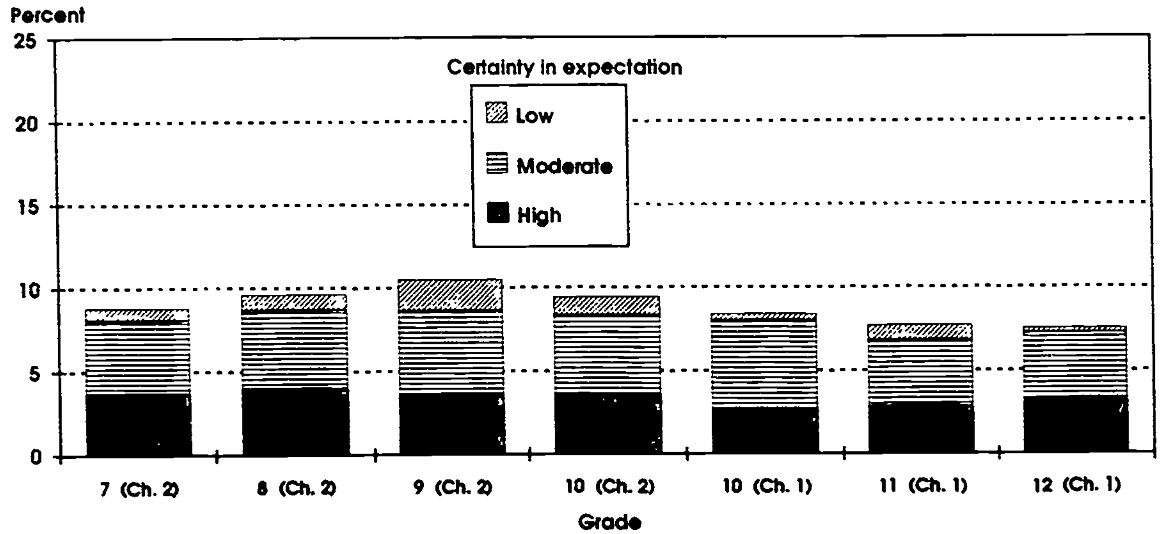
Although these three studies were begun at different times (1972, 1980, and 1987) and conducted by different research teams, efforts were made to collect data using a number of the same items. The research designers of HS&B used items from NLS-72, and efforts were made by the LSAY research team to include items from both NLS-72 and HS&B so that appropriate comparisons of results could be made. LSAY collected data from public school students only; therefore, comparable data discussed in this chapter were obtained from NLS-72 and HS&B by including data from public school students only.

The combined data from these three longitudinal studies provide an important database on student achievement, attitudes, and career expectations.

[3]See Technical Notes in Appendix B for detailed information on these surveys.

Figure 4-11

Percent of public middle school and high school students expecting a career in science, mathematics, or engineering, by certainty level: 1987 to 1991



NOTE: Ch. 1 refers to LSAY Cohort 1, and Ch. 2 refers to LSAY Cohort 2. See figure 4-9 for descriptions of Cohort 1 and Cohort 2.

See appendix table 4-15. NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

level of certainty about an S&E career expectation, and an additional 4.0 percent expressed a moderate level of certainty. (See figure 4-11.) A comparison of the tenth-grade students in the two LSAY cohorts indicated that about 1 percent more of the younger cohort were highly confident about an S&E career, suggesting a small increase in the reported expectations of 1993 seniors.

Student, Family, and Community Characteristics

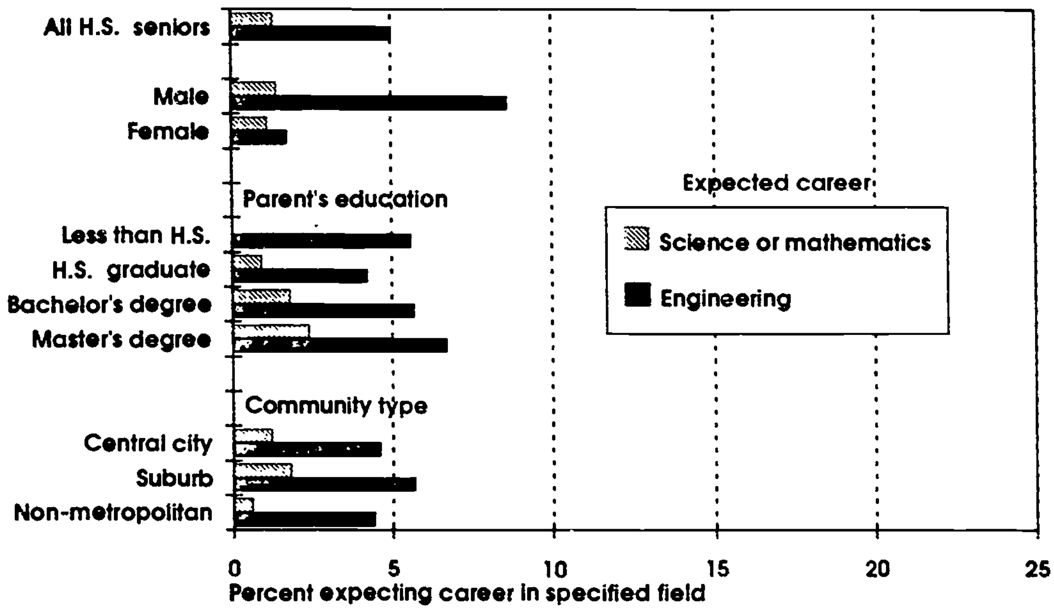
In 1990, approximately four times as many high school senior males as senior females expected science, mathematics, or engineering careers, but the gap between males and females in such career expectations has narrowed since 1972. The proportion of female high school seniors interested in science or mathematics has remained stable at about 1 percent during the last two decades, whereas the proportion of their male counterparts declined from 2.5 percent in 1972 to 1.4 percent in 1990. (See appendix table 4-14.)

The proportions of senior males and females expecting careers in engineering have increased by about 1.6 percentage points, but male expectations of careers in this field continue to outweigh those of females. On the other hand, in 1990, fewer than 3 percent of senior females expected careers in science, mathematics, or engineering. (See figure 4-12.)

The proportion of students expecting an S&E career did not differ significantly by the level of parent education among 1990 high school seniors. Similarly, the percentage of 1990 high school seniors who expected to pursue such careers did not differ significantly among central city, suburban, or non-metropolitan schools. (See figure 4-12.)

145

Figure 4-12
Percent of public high school seniors expecting a career in science, mathematics, or engineering, by selected characteristics: 1990



See appendix table 4-16. NSF Education Indicators—1992

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992), and unpublished tabulations.

Summary

The career expectation findings from the last two decades indicate that the proportion of high school seniors expecting to seek careers in science, mathematics, or engineering has not changed significantly. Approximately 6 percent of public high school seniors plan such careers, and this proportion has remained relatively stable during the last two decades. Despite substantial advantages in science and mathematics course persistence, students whose parents have more years of schooling were not significantly more likely to plan science, mathematics, or engineering careers than were students whose parents had fewer years of schooling.

Chapter 5: Higher Education

Overview

"Higher education provides the professional preparation of many of our Nation's future business leaders, public officials, socially concerned citizens, and virtually all engineers, mathematicians, and scientists, including those who will become future faculty at all educational levels." (NSF-EHR 1992a)

This statement, made at a recent colloquium sponsored by the National Science Foundation (NSF) for the Nation's top young science and engineering faculty, emphasizes higher education's impact on and importance to the Nation and its citizenry. Higher education not only transmits factual knowledge but also helps students develop essential critical thinking and reasoning abilities. Policy makers are asking whether the U.S. system of higher education is producing the graduates needed to power the American economy in a technological and competitive world. Do U.S. graduates have the breadth of skills necessary to excel in the workplace and the knowledge necessary to exercise the rights and responsibilities of citizenship within the larger context of a changing society?

This chapter examines higher education issues from the viewpoint of the educational experiences of students. At the outset, the goal was to identify and present indicators of the condition of higher education, including the quality of the educational experience and the output of the higher education system. However, few national indicators of science and mathematics study at the college and university levels were available. Thus, the chapter presents a limited set of statistical information and trends as indicators of higher education. Specifically, it investigates the **quantity** of students completing academic studies in science and engineering and, to a limited extent, the **quality** of science and engineering graduates and courses as perceived by faculty and students.[1]

In many ways, this chapter differs from the others in this volume. The preceding four chapters focus on education from kindergarten through twelfth grade where attendance is generally mandatory. Students attend college on a voluntary basis. Thus, many of the statistics cited in the previous chapters are unavailable for higher education. For example, international comparisons of student achievement become more difficult in a college system that is voluntary. Achievement is more difficult to measure in higher education, in part because little consensus exists on whether it can be measured and, if so, exactly what should be measured. No national studies on the quality of curricula or the quality of faculty in higher education exist. Finally, readers should note that issues of workforce readiness and technical workforce supply and demand are not discussed in this chapter.

This chapter is organized according to a simple model of the higher education process. Information on career intentions of students is presented first, followed by an analysis of student course-taking patterns. Student satisfaction with certain courses and faculty satisfaction with students are then presented. The chapter concludes with a discussion of trends in degrees awarded in science and engineering during the past 20 years, with a special emphasis on groups traditionally underrepresented in science and engineering studies—women, African Americans, Hispanics, Native Americans, and persons with disabilities.

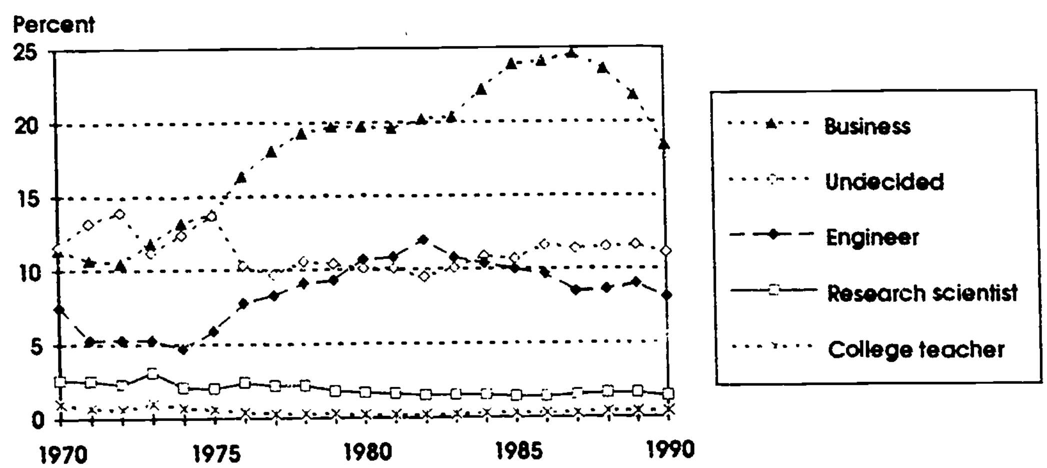
[1]No enrollment data are included in this chapter. For comprehensive statistics on enrollment, see the National Center for Education Statistics, U.S. Department of Education, *Digest of Education Statistics 1991* (NCES 91-697).

Throughout the chapter, indicators for specific fields within science and engineering are presented. The three major fields are (1) natural sciences, which include computer and information sciences, mathematics, life sciences, and physical sciences; (2) engineering; and (3) social and behavioral sciences, which include psychology and social sciences. On occasion, these science and engineering fields are contrasted with two other fields—business and humanities.

Freshman Career Expectations

Changes in the interest shown by college freshmen in science careers is one indicator of student awareness of career opportunities. In an annual survey of college freshmen, students are asked to select their career plans from 15 choices.[2] Figure 5-1 shows that fewer than 10 percent of the 1990 freshmen intended to pursue careers in science and engineering. Of this 10 percent, 8 percent preferred engineering; slightly more than 1 percent opted for scientific research. Only 0.4 percent wanted to become college teachers, although the teaching subject was not specified. According to this survey, engineering as a career preference peaked for all students in 1982 at 12 percent, then declined gradually during the next 8 years. Ten times more freshman women selected engineering in 1990 than in 1966, although women make up a relatively small proportion of the engineering total. (See appendix table 5-1.) Business remained the most popular career choice among 1990 freshmen surveyed by CIRP, although this choice had fallen from a 1987 peak of 25 percent. Students interested in science careers, as defined by this survey, represented a very small proportion of the 1990 college freshmen.

Figure 5-1
Percent of U.S. college freshmen choosing selected careers: 1970 to 1990



See appendix table 5-1.

NSF Education Indicators—1992

SOURCE: E.L. Dey, A.W. Astin, and W.S. Korn, *The American Freshman: Twenty-Five Year Trends, 1966–1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991).

[2] The Cooperative Institutional Research Program (CIRP), conducted by the Higher Education Research Institute at the University of California, Los Angeles (UCLA), is a national longitudinal study of U.S. freshmen, administered annually. See the notes in appendix table 5-1 for a list of the choices; also see the detailed description of the survey in the Technical Notes in Appendix B to this report.

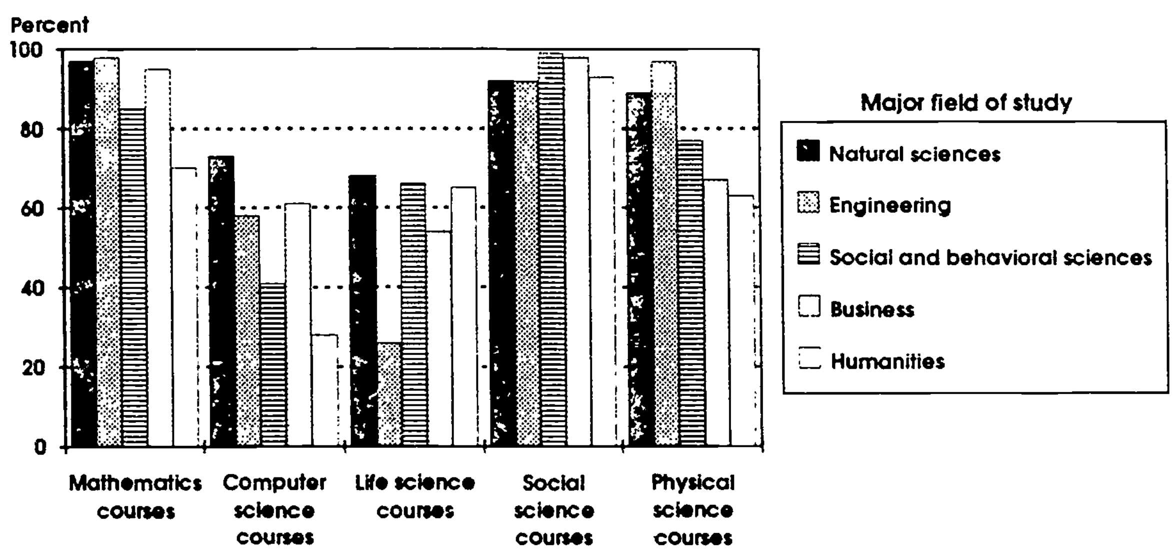
Undergraduate Course-Taking

One of the goals listed in the national education goals adopted by President Bush and the Nation's governors in 1990 says: "Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship" (E.D, 1991). The global economy is becoming more dependent on technology. Many of the most vital domestic industries—computers, semiconductors, synthesized materials, and biotechnology, for example—depend on people with scientific knowledge and technological skills (NSF-EHR 1992b). One route to achieving this broad knowledge is through the taking of science and mathematics courses in high school and college.

The Survey of Recent College Graduates (RCG) of 1985–86 bachelor's degree recipients conducted by the National Center for Education Statistics of the U.S. Department of Education presents course-taking behavior for different majors (NCES 1993). Although several years old, these results are the most current available. Figure 5-2 shows the percentage of college graduates in each of five major fields who took one or more courses in mathematics, computer sciences, or other sciences while in college. Some of the findings from the RCG study are presented below.

- Mathematics courses: Most undergraduate students took one or more courses in mathematics before they graduated—even students not majoring in science and engineering. Of natural sciences, engineering, and business majors, 95 percent took one or more courses in mathematics. Surprisingly, 85 percent of social and behavioral sciences majors did so, along with 70 percent of humanities majors.

Figure 5-2
Percent of bachelor's degree recipients who took one or more selected science and engineering courses, by major field of study: 1985–86



See appendix table 5-2. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, unpublished tabulations from the 1987 Recent College Graduates Transcript Study: Estimates of 1985–86 Bachelor's Degree Recipients Course-taking Behavior.

- Physical sciences courses: As might be expected, almost all engineering students took at least one physical sciences course, as did 89 percent of the natural sciences majors. Interestingly, more than 60 percent of the students in the other three majors did likewise.

- Computer sciences courses: Many undergraduates did not take any computer sciences courses. Only 28 percent of humanities majors and 41 percent of social and behavioral sciences majors took one or more computer courses. In contrast, nearly three-quarters of the natural sciences majors took computer science during their undergraduate studies. Approximately 60 percent of engineering majors took one or more computer courses.

- Life sciences courses: As might be expected, about two-thirds of the natural sciences, social and behavioral sciences, and humanities majors took one or more life sciences courses. Slightly more than half of the business majors did the same; however, only about one-quarter of the engineering majors took one or more courses in the life sciences.

Appendix table 5-2 also shows the average number of courses taken in each subject—for all those who took one or more courses—by the five different majors. Future studies of a similar nature will show whether and how student course-taking patterns changed towards the end of the 1980s and in the early 1990s.

Student Satisfaction With Courses

In 1988, the Higher Education Research Institute at UCLA asked selected students who were freshmen in 1984 to rate their levels of satisfaction with courses and instruction (Astin et al. 1990). In general, students seemed satisfied with the courses they took in science and mathematics. (See figure 5-3.) Female students in 4-year colleges appeared to be less satisfied with their courses in science and mathematics than male students. Students in 2-year institutions were more often satisfied with science and mathematics courses than were their counterparts in 4-year institutions. These student assessments of courses, however limited, suggest that further investigation of instructional quality is required.

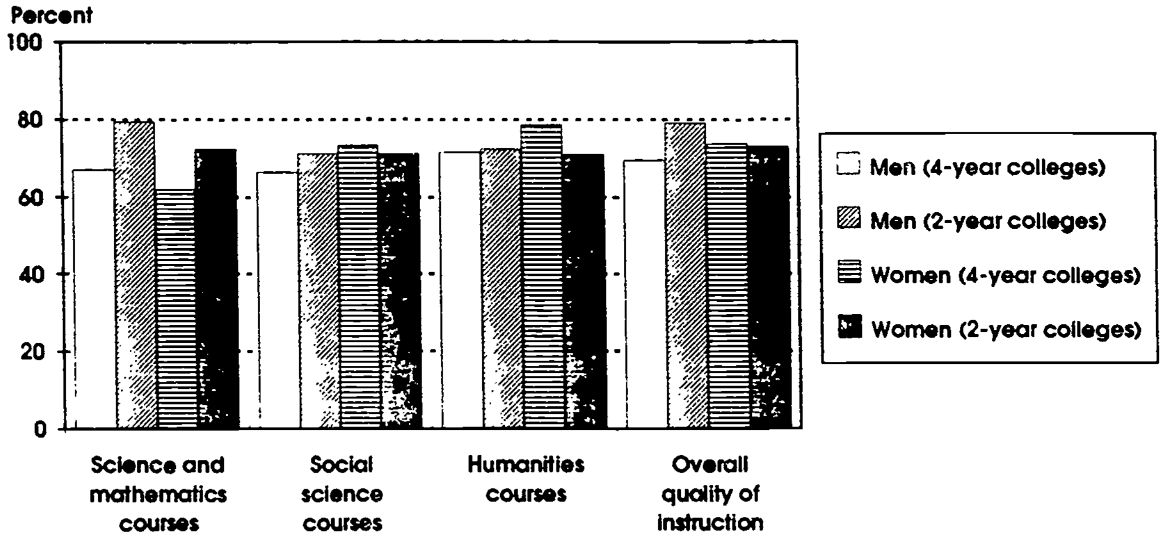
Quality of Students: Faculty Satisfaction

A 1988 national survey of postsecondary faculty asked 8,380 faculty to assess their levels of satisfaction with undergraduate and graduate students at their institutions (NCES 1990). Figure 5-4 presents the results. Of particular interest are the ratings from faculty in the science and engineering fields. Figure 5-4 shows that engineering faculty were the most satisfied with their undergraduate students, followed closely by business faculty. Faculty ratings in the other three fields—natural sciences, social and behavioral sciences, and humanities—clustered around the 60-percent satisfaction level. Faculty ratings for graduate students were similar across the five major fields; approximately 70 percent were somewhat or very satisfied. However, the extent to which differences in the levels of faculty satisfaction with students reflect differing faculty expectations or genuine differences in the quality of students is not known.

The same 1988 survey asked faculty their opinions of the quality of undergraduate students in higher education. Faculty selected one of four qualitative descriptions: Improved, Stayed the same, Worsened, or Have no idea. The results of this previously unpublished tabulation are presented in appendix table 5-5. Substantial proportions of faculty from all fields believed that the quality of undergraduate students had worsened—specifically, 52 percent of

Figure 5-3

Percent of students rating selected classroom experiences as satisfactory or very satisfactory, by sex and institution type: 1988 follow-up of fall 1984 freshmen

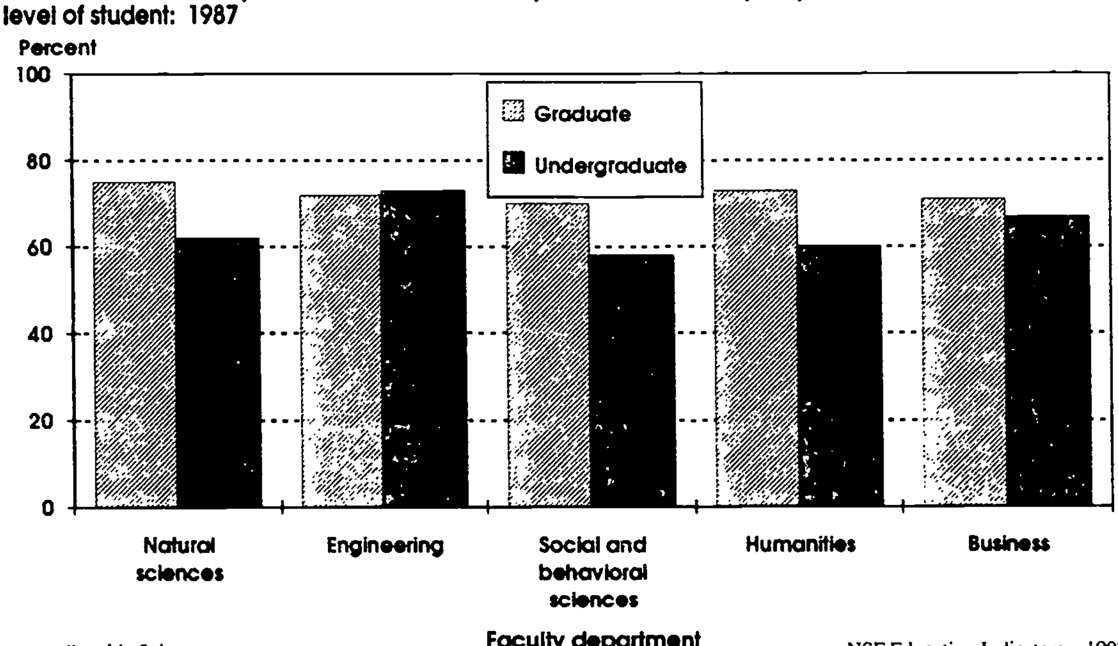


See appendix table 5-3. NSF Education Indicators—1992

SOURCE: A.W. Astin, W.S. Korn, E.L. Dey, and S. Hurtado, *The American College Student, 1988: National Norms for 1984 and 1986 College Freshmen* (Los Angeles: Higher Education Research Institute, UCLA, 1990).

Figure 5-4

Percent of full-time faculty who are somewhat or very satisfied with the quality of their students, by level of student: 1987



See appendix table 5-4. NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, "1988 National Survey of Postsecondary Faculty," as cited in *Faculty in Higher Education Institutions, 1988* (Data series DR-NSOPF-87/88-1.27).

the natural sciences faculty, 41 percent of the engineering faculty, and 43 percent of faculty in the social and behavioral sciences.

Although faculty from the natural sciences were most likely to report the perception of worsening undergraduate quality, the perception was not confined to science and engineering faculty. About the same proportion of humanities and business faculty felt the same.

Graduate Record Examination Trends

The Graduate Record Examination (GRE), conducted by the Educational Testing Service since 1952, is a series of tests used by colleges and universities in admitting new graduate students. The GRE provides common measures for comparing the qualifications of applicants wishing to pursue graduate study in a particular field. For the purposes of this chapter, GRE subject test results from the 1980s are used as measures of the quality of students wishing to pursue graduate study in science and engineering.

A graduate school may require applicants to take either the GRE general test or the general test and the subject test. The general test measures academic ability and skills developed over time. The subject tests measure achievement in 16 specific fields of study, including 11 science and engineering fields. Not all college graduates take the GRE, nor do all graduate programs require that GRE tests be taken. As a result, GRE scores are not representative of the abilities or achievement of all college graduates or graduate school applicants. Nevertheless, the subject test scores are the best measure available of the quality of students who want to pursue graduate studies in science and engineering.

Comparability of Scores

Theoretically, scores on the GRE subject test range from a low of 200 to a high of 990. However, the possible score range and the obtained range vary by subject test. Moreover, scores are **not** comparable across subjects. Thus, for example, a score of 680 on the mathematics test is in no way comparable to a score of 680 on the computer science test. GRE subject test scores are available for the academic years 1978–79 to 1990–91, allowing comparison of scores on specific subject tests over time.[3]

Recent Trends in Scores

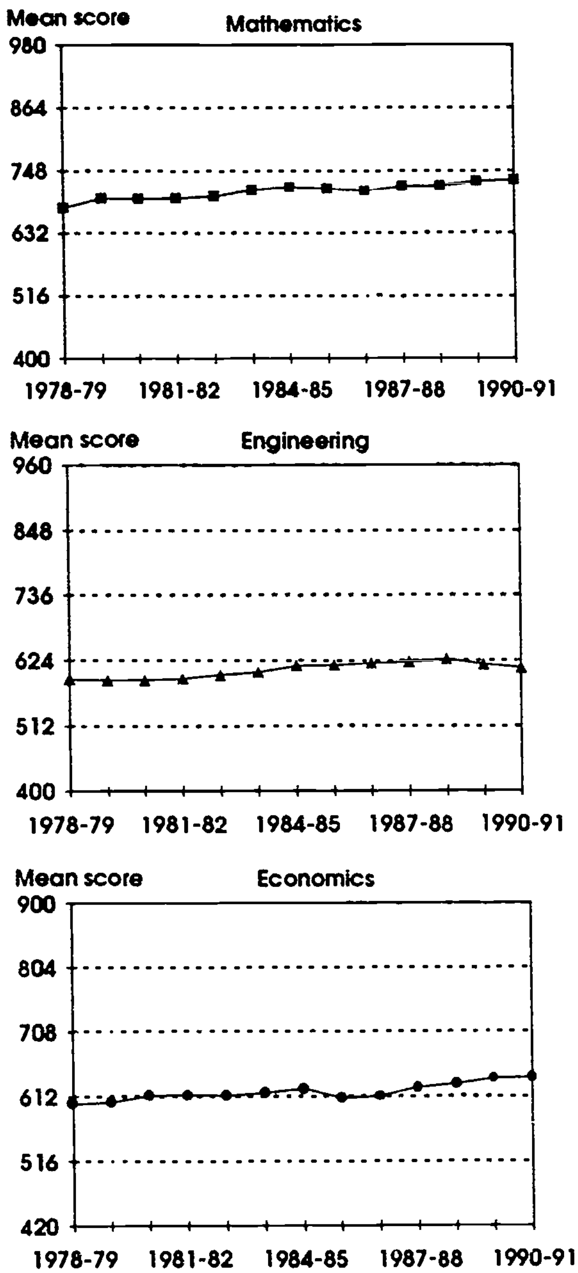
Mean scores on GRE subject tests in mathematics, economics, chemistry, and computer sciences increased measurably between 1978 and 1991. Mean scores for other subject tests either increased slightly, held steady, or decreased very slightly. What effect the recent increases in foreign graduate student enrollments have had on the mean scores is unknown.

Natural Sciences

Appendix table 5-6 shows the mean scores over time for 10 science-related subjects. The mean scores for those taking the mathematics, chemistry, computer sciences, and physics tests increased between 1978–79 and 1990–91. The geology test score mean remained unchanged, and the biology mean score decreased very slightly. However, these results indicate that the quality of students pursuing graduate studies in these fields in 1991 was at least as high as it was in 1979. Some changes in mean scores were small; these changes may not reflect significant shifts

[3]Scores on GRE subject tests prior to 1977 are not comparable to scores in later years; therefore, trend data presented here begin with the academic year 1978–79.

Figure 5-5
Mean score on GRE subject test in mathematics, engineering, and economics: 1978-79 to 1990-91



See appendix table 5-6. NSF Education Indicators—1992

SOURCE: D.M. Wah and D.S. Robinson, *Examinee and Score Trends for the GRE General Test: 1977–78, 1982–83, 1986–87, and 1987–88* (Princeton: Educational Testing Service, 1990).

in the content of student knowledge but may reflect factors having little or nothing to do with student ability (for example, changes in those taking the test, potential error in measurement, etc.). (See figure 5-5 for the mathematics mean scores.)

Engineering

The engineering test score mean increased slightly during the same period. (See figure 5-5.) The 36-percent increase in the number of graduate students enrolled in engineering between 1981 and 1990 did not affect test score means.

Social and Behavioral Sciences

There was no significant change in the mean test scores of those taking the psychology or sociology tests between 1978 and 1991. However, the mean scores for economics increased noticeably. (See figure 5-5.)

Educational Transition Points

In higher education, there are several points at which students may enter the workforce or pursue further studies in science and engineering. These occur—

- At the transition from 2-year to 4-year institutions.
- Between the bachelor's degree and graduate matriculation.
- Within the graduate level, often between master's and doctoral studies.

Students may also return to the educational system from elsewhere at any of these points. The ability of students to make these transitions has important implications for the science and engineering educational system and, ultimately, the workforce. A complicating factor in determining the ease with which these transitions are made is the difficulty of maintaining, over time, national records regarding students' intentions, their subsequent decisions at the different transition points, and the factors influencing those decisions.

The Transition From 2-Year Colleges

Unpublished tabulations from RCG show that only 7 percent of the 1985–86 science and engineering bachelor's degree recipients had transferred degrees or certificates from any colleges (2- or 4-year) or universities to their graduating institutions. Among bachelor's degree recipients, the transfer of an associate or other degree to the bachelor's degree-granting institution was not a common phenomenon. Many more students transferred courses, not degrees, from one institution to another: 55 percent of all 1985–86 bachelor's degree recipients in science and engineering transferred one or more courses, degrees, or both from other institutions to the institutions from which they graduated. This proportion varies little across fields of study. However, just 7 percent transferred degrees or certificates.

Two-year colleges are one source of training for future scientists and engineers. Nevertheless, very few students attend a 2-year college, receive associate degrees, then transfer those degrees to 4-year institutions. Special tabulations of the college records from the longitudinal study of 1972 high school seniors (NLS-72) show that only 7 percent of the graduates of 4-year colleges with degrees in the natural sciences and engineering had received associate degrees before attending the 4-year colleges. However, the study also shows that about 20 percent of college graduates with bachelor's degrees in the natural sciences and engineering had taken courses at 2-year colleges.

Further study of the types of courses that graduates had taken at 2-year colleges and of changes in these transitions since the 1970s will be possible in 1993 when the results of new surveys of graduates become available. It will be possible to learn whether 2-year colleges have played an increasingly important role in educating science and engineering graduates of 4-year institutions.

The Post-Baccalaureate Transition

What happens to science and engineering degree recipients after graduation? The next section examines graduates' academic and occupational pursuits using the results of a 1990 survey of recent science, social science, and engineering graduates that show how many graduates found jobs in their fields and how many pursued graduate studies.

Graduate School

Approximately 20 percent of students awarded bachelor's degrees in science or engineering fields in 1988 and 1989 were attending graduate school full time in 1990. (See figure 5-6.) Of those awarded bachelor's degrees in the natural sciences, 25 percent were enrolled in graduate school, as were 20 percent of those awarded bachelor's degrees in the social and behavioral sciences. In contrast, only about 1 in 10 of their peers in engineering was enrolled full time in graduate school in 1990.

Workforce

Of all science and engineering bachelor's degree recipients in 1988 and 1989, 44 percent were employed in science- and engineering-related occupations in 1990. Seventy-three percent of engineering graduates found jobs in science and engineering. Those with bachelor's degrees in the social and behavioral sciences were least likely to be employed in their fields of study. (See figure 5-6.)

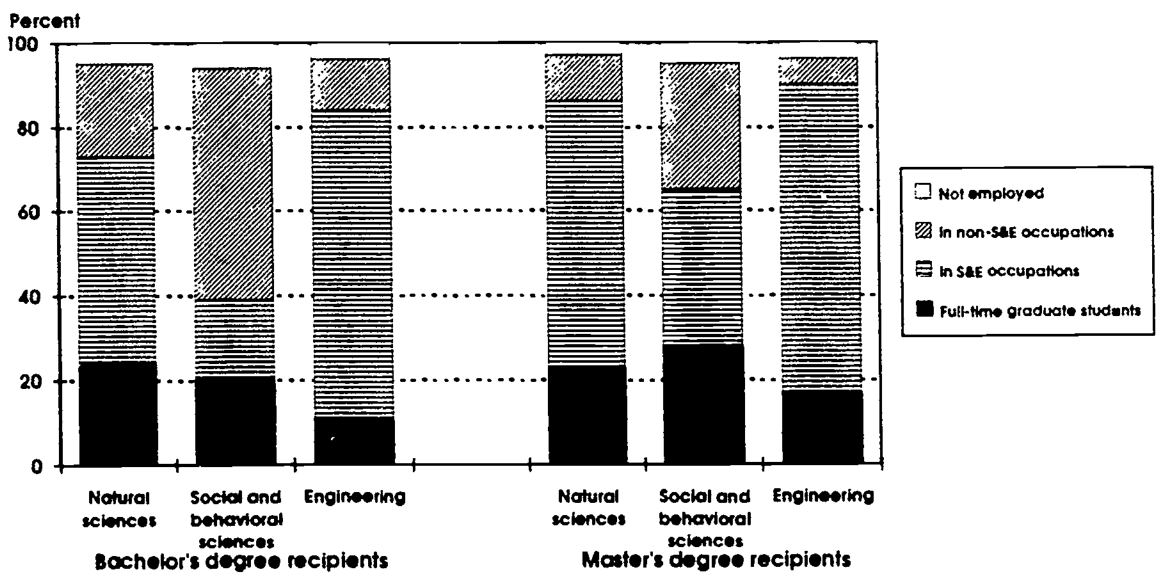
The 1990 median annual salary of those who earned engineering bachelor's degrees in 1988–89 was $33,000—27 percent higher than the average for all science and engineering bachelor's degree recipients that year. Social and behavioral sciences graduates were paid the least: their median salary was 20 percent below the science and engineering average. Natural sciences bachelor's degree recipients earned about 6 percent less than the average. (See appendix table 5-7.)

The Post-Graduate Transition

Doctoral Studies

Who pursues doctoral studies in science and engineering after receiving a master's degree? Students awarded master's degrees in the natural sciences and the social and behavioral sciences in 1988 and 1989 were more likely to go on to study for doctorates than were their peers in engineering. (See figure 5-6.) In all three major fields, fewer than 30 percent of the master's recipients pursued studies at the doctoral level. The subfield with the highest continuation rate was physical sciences. (See appendix table 5-7.)

Figure 5-6
Employment status of 1988 and 1989 bachelor's and master's degree recipients in science and engineering, by major field of study: 1990



See appendix table 5-7. NSF Education Indicators—1992

Source: Division of Science Resources Studies, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990*, as cited in the NSF article "Activities of Recent S&E Graduates Vary Significantly by Field of Degree" (NSF 91-121).

Workforce

A similar employment pattern occured at the master's level as at the bachelor's level. In 1990, 73 percent of the master's degree recipients in engineering were employed in their field; 6 percent were employed in other fields, while 3 percent were unemployed. Among their peers in the natural sciences and social and behavioral sciences, 50 percent were employed in science and engineering occupations; 20 percent were not, while 5 percent were unemployed.

Trends in Science and Engineering Degree Production

This section describes trends in degree production for bachelor's, master's, and doctoral degrees during a 20-year period—that is, academic years 1970–71 to 1989–90. In this period, significant changes in degree production occurred in science and engineering.

Associate degree trend data by disciplinary field of study is available for the years 1985–86 to 1989–90. Therefore, throughout this section, a 5-year trend is presented for the four degree categories, the three major science and engineering fields, and certain subfields. This more recent 5-year trend is important to examine because the direction or magnitude of change differs from the 20-year trend in some fields and subfields.

The number of associate degrees[4] conferred in science and engineering fell 24 percent between 1986 and 1990. By comparison, during the same period, virtually no change occurred in the number of bachelor's degrees awarded in these fields. The number of master's degrees granted went up 8 percent, and the number of doctoral degrees awarded in science and engineering fields rose 18 percent.

Associate Degrees

Associate degree-granting institutions fulfill a role that has traditionally been considered different from that of 4-year institutions. In a survey conducted by the Carnegie Foundation for the Advancement of Teaching, 50 percent of the students surveyed said they were attending 2-year institutions because they were seeking skills for a new or current occupation; 36 percent indicated that they were there as "preparation for transfer to a 4-year college or university" (Commission on the Future of Community Colleges 1988).[5]

The strong occupational focus of associate degree-granting institutions may explain in part why relatively few degrees are awarded at this level in the traditional science and engineering fields. In 1989–90, U.S. institutions of higher education granted 454,679 associate degrees. Only 4 percent of that total was in natural sciences, engineering, and social and behavioral sciences. (See appendix table 5-8.) The largest share was awarded in liberal or general studies (28 percent), followed by business and management (24 percent), allied health sciences (14 percent), and engineering technologies (11 percent). It is noteworthy that the number of associate degrees awarded represents close to half the number of bachelor's degrees awarded in 1989–90 (1,062,151) and more than 12 times the number of doctorates awarded that year (36,027).

[4]Associate degree data collected by the National Center for Education Statistics were used for this report. Data on bachelor's, master's, and doctoral degrees came from the Division of Science Resources Studies at the National Science Foundation. It should be noted that SRS and NCES do not categorize major fields in exactly the same way.

[5]Some students chose two or more reasons. Other reasons given by students were that they attended to fulfill a personal interest (14 percent); or to improve basic English, reading, or mathematics skills (4 percent).

Natural Sciences

Between 1985–86 and 1989–90, the number of associate degrees awarded in natural sciences fell by 20 percent, reflecting a substantial decrease in the number of associate degrees awarded in computer and information sciences. (See figure 5-7.) In contrast, associate degree production in the other three natural sciences fields—life sciences, mathematics, and physical sciences—increased.

Engineering

The number of associate degrees awarded in engineering declined by 55 percent during the 5-year period studied. Concurrently, associate degree production in the comparatively large field of engineering technology—an occupationally focused, engineering-based field—dropped by 11 percent.

Social and Behavioral Sciences

The number of associate degrees conferred in social and behavioral sciences increased by 14 percent between 1985–86 and 1989–90. The increase in the number of associate degrees awarded in psychology (18 percent) was double the increase in the number of associate degrees awarded in social sciences.

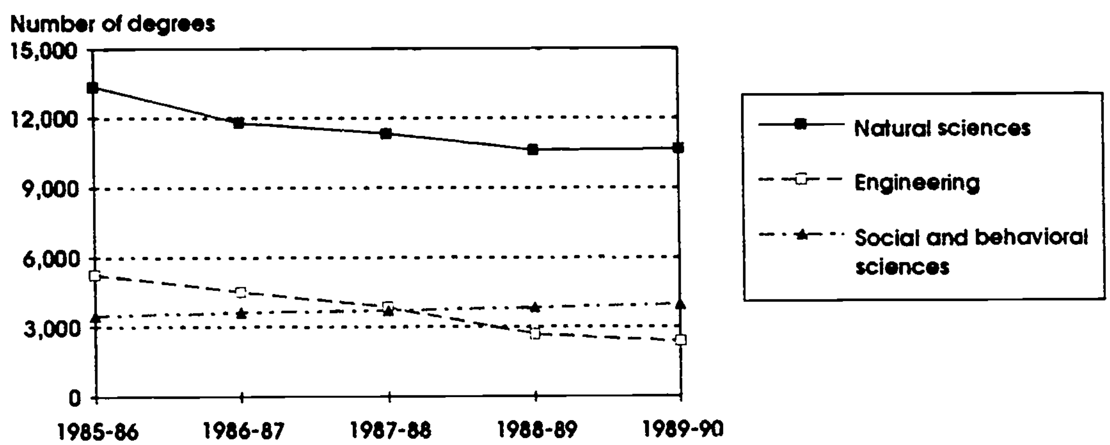
Bachelor's Degrees

In 1989–90, 1,062,151 bachelor's degrees were awarded by U.S. institutions. Science and engineering accounted for almost one-third of that total. Between 1970–71 and 1989–90, bachelor's degrees awarded in science and engineering fields increased by about 12 percent. (See figure 5-8.) However, total bachelor's degree production increased by 26 percent during that 20-year period. From 1985–86 to 1989–90, science and engineering bachelor's degree production showed a 2-percent decline.

Natural Sciences

In 1989–90, 11 percent more degrees in natural sciences were awarded than was the case in 1970–71. Two subjects recorded major changes in the 20-year period: the 1989–90 total for computer and information sciences degrees represented a tenfold increase

Figure 5-7
Associate degrees awarded in science and engineering, by major field of study: 1985–86 to 1989–90



See appendix table 5-8.

NSF Education Indicators—1992

SOURCE: National Center for Education Statistics, U.S. Department of Education, "Degrees and Other Formal Awards Conferred" surveys, and Integrated Postsecondary Education Data System (IPEDS) "Completions" survey, as cited in *NCES Digest of Education Statistics: 1991*, No. NCES 91-697, and unpublished tabulations.

International Comparisons: Degree Production

To compare science and engineering degree production among countries, the number of students graduating with first university degrees—and those graduating in the natural sciences and engineering—was compared with the size of the 22-year-old population in each country.[6] In the United States, first university degree graduates represent about 28 percent of the 22-year-old population. This is roughly the same proportion as in Canada but a larger share than in other industrialized countries, such as Japan, the United Kingdom, France, and Germany. (See text table 5-1.)

Despite graduating a larger proportion of its population than most other countries for which data were collected, the United States graduated a smaller fraction of its students in the natural sciences and engineering than did either Canada or Japan[7] but a slightly larger fraction than did the European countries.

over 1970–71, while the total for mathematics showed a 41-percent decline.

Between 1985–86 and 1989–90, bachelor's degrees in natural sciences fell by 20 percent. Within specific natural sciences fields, both computer and information sciences and physical sciences experienced substantial declines (34 percent and 26 percent, respectively).

Text table 5-1
Recipients of first university degrees as a percent of all persons 22 years old, by major field of study and country

Country	Year	All fields	Natural sciences and engineering
United States	1990	28.3	4.5
Canada	1990	27.5	5.4
Japan	1990	22.4	6.0
United Kingdom	1988	16.0	3.1
France	1990	9.2	3.6
Germany	1990	8.0	2.8

See appendix table 5-9. NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, National Science Foundation, international database on human resources.

Engineering

The 20-year trend in engineering showed a 43-percent growth in the number of bachelor's degrees awarded. During the 5-year period, engineering bachelor's degree production fell by 16 percent.

Social and Behavioral Sciences

Unlike the recent declines in natural sciences and engineering bachelor's degrees, social and behavioral sciences experienced a 25-percent increase in the number of degrees awarded between 1985–86 and 1989–90. During the 20-year period, however, bachelor's degree production in this field fell by 3 percent, reflecting a 10-percent decline in social sciences bachelor's degree production.

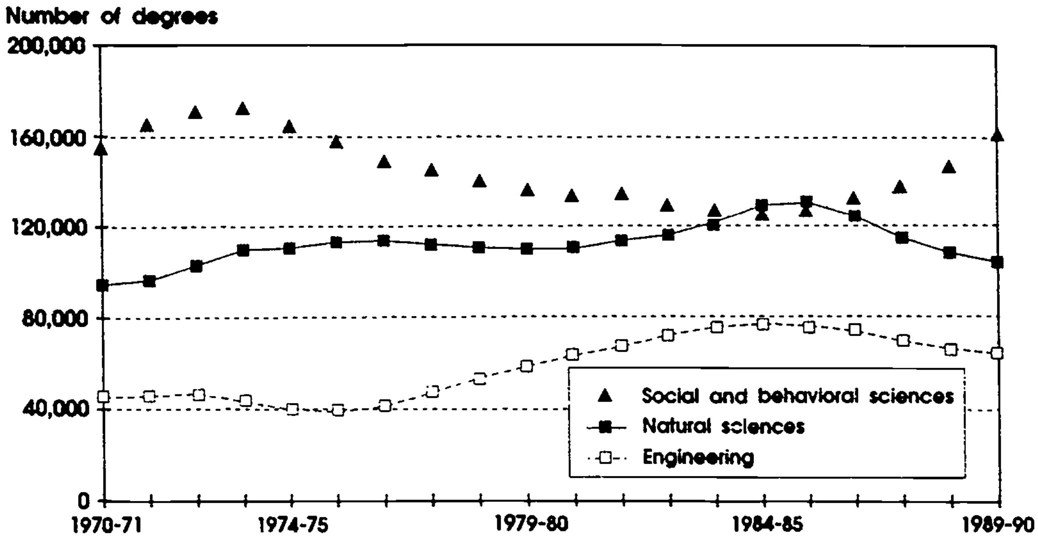
Master's Degrees

In 1989–90, 324,947 master's degrees were awarded by U.S. institutions. Science and engineering accounted for almost one-quarter of that total. Between 1970–71 and 1989–90, science and engineering master's degree production increased by 38 percent, keeping pace with the increase in master's degrees awarded in all fields (40 percent). The more recent 5-year trend continued upward. (See figure 5-9.)

[6]Data were supplied from the National Science Foundation's Division of Science Resources Studies' database on international human resources, which is compiled from a variety of sources including the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the U.S. Department of Education, and several foreign sources.

[7]Most of the natural sciences and engineering degree production in Japan was in engineering rather than in the natural sciences. See appendix table 5-9 for a complete breakdown.

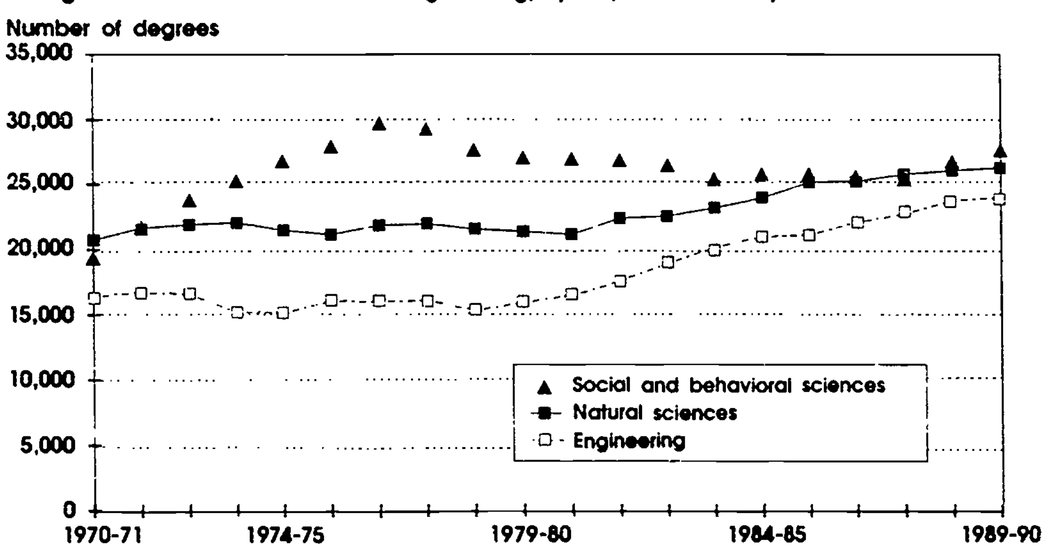
Figure 5-8
Bachelor's degrees awarded in science and engineering, by major field of study: 1970–71 to 1989–90



See appendix table 5-10. NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966–90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Figure 5-9
Master's degrees awarded in science and engineering, by major field of study: 1970–71 to 1989–90



See appendix table 5-13. NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966–90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Financial Support

The Federal Government supports a sizable fraction of graduate students in science and engineering. (See figure 5-10.) On the basis of data collected by Science Resources Studies (NSF-SRS 1991b), 20 percent of science and engineering graduate students in 1990 received their largest share of support from the Federal Government; 53 percent received their largest share of support from non-Federal sources; and 27 percent financed the majority of their education expenses themselves, through loans or family sources. (See appendix table 5-16.) The Federal share remained quite steady throughout the last decade, whereas the percentage of students financing their education themselves dropped from 31 percent to 27 percent; this means that non-Federal sources of support increased.

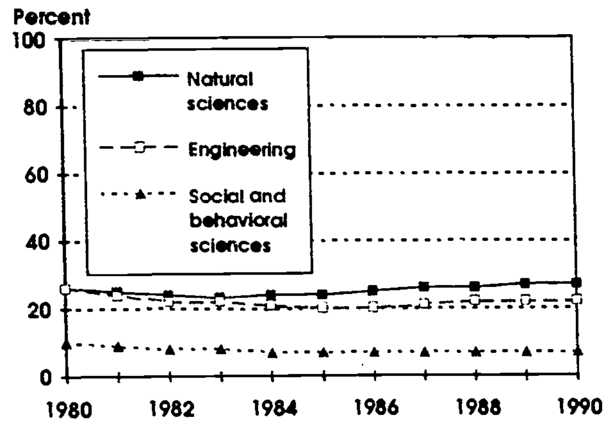
Between 1980 and 1990, the number of full-time science and engineering graduate students with tuition support[8] increased by 24 percent (Federal and non-Federal sources), while graduate enrollment in these fields increased by 34 percent. The number of students supported on fellowships (grants to students) increased by 24 percent, but the number supported on traineeships (grants to institutions for student support) fell by 14 percent. (See figure 5-11.)

There have been large increases in the number of students supported through assistantship activities, which are usually included in faculty research grants and require students to assist faculty in exchange for tuition support. The number of students supported on research assistantships increased by 57 percent over the decade, while teaching assistantships increased more modestly (21 percent). (See figure 5-14.)

Natural Sciences

The 20-year trend shows that natural sciences master's degrees increased by 27 percent. The 5-year trend shows an increase of 4 percent. Recently, physical and life sciences experienced slight declines in master's degree production, while computer sciences and mathematics grew 19 percent and 16 percent, respectively.

Figure 5-10
Percent of graduate students receiving Federal support, by major field of study: 1980 to 1990



See appendix table 5-16. NSF Education Indicators—1992

SOURCES: Division of Science Resources Studies, *Selected Data on Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: National Science Foundation, 1991), unpublished tabulations, and annual series, as cited in *Science and Engineering Indicators 1991*, NSF-NSB 91-1.

Engineering

The number of master's degrees conferred in engineering rose dramatically during the 20-year period—up 47 percent over the figure for 1970–71. The 5-year trend in engineering master's degrees shows a 14-percent increase.

Social and Behavioral Sciences

By 1989–90, master's degree production in social and behavioral sciences increased by 42 percent over the 1970–71 figure—fueled in part by the 110-percent increase in master's degrees in psychology. The more recent 5-year trend shows that master's degree completions in the social and behavioral sciences increased by 8 percent.

Doctoral Degrees

In 1989–90, 36,027 doctoral degrees were awarded by U.S. institutions of higher education.

[8] Tuition support includes fellowships, traineeships, research assistantships, and teaching assistantships.

Science and engineering accounted for 63 percent of that total. Between 1970–71 and 1989–90, doctoral degree production increased by about 18 percent in science and engineering (see figure 5-12) compared with 13 percent in all fields. Between 1985–86 and 1989–90, an increase of 18 percent in science and engineering doctoral degrees occurred as a result of a rise in the number of doctorates conferred to both U.S. and non-U.S. citizens.

Natural Sciences

The 20-year trend shows an 11-percent increase in doctoral degree production in natural sciences. In the more recent 5-year period, it increased 18 percent. After having fallen substantially throughout the 1970s and early 1980s, doctoral degree production in mathematics and physical sciences rebounded strongly between 1985–86 and 1989–90—increasing by 22 and 16 percent, respectively.

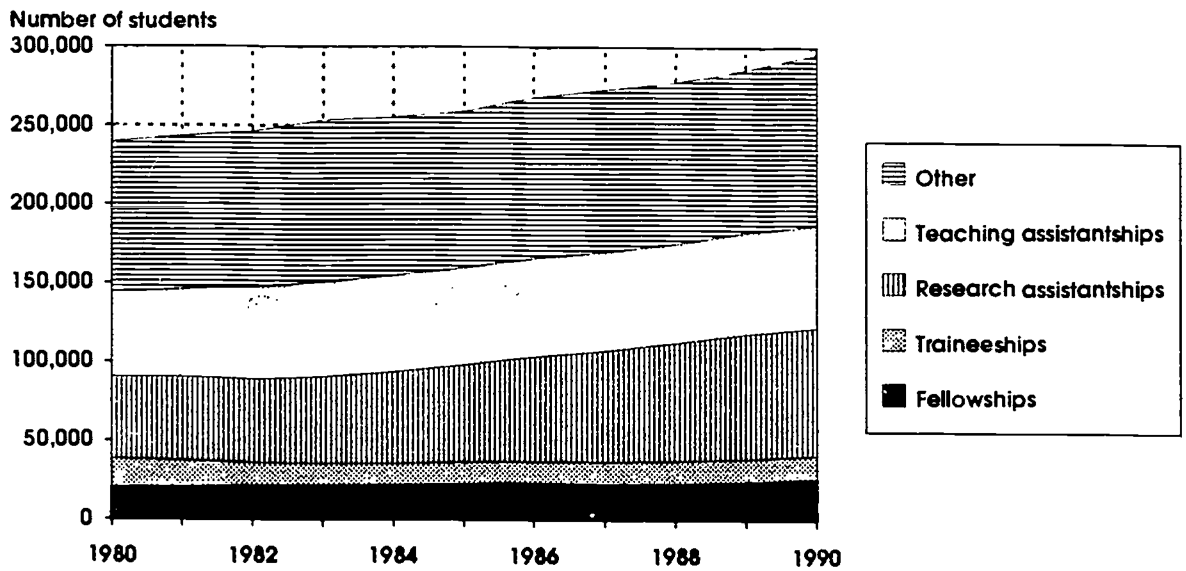
Engineering

The number of doctoral degrees conferred in engineering rose by 39 percent during the 20-year period. After falling by 31 percent in the 1970s, engineering doctorates began to climb. In 1989–90, 45 percent more doctorates were awarded in engineering than were awarded 5 years earlier.

Social and Behavioral Sciences

Doctoral degrees awarded in social and behavioral sciences increased by 18 percent during the 20-year period studied. This increase resulted from a 52-percent rise in the number of doctorates conferred in psychology. The number of doctorates conferred in social sciences fell by 3 percent during the 20-year period. For both fields, the more recent trend shows a slight increase.

Figure 5-11
Full-time science and engineering graduate students, by major type of support: 1980 to 1990

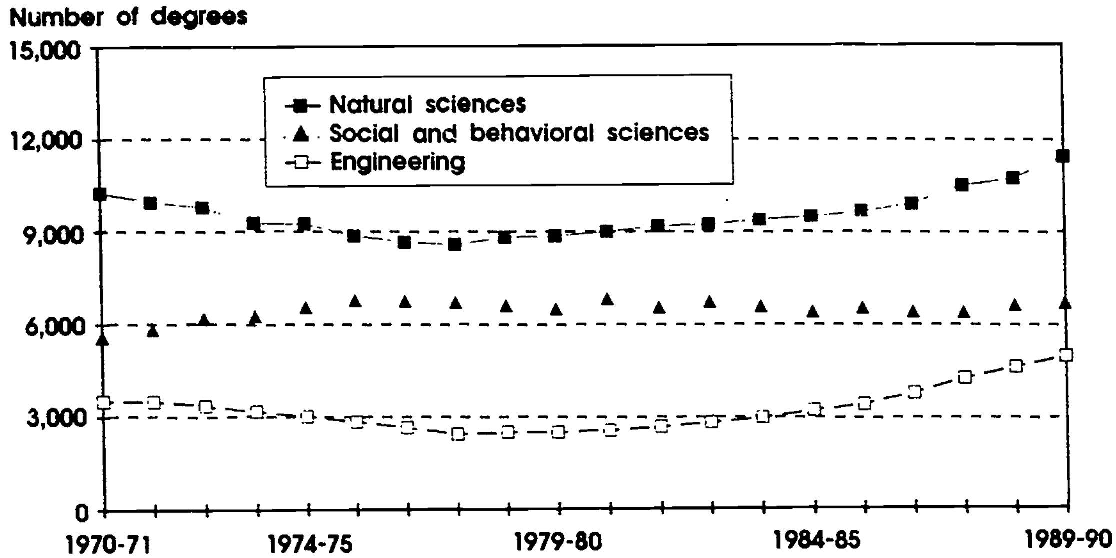


See appendix table 5-17.

NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Graduate Students and Postdoctorates in Science and Engineering.

Figure 5-12
Doctoral degrees awarded in science and engineering, by major field of study: 1970–71 to 1989–90



See appendix table 5-18. NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Foreign Students Enrolled in U.S. Institutions

UNESCO reports that between 1986–87 and 1990–91, the number of foreign students studying in the United States increased by 18 percent (IIE 1991). In 1991, slightly more than half of all engineering doctoral degrees awarded by U.S. institutions were awarded to non-U.S. citizens. (See appendix table 5-23.) These and sim'lar findings have fueled a debate in academic and policy circles about the reasons for and effect of foreign students studying in U.S. institutions of higher education.

The effect of foreign student enrollments on the U.S. higher education enterprise is also difficult to gauge. However, from 1987 through 1991—concurrent with a 51-percent increase in the number of engineering doctorates awarded to foreign students—there was a 27-percent increase in the number of doctorates awarded to U.S. citizens in that field. (See appendix table 5-23.) Moreover, foreign students were slightly more likely to be enrolled as undergraduates (47 percent) in 1991 than as graduate students (45 percent).

World Region of Origin

The total number of foreign students studying in the United States rose sharply, increasing more than two-and-a-half times between 1970–71 and 1990–91 when it totaled 407,530. Much of this increase results from the dramatic rise in the number of Asians studying in the United States. (See figure 5-13.) Between 1970–71 and 1990–91, the number of Asian students in this country more than quadrupled.

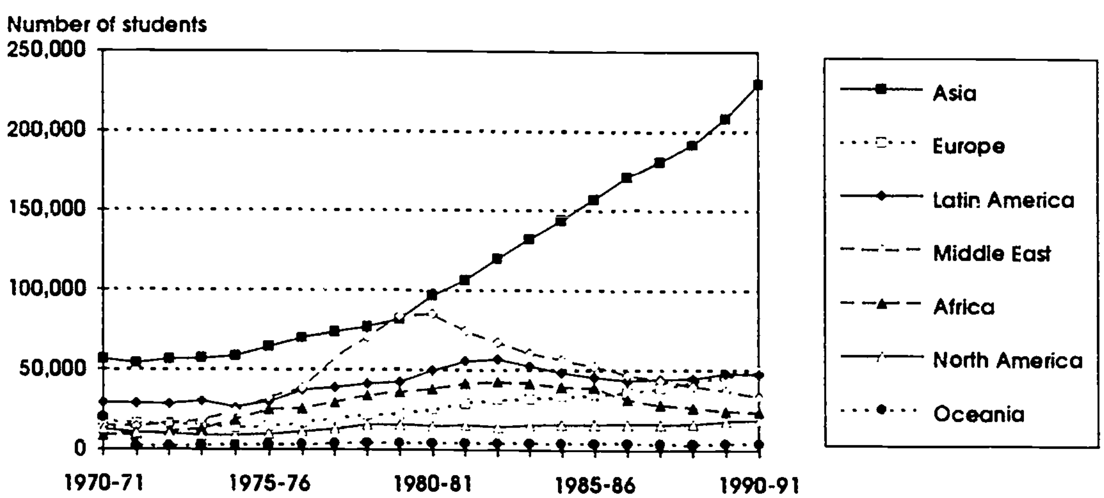
International Perspectives

According to studies conducted by UNESCO, despite recent and continuing increases in foreign student enrollments in U.S. higher education institutions, only 3 percent of all students enrolled in U.S. colleges and universities in 1987 were foreign. In many nations, this percentage was much higher. (See appendix table 5-21.) In Switzerland, for example, foreign enrollments constituted more than 10 percent of total enrollment. France, Belgium, Sweden (1985 data), the United Kingdom, West Germany, Australia (1985 data), and Denmark all had larger proportions—ranging from 9 percent to 4 percent—of foreign enrollments than did the United States. On the other hand, foreign enrollments in Japan constituted only 0.7 percent of total enrollment in 1987.

In 1990–91, more than half of all foreign students enrolled in U.S. colleges and universities were from Asia.

Increases in the numbers of foreign students studying in the United States are not confined to Asians, however. The number of European students studying in the United States rose by 170 percent between 1970–71 and 1990–91. Also on the rise was the number of Latin Americans studying in the United States: their number increased by 62 percent between 1970–71 and 1990–91. Africa, Oceania, and North America (Canada) also experienced large-percentage increases in their representation during this period; however, the overall numbers of students from these regions remained relatively low. (See appendix table 5-22.) The Middle East, once the largest source of foreign students studying in U.S. colleges and universities, now ranks fourth because of a turn in political events in the late 1970s.

Figure 5-13
Foreign students studying in the United States, by world region of origin: 1970–71 to 1990–91



NOTE: Oceania includes Australia, New Zealand, and 18 Pacific Ocean Island areas.

See appendix table 5-22.

NSF Education Indicators—1992

SOURCE: Institute of International Education, *Open Doors, 1990–1991, Report on International Educational Exchange* (New York: 1991).

Doctoral Degrees Earned by Non-U.S. Citizens

Between 1971 and 1991, the number of doctorates awarded to non-U.S. citizens[9] in science and engineering rose 135 percent, while doctorates awarded to U.S. citizens in these fields fell by 10 percent. (See figure 5-14.)

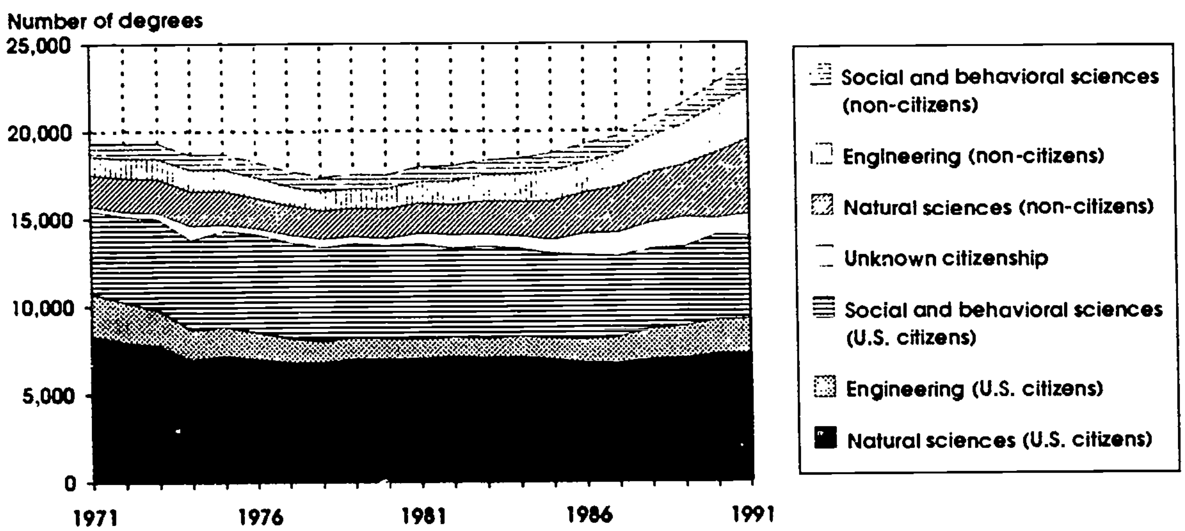
This trend is most pronounced in the field of engineering. In engineering, the number of doctorates awarded to non-U.S. citizens increased by 170 percent in the last 20 years, whereas the number conferred to U.S. citizens fell by 19 percent. The number of doctorates awarded to non-U.S. citizens in natural sciences fields increased by 137 percent, while U.S. citizens earned 13 percent fewer doctorates in these fields in 1991 than they did in 1971.

In recent years, the downward trend in the number of U.S. citizens earning science and engineering doctorates reversed. Between 1987 and 1991, the number of science and engineering doctorates conferred to U.S. citizens increased by almost 9 percent. In 1991, 27 percent more U.S. citizens earned doctorates in engineering than they did in 1987.

A striking portion of the increase in numbers of doctorates awarded to non-U.S. citizens occurred only recently: 61 percent of the increase in the number of non-U.S. citizens earning science and engineering doctorates in U.S. colleges and universities in the past 20 years occurred in the last 5 years of that period (1987 through 1991). From 1987 through 1991, doctorates awarded by U.S. colleges and universities to non-U.S. citizens—

- Increased 63 percent in natural sciences, compared with 9 percent for U.S. citizens.
- Increased 51 percent in engineering, compared with 27 percent for U.S. citizens.
- Increased 35 percent in social and behavioral sciences, compared with 2 percent for U.S. citizens.

Figure 5-14
Doctoral degrees awarded in science and engineering, by citizenship and major field of study: 1971 to 1991



See appendix table 5-23.

NSF Education Indicators—1992

SOURCES: Division of Science Resources Studies. *Science and Engineering Doctorates: 1960–90*. NSF 91-310 (Washington, DC: National Science Foundation, 1991); Division of Science Resources Studies. *Selected Data on Science and Engineering Doctorates, 1991*. NSF 92-309 (Washington, DC: National Science Foundation, 1992).

[9] Non-U.S. citizens includes permanent residents and temporary residents.

Plans of Foreign Students

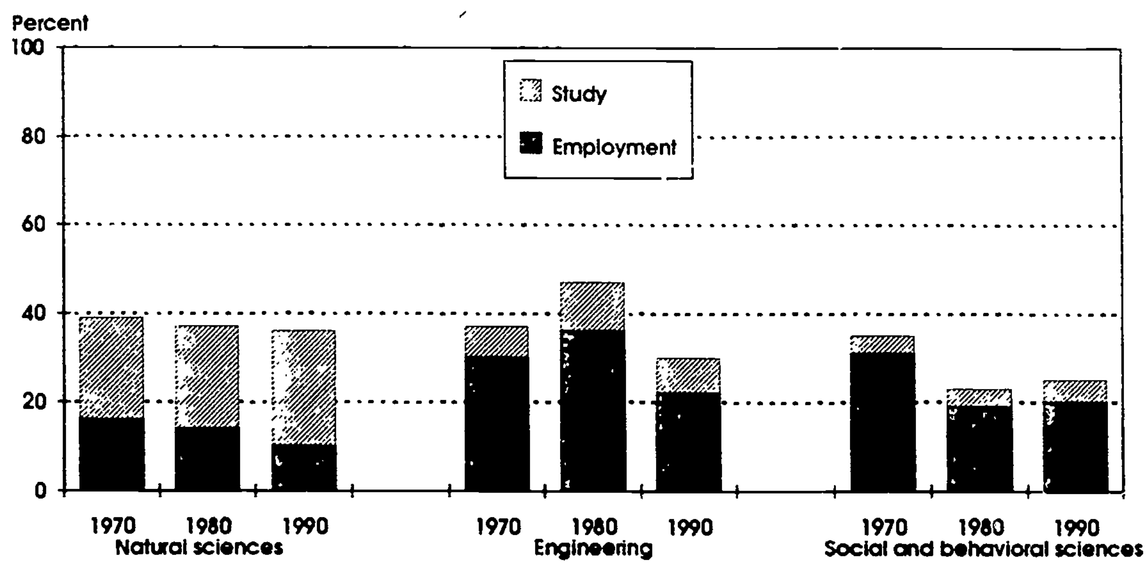
Because of large increases in the number of science and engineering doctorates awarded to non-U.S. citizens by U.S. institutions, it is important to consider how this may affect the supply of scientists and engineers in this country. Thus, some indication of what proportion of recent foreign doctorate recipients planned to stay and seek employment in the United States is needed.

About one-third of 1990 foreign doctoral recipients in science and engineering had definite postgraduation plans to remain in the United States, although this fraction differed somewhat between disciplinary fields. (See figure 5-15.) This proportion reflects a drop from the percent who planned to stay in 1970 (down 3 percentage points in natural sciences, 7 percentage points in engineering, and 10 percentage points in social and behavioral sciences). The decrease was the result of fewer recent foreign doctorate recipients having definite postgraduation plans for employment in the United States rather than plans for further academic study (which has increased slightly over the period). What proportion of foreign doctorate recipients stay permanently in the United States is unknown.

Thus, increases in science and engineering doctorates awarded to non-U.S. citizens outpaced increases in the number of doctorates conferred to U.S. citizens between 1987 and 1991.

In 1991, there were 23,748 science and engineering doctorates awarded by U.S. colleges and universities. Of that number, 58 percent were awarded to U.S. citizens and 36 percent were awarded to non-U.S. citizens. The citizenship status of the remaining 6 percent is unknown. In 1971, 80 percent of the doctorates conferred in science and engineering were awarded to U.S. citizens. Engineering is the field with the highest proportion of non-U.S. citizens earning doctorates. In 1991, 55 percent of doctorates awarded in engineering were awarded to non-U.S. citizens; in 1971, the proportion was 30 percent.

Figure 5-15
Percent of non-citizen doctoral recipients with definite postgraduation plans in the United States, by type of plan and major field of study: 1970 to 1990



See appendix table 5-24.

NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, *Science and Engineering Doctorates, 1960–90*, NSF 91-310 (Washington, DC: National Science Foundation, 1991).

Participation of Students Underrepresented in Science and Engineering

Women

Women represent the majority of students enrolled in colleges and universities. In 1988, women accounted for 52 percent of total enrollment in 4-year institutions of higher education (NCES 1991b). Yet women are underrepresented in natural sciences and engineering fields and made marginal progress toward boosting their numbers in recent years. For example, in 1989–90, women earned 28 percent of all doctorates in science and engineering fields, compared with 27 percent earned 5 years earlier. The continuing disparity between women's majority representation in higher education enrollment and their underrepresentation in science and engineering degree completions makes women an obvious target group for educators and policy makers who wish to increase the number of science and engineering degrees awarded to U.S. citizens.

In surveying 276 presidents and chancellors of the Nation's universities and colleges in 1991, the American Association for the Advancement of Science found, however, that few programs directly targeted female students. Fewer than 10 percent of the programs described in the survey as aiming to increase the representation of women, minorities, and people with disabilities in science and engineering were specifically targeted at the recruitment or retention of women. Programs aimed at women faculty and graduate students were even more rare (Matyas and Malcom 1991).

Women's underrepresentation in science and engineering results from an earlier failure to attract and retain women in these fields. Using longitudinal data from the High School and Beyond Study, NSF researchers have found that only one-third of 1980 freshmen who indicated that they planned to major in a natural sciences or engineering field were women. Moreover, just 35 percent of those women (compared with 43 percent of men) actually completed a bachelor's degree in a natural sciences or engineering field by 1986 (NSF 1990). More recent studies of decisions by women to remain in science and engineering fields have found that women chose to change majors out of science more frequently than did men (Manis et al. 1989).

Researchers and policy makers have identified several factors that affect women's success in pursuing science and engineering degrees:

- In a University of Michigan study, more women than men reported that they had taken natural sciences or engineering courses in their freshman years that had dampened their interest in science (Manis et al. 1989).
- Some studies suggest that academically well-prepared female students apparently lose their self-esteem, never develop the same levels of self-confidence as men do, or both. In many cases, this loss or lack results from negative experiences in their freshman or sophomore years (University of Michigan 1992). Seymour (1992b) found in a study of four diverse Colorado institutions that more than three-quarters (78 percent) of women who switched from science, mathematics, and engineering majors cited this loss or lack as a contributing factor in their decisions to change majors, compared with about 43 percent of men.
- Many women describe a "chilly" or inhospitable classroom climate (Hall and Sandler 1982). Although acts of overt sexism on the part of fellow students and faculty were rare, subtle sex-based cues (Brush 1991) reinforced the inhospitable climate women perceived. Certain structural features of the science and engineering culture—for example, the lack of

female role models and the existence of an "old boys' network" (Seymour 1992a)—also contributed to women's lower participation rates.

- Widnall (1988) refers to a combative communication style of scientific interchange. Several other researchers refer to women's distaste for the competitive environments of science and engineering classrooms that foster communication styles that diverge from styles with which many women feel most comfortable (University of Michigan 1992; Manis et al. 1989; Brush 1991).

Attitudes Toward Women in Engineering

Recent studies show that women participate in engineering in even lower numbers than they participate in natural sciences fields. In 1990, women accounted for 45 percent of the U.S. workforce, but about 26 percent of all natural scientists and only about 8 percent of all engineers were women (NSF-SRS 1992e). Some feel that long-held sexual stereotypes are a major reason why women have not participated in engineering. For example, in a 1960s survey of 14,500 college graduates, 61 percent of the respondents agreed that women did not pursue careers in engineering primarily because they "are afraid they will be considered unfeminine if they enter this field" (Rossi 1965). More recently, the Cooper Union in New York surveyed 2,077 women who were engineers. Although 90 percent of these women did not feel less feminine because they were engineers, about two-thirds of them thought that social acquaintances were intimidated by their profession (Brush 1991).

Text table 5-2 shows the leading institutions that awarded bachelor's degrees in engineering to women in 1990.

Text table 5-2
Top 10 institutions conferring bachelor's degrees in engineering on women: 1990

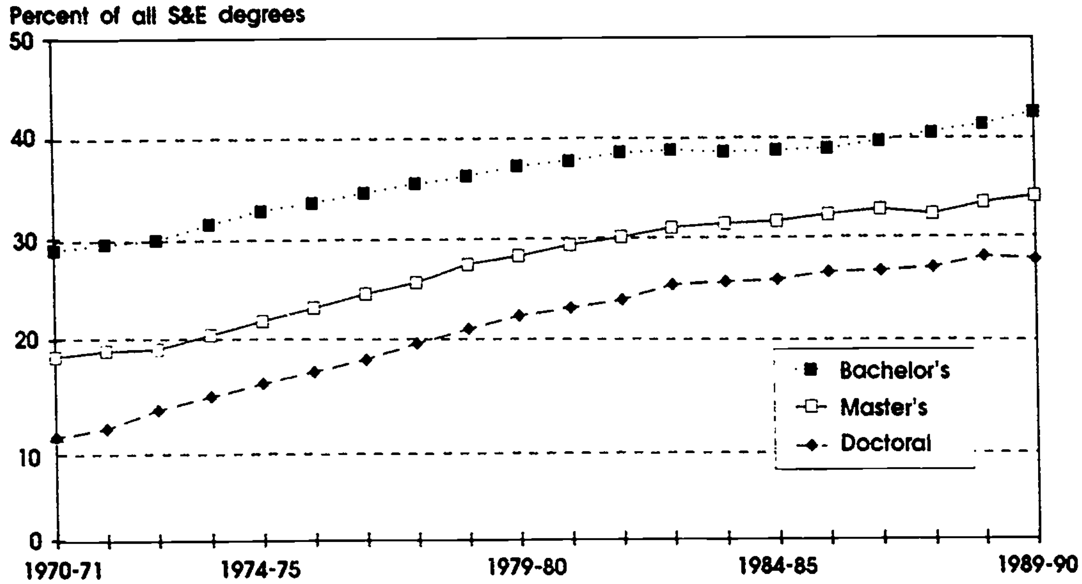
Institution	Number	Percent of total B.Sc. degrees in engineering conferred
Purdue University	277	24
Georgia Institute of Technology	203	18
North Carolina State University at Raleigh	195	19
University of Illinois, Champaign	192	15
Massachusetts Institute of Technology	186	29
University of Michigan, Ann Arbor	168	20
Pennsylvania State University	163	14
University of California, Berkeley	160	21
Texas A&M University	158	16
University of Washington	147	21

NSF Education Indicators—1992

SOURCE: Engineering and Technology Degrees 1975 through 1990, Engineering Manpower Commission, as cited in *Professional Women and Minorities, A Manpower Data Resource Service* (Washington, DC: Commission on Professionals in Science and Technology, 1991).

Figure 5-16

Science and engineering (S&E) degrees awarded to women as a percentage of all S&E degrees awarded to U.S. citizens and permanent residents, by degree level: 1970–71 to 1989–90



See appendix tables 5-25, 5-26, and 5-27.

NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies. *Science and Engineering Degrees: 1966–90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Degrees Earned by Women: Share[10]

Despite the fact that, in 1989–90, women earned more than half of all degrees that were awarded to U.S. citizens and permanent residents at the associate, bachelor's, and master's levels and more than one-third of those awarded at the doctoral level, women's share of science and engineering degrees was much lower at all levels but the associate. They earned 58 percent of the associate degrees, 43 percent of the bachelor's degrees, 34 percent of the master's degrees, and 28 percent of the doctoral degrees awarded in science and engineering.

In 1989–90, women were best represented in science and engineering at the bachelor's degree level and least well represented at the doctoral level. (See figure 5-16.) By field, women were best represented in social and behavioral sciences and least well represented in engineering. That year, women accounted for 53 percent of the bachelor's and master's degrees and 46 percent of the doctoral degrees awarded in social and behavioral sciences—compared with engineering, where 14 percent of bachelor's and master's degrees and 9 percent of doctorates were awarded to women.

Degrees Earned by Women: Trends

Women made substantial gains between 1970–71 and 1989–90 in the number of degrees they earned as a proportion of the total degrees granted (NSF-SRS 1992b). In 1989–90, women earned—

- 43 percent of all science and engineering bachelor's degrees, compared with 29 percent in 1970–71.

[10]The data referred to in this section are confined to degrees awarded to U.S. citizens and permanent residents only. Thus, degrees earned by foreign students have been excluded from the totals. This distinction has been made to demonstrate the proportion of women within the U.S. population who are earning degrees in science and engineering fields.

- 34 percent of all master's degrees in science and engineering, compared with 18 percent in 1970–71.
- 28 percent of all science and engineering doctoral degrees, compared with 10 percent in 1970–71. (See figure 5-16.)

However, it is important to note that, despite large gains made during the 20-year period, progress for women slowed at all three levels from 1985–86 to 1989–90. The proportion of degrees earned by women in that 5-year period increased by 4 percent or less.

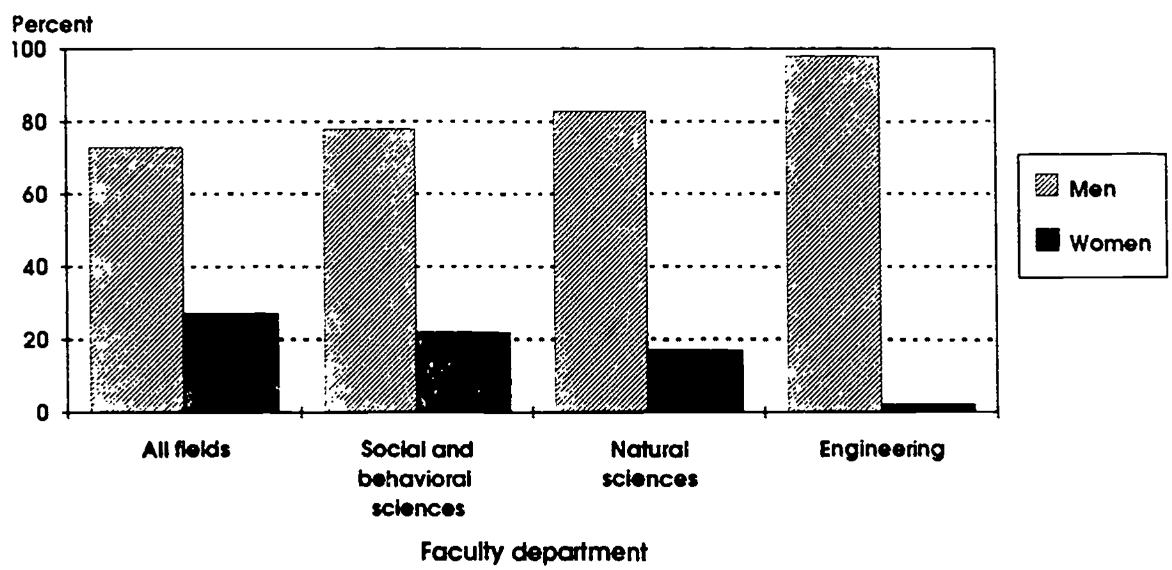
Looking specifically at engineering degrees, in 1970–71, women earned about 1 percent of all engineering degrees conferred at all levels. (See appendix tables 5-12, 5-13, 5-17.) By 1980–90, women were earning 15 percent of bachelor's degrees, 14 percent of master's degrees, and 8 percent of doctoral degrees. The 5-year trend shows that the proportion grew by 1 percent at the bachelor's level, 3 percent at the master's level, and 1 percent at the doctoral level.

Faculty

The relative scarcity of female role models among science and engineering faculty members at institutions of higher education may help explain the low numbers of women who earn advanced degrees in these fields. (See figure 5-17.) In 1987–88, when women made up 27 percent of all full-time instructional faculty members at institutions of higher education, they accounted for only 2 percent of the engineering faculty, 17 percent of natural sciences faculty, and 22 percent of social and behavioral sciences faculty.

Not only are women substantially underrepresented among the science and engineering instructional faculty, they are also underrepresented in terms of tenure and promotion. Among scientists and engineers with doctorates who were employed by 4-year institutions of higher education in 1987, 58 percent of

Figure 5-17
Full-time instructional faculty in institutions of higher education, by sex and faculty department: 1987–88



See appendix table 5-28. NSF Education Indicators—1992

SOURCE: U.S. Department of Education, National Survey of Postsecondary Faculty (NSOPF), 1987–88, as cited in *NCES Digest of Education Statistics, 1991*, NCES 91-697.

women held tenure track positions, compared with 74 percent of men. More strikingly, in that same year, 36 percent of academic female scientists and engineers with doctorates held tenure, compared with 60 percent of men. Finally, only 18 percent of women scientists and engineers at 4-year institutions are full professors, compared with 46 percent of the men (NSF 1990).

African Americans, Hispanics, and Native Americans

African Americans, Hispanics, and Native Americans are underrepresented among U.S. citizens and permanent residents earning higher education degrees in science and engineering. For example, in 1990, African Americans accounted for 9 percent of the

Top 10 Institutions for African American Engineering Bachelor's Degrees

The institutions listed in text table 5-3 were the top 10 producers of African American engineering graduates in 1990. Six of these institutions are historically black colleges and universities (HBCUs). In the fall of 1989, there were 105 HBCUs in the United States, with total enrollment of 249,178 students; this enrollment level represented a 7-percent increase over the 1980 figure.

Factors contributing to the relative success of HBCUs in producing African American graduates include (1) the presence of a relatively large number of African American students at these institutions, (2) African American faculty role models, and (3) a more sensitive social and cultural environment (Garrison 1987; OTA 1989).

Text table 5-3
Top 10 institutions conferring bachelor's degrees in engineering on African Americans: 1990

Institution	Number	Percent of total B.Sc. degrees in engineering conferred
Howard University*	105	97.2
North Carolina A&T State University*	100	80.0
City College, CUNY	85	25.1
Tuskegee University*	84	91.3
Prairie View A&M University*	80	71.4
Georgia Institute of Technology	68	6.0
Southern University*	62	62.6
Pratt Institute	55	39.3
NC State University at Raleigh	54	5.4
Tennesee State University*	53	43.8

*Indicates HBCU.

NSF Education Indicators—1992

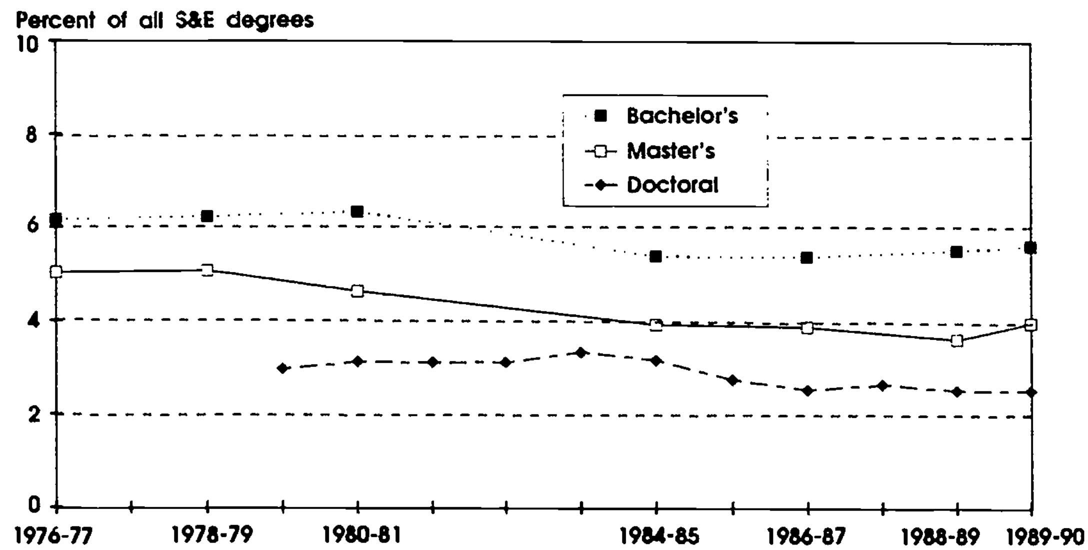
SOURCE: Engineering and Technology Degrees, 1990, Engineering Manpower Commission, as cited in *Professional Women and Minorities, A Manpower Data Resource Service* (Washington, DC: Commission on Professionals in Science and Technology, 1991).

higher education enrollment, but they earned only 6 percent of the science and engineering bachelor's degrees—and only 3 percent of all science and engineering doctorate degrees conferred in 1989–90. Similarly, Hispanic students constituted 6 percent of 1990 higher education enrollment but earned about 4 percent of the science and engineering bachelor's degrees and 3 percent of all doctoral degrees in 1989–90.

In 1980, African Americans, Hispanics, and Native Americans together constituted 14 percent of the enrollment in higher education. A decade later, that proportion had increased to 16 percent. This change in the ethnic and racial composition of higher education enrollment—combined with the underrepresentation of African Americans, Hispanics, and Native Americans—has led many in academia and Government to target these groups for increased participation in science and engineering.

One possible reason for the underrepresentation of African American, Hispanic, and Native American students is higher-than-average rates of attrition from science and engineering. The High School and Beyond Study shows that just 21 percent of African American, Hispanic, and Native American freshmen in 1980 who intended to major in natural sciences or engineering actually graduated with a degree in one of these fields by 1986, compared with 43 percent of students of other races and ethnicities (NSF 1990). Many factors may account for these differences—among them inadequate precollege academic preparation, historical barriers to entry, and other issues such as socioeconomic status (NSF-SRS 1992b; OTA 1989).

Figure 5-18
Science and engineering (S&E) degrees awarded to African Americans as a percentage of all S&E degrees awarded to U.S. citizens and permanent residents, by degree level: 1976–77 to 1989–90



NOTES: The data series for the bachelor's and master's degrees includes only the years shown at the bottom of the graph. Other years are interpolated. Doctoral degrees awarded are available annually and shown annually in the graph.

See appendix tables 5-29, 5-30, and 5-31.

NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977–90*, NSF 92-327 (Washington, DC: National Science Foundation, 1992).

African American Students: Trends[11]

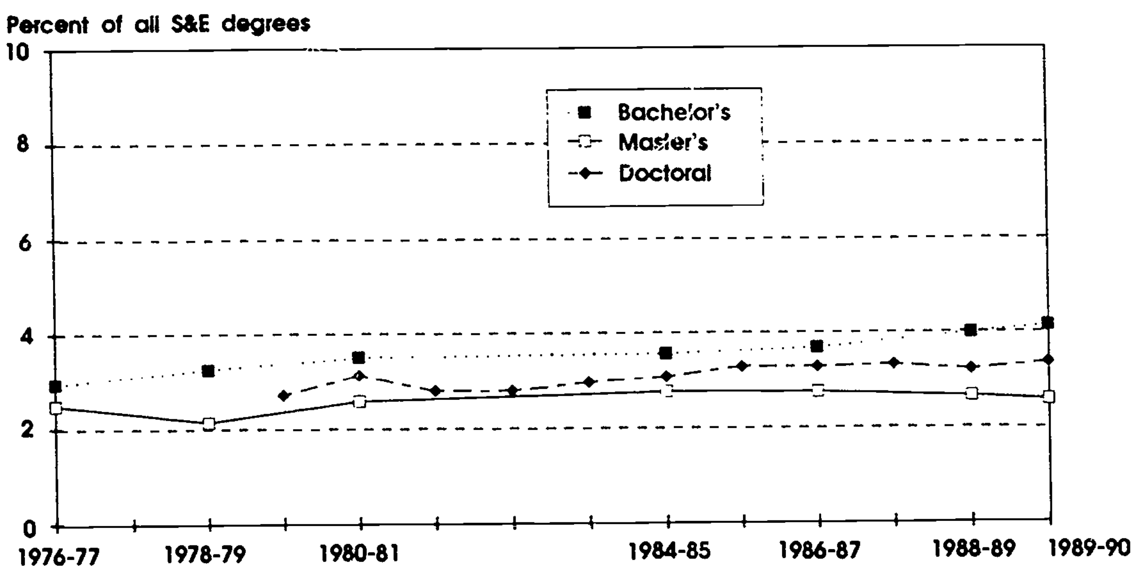
In 1989–90, 6 percent of all bachelor's degrees in science and engineering were awarded to African Americans, which represents no change from 1976–77 (NSF-SRS 1992b).[12] (See figure 5-18.) They earned roughly the same proportion of the bachelor's degrees conferred in natural sciences and social and behavioral sciences as they did in all fields (6 percent) in 1990. However, African Americans earned a much lower proportion (4 percent) of engineering bachelor's degrees. African Americans were also represented at the graduate level, where they earned 3 percent of science and engineering doctorates, compared with 4 percent of doctorates in all fields.

African Americans constituted about 8 percent of the enrollment in 4-year institutions of higher education in 1988. Their degree-earning shares were considerably lower in all fields (not just in science and engineering) than their enrollment shares, suggesting that attrition is a key contributor to their underrepresentation.

Hispanic Students: Trends

Hispanics accounted for 4 percent of the enrollment in 4-year institutions in the fall of 1988. They earned about the same proportion of total bachelor's degrees in science and engineering (4 percent) as their share of bachelor's degrees in all fields in 1989–90

Figure 5-19
Science and engineering (S&E) degrees awarded to Hispanic Americans as a percentage of all S&E degrees awarded to U.S. citizens and permanent residents, by degree level: 1976–77 to 1989–90



NOTES: The data series for the bachelor's and master's degrees only includes the years shown at the bottom of the graph. Other years are interpolated. Doctoral degrees awarded are available annually and shown annually in the graph.

See appendix tables 5-29, 5-30, and 5-31.

NSF Education Indicators—1992

SOURCE: Division of Science Resources Studies. *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977–90*, NSF 92-327 (Washington, DC: National Science Foundation, 1992).

[11] The data referred to in this section are confined to degrees awarded to U.S. citizens and permanent residents only. Degrees earned by foreign students have been excluded from the totals. This distinction has been made to demonstrate the proportions of African Americans, Hispanics, and Native Americans within the U.S. population who earned degrees in science and engineering fields.

[12] First year of degree data available by field of study and by race and ethnicity.

(NSF-SRS 1992b). (See figure 5-19.) They also earned 4 percent of all natural sciences and engineering bachelor's degrees conferred that year. Twelve years earlier, Hispanics had earned about 2 percent of all bachelor's degrees awarded in natural sciences and engineering. At the graduate level in 1989–90, Hispanics earned the same number of doctoral degrees in science and engineering (3 percent) as they did in all other fields.

Native American Students[13]

In 1990, Native Americans accounted for 0.8 percent of the total enrollment in higher education, but they earned 0.4 percent of the bachelor's and master's degrees and 0.3 percent of the doctorate degrees in science and engineering conferred in 1988–89. They earned similar proportions of academic degrees conferred in all fields in that year.

Faculty

The underrepresentation of African American and Hispanic scientists and engineers among instructional faculty in U.S. colleges and universities means that there are few role models to guide and support aspiring African American and Hispanic students in these fields. In general, African Americans and Hispanics are substantially underrepresented among full-time instructional faculty in higher education. (See text table 5-4.)

African Americans and Hispanics accounted for only 3 and 2 percent, respectively, of faculty in all fields according to the National Survey of Post-secondary Faculty conducted in 1987–88. Within science and engineering fields, fewer than 0.5 percent of the faculty in engineering were African American, and only 2 percent were Hispanic. Of the faculty in natural sciences, 2 percent were African American, and 1 percent was Hispanic.

African Americans and Hispanics were less likely to be tenured. In 1989, 49 percent of African American faculty with doctorates in science and engineering held tenure, compared with 56 percent of white faculty in these fields. Only 27 percent of African American faculty were full professors in 1989, compared with 42 percent of white faculty (NCES 1991b).

Text table 5-4
Full-time instructional faculty in institutions of higher education, percent African American and percent Hispanic: 1987–88

Faculty department	African American	Hispanic
All fields	3	2
Social and behavioral sciences	5	3
Natural sciences	2	1
Engineering	<1	2

See appendix table 5-28. NSF Education Indicators—1992

SOURCE: U.S. Department of Education, National Survey of Postsecondary Faculty (NSOPF), 1987–88, as cited in NCES *Digest of Education Statistics, 1991*, NCES 91-697.

Persons With Disabilities

About 11 percent of students enrolled in post-secondary institutions in the fall of 1986 (the most recent data available) reported that they had one or more learning or physical disabilities. At the undergraduate level, 10 percent of students with disabilities were enrolled in natural sciences, 9 percent were enrolled in engineering, and 9 percent were enrolled in social and behavioral sciences. These are the same proportions as for students without disabilities. At the graduate level, the proportional distribution of enrollment across science and engineering fields for students with disabilities is also roughly the same as for students without disabilities (NCES 1991).

[13] Trend data on degree production by field of study were not available for Native Americans at the time of publication of this report.

Chapter Summary

This chapter presented selected indicators on science and engineering education from available national studies. It covered undergraduate course-taking, student and faculty perceptions, educational transition points, and science and engineering degree production.

From 1985–86 to 1989–90, undergraduate degree production (associate and bachelor's) fell in natural sciences and engineering but not in social and behavioral sciences. At the graduate level (master's and doctoral), science and engineering degree production increased. The preponderance of this growth was due to large increases in the number of noncitizens receiving degrees in natural sciences and engineering.

Although women represented the majority of those enrolled at 4-year institutions of higher learning in the late 1980s, they earned less than one-half of all science and engineering undergraduate degrees and less than one-third of all graduate degrees conferred in these fields. From 1970–71 to 1989–90, substantial progress was made in the number of women earning degrees in science and engineering at all levels. However, since 1985–86, increases have been relatively muted at the undergraduate level compared with earlier progress.

African Americans and Hispanics remain underrepresented in science and engineering. The number of science and engineering degrees awarded to African Americans fell at all degree levels between 1977 and 1990. The number of degrees awarded to Hispanics increased, sometimes substantially. African Americans and Hispanics are enrolled in 4-year colleges and universities in higher proportion to the share of degrees they earn both in science and engineering fields and in nonscience and engineering fields. This suggests that the underrepresentation of these groups is not confined to science and engineering and may be due to the attrition from higher education in general.

Two-year institutions play a role in the preparation of our Nation's scientists and engineers. One study showed that nearly one in five science and engineering bachelor degree recipients had taken courses at 2-year colleges, although fewer actually obtained and transferred associate degrees.

More systematic research of a national scope is needed in the area of the quality of the education received by students in colleges and universities. Although available indicators related to quality have been presented, important areas of instructional practices, the quality of courses and other educational resources, and student achievement have not yet been adequately investigated.

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Appendix A

Detailed Tables

List of Tables

Background and Summary

Chapter 1 Cognitive Achievement

Chapter 2 Science and Mathematics Curricula

Chapter 3 Science and Mathematics Teachers

Chapter 4 Persistence and Career Choice

Appendix Table Intro-1

Total budget obligations in fiscal year 1992 for mathematics, science, and technical education of 11 Federal agencies (dollars in millions)

Level of school	Total enacted	Federal agency: National Science Foundation	Dept. of Education	Dept. of Health & Human Services	Dept. of Defense	Other 7 agencies /1
Grand total	1,997.55	504.32	312.15	439.77	427.67	313.62
K-12	702.96	299.17	301.32	20.17	12.15	70.95
Undergraduate	428.52	129.20	10.50	27.49	163.17	98.16
Graduate	796.52	70.02	0.00	389.71	252.36	84.43
Public science literacy (informal science)	68.75	5.93	0.33	2.40	0.00	60.09

1/ Other Federal agencies include Department of Agriculture, Department of Commerce, Department of Energy, Department of the Interior, Smithsonian Institution, National Aeronautics and Space Administration, and Environmental Protection Agency.

SOURCE: Special tabulations provided by the working group on the budget of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) Committee on Education and Human Resources.

Indicators of Science and Mathematics Education 1992

Appendix Table Intro-2

Summary of NSF funding for the Directorate for Education and Human Resources (EHR): 1952 to 1992 (dollars in millions)

Fiscal year	Total NSF	EHR Total	EHR Percent	K-12 Total	K-12 Percent of EHR	Undergraduate Total	Undergraduate Percent of EHR	Graduate Total	Graduate Percent of EHR	Informal Total	Informal Percent of EHR
1952	$3.47	$1.54	44.4	$0.00	0.0	$0.00	0.3	$1.54	99.7	$0.00	0.0
1953	4.42	1.41	31.9	0.01	0.7	0.03	2.1	1.37	97.2	0.00	0.0
1954	7.96	1.89	23.7	0.04	2.1	0.09	4.8	1.76	93.1	0.00	0.0
1955	12.49	2.10	16.8	0.13	6.2	0.19	9.0	1.79	85.2	0.00	0.0
1956	15.99	3.52	22.0	0.85	24.1	0.56	15.9	2.08	59.1	0.00	0.0
1957	38.63	14.30	37.0	10.15	71.0	1.14	8.0	3.00	21.0	0.00	0.0
1958	49.97	19.20	38.4	12.67	66.0	2.50	13.0	4.22	22.0	0.00	0.0
1959	132.94	61.29	46.1	41.06	67.0	10.42	17.0	9.81	16.0	0.02	0.0
1960	158.60	63.74	40.2	41.43	65.0	11.47	18.0	10.20	16.0	0.32	0.5
1961	174.99	63.44	36.3	38.70	61.0	13.96	22.0	10.78	17.0	0.32	0.5
1962	260.82	83.60	32.1	52.67	63.0	15.88	19.0	14.21	17.0	0.33	0.4
1963	320.75	98.72	30.8	56.27	57.0	22.71	23.0	18.76	19.0	0.39	0.4
1964	354.58	111.23	31.4	60.06	54.0	23.36	21.0	26.70	24.0	0.44	0.4
1965	415.97	120.41	28.9	52.98	44.0	31.31	26.0	36.12	30.0	0.36	0.3
1966	466.43	124.31	26.6	52.21	42.0	32.32	26.0	39.78	32.0	0.12	0.1
1967	465.10	125.82	27.1	50.33	40.0	30.20	24.0	45.30	36.0	0.38	0.3
1968	500.29	134.46	26.9	53.78	40.0	34.96	26.0	44.37	33.0	0.27	0.2
1969	432.59	115.30	26.7	44.97	39.0	29.98	26.0	40.36	35.0	0.23	0.2
1970	462.49	120.42	26.0	50.48	41.9	27.64	23.0	42.06	34.9	0.24	0.2
1971	496.14	98.81	19.9	36.56	37.0	21.74	22.0	39.52	40.0	0.39	0.4
1972	600.72	86.10	14.3	35.30	41.0	27.55	32.0	23.25	27.0	0.69	0.8
1973	610.27	62.23	10.2	24.29	39.0	17.42	28.0	19.29	31.0	0.62	1.0
1974	645.65	80.71	12.5	30.67	38.0	29.06	36.0	19.37	24.0	2.42	3.0
1975	693.13	74.03	10.7	28.13	38.0	21.47	29.0	22.21	30.0	1.48	2.0
1976	724.42	62.50	8.6	7.50	12.0	35.00	56.0	17.50	28.0	2.50	4.0
1977	791.77	74.30	9.4	9.69	13.0	43.10	58.0	17.83	24.0	3.72	5.0
1978	857.25	73.96	8.6	14.05	19.0	35.50	48.0	18.4[illegible]	25.0	5.18	7.0
1979	926.93	80.00	8.6	16.00	20.0	36.80	46.0	20.80	26.0	6.40	8.0
1980	975.1[illegible]	77.19	7.9	16.93	21.9	32.30	41.8	20.33	26.3	7.62	9.9
1981	1,035.27	70.66	6.8	26.08	36.9	26.00	36.8	14.83	21.0	3.75	5.3
1982	999.14	20.90	2.1	3.82	18.3	0.00	0.0	15.00	71.8	2.08	10.0
1983	1,101.69	30.00	2.7	12.81	42.7	0.00	0.0	15.00	50.0	2.19	7.3
1984	1,306.92	75.00	5.7	52.50	70.0	0.00	0.0	20.30	27.1	2.20	2.9
1985	1,507.07	81.96	5.4	42.46	51.8	5.00	6.1	27.30	33.3	7.20	8.8
1986	1,493.17	84.59	5.7	44.72	52.9	5.35	6.3	26.54	31.4	7.97	9.4
1987	1,627.62	99.00	6.1	50.80	51.3	9.50	9.6	27.30	27.6	11.38	11.5
1988	1,722.57	139.20	8.1	76.43	54.9	19.00	13.6	30.30	21.8	13.53	9.7
1989	1,885.88	171.00	9.1	104.00	60.8	28.00	16.4	24.00	14.0	15.00	8.8
1990	2,026.07	204.30	10.1	125.00	61.2	34.00	16.6	29.90	14.6	15.40	7.5
1991 /1	2,343.50	321.96	13.7	NA	NA	NA	NA	NA	NA	NA	NA
1992 /1	2,550.02	441.54	17.2	NA	NA	NA	NA	NA	NA	NA	NA

NA Not available at time of publication.

1/ Due to organizational changes in NSF, these figures include funds that were not counted in previous years--approximately $35 million in FY 1991 and $47 million in FY 1992.

SOURCE: National Science Foundation. *EHR Directory of Awards: Fiscal Year 1990.* NSF 92-75 (Washington, DC: NSF), and unpublished NSF budget figures.

Appendix Table Intro-3

Number and percent of students enrolled in grades 1-12 and college, by race and ethnicity: 1970 to 1990

Level of school	Race and ethnicity	1970	1975	1980	1985	1990
		Number (in thousands)				
Number (in thousands)						
Grades 1-12	All races	48,665	46,129	42,005	40,845	41,984
	White	41,361	38,636	34,566	32,971	33,520
	Black	6,702	6,708	6,459	6,438	6,602
	Other races	602	785	980	1,436	1,862
	Hispanic /1	NA	3,010	3,411	3,959	4,738
College	All races	7,413	9,697	10,180	10,863	11,303
	White	6,759	8,516	8,875	9,334	9,465
	Black	522	948	1,007	1,049	1,187
	Other races	132	233	298	480	651
	Hispanic /1	NA	411	443	579	617
Percent						
Grades 1-12	All races	100	100	99	101	100
	White	85	84	82	81	80
	Black	14	15	15	16	16
	Other races	1	1	2	4	4
	Hispanic /1	NA	7	8	10	12
College	All races	100	100	100	100	101
	White	91	88	87	86	84
	Black	7	10	10	10	11
	Other races	2	2	3	4	6
	Hispanic /1	NA	4	4	5	5

1/ Of any race.
NA Not available.
SOURCES: For 1970 to 1985, Bureau of the Census, U.S. Department of Commerce, *School Enrollment--Social and Economic Characteristics of Students: 1989*, Current Population Reports, Population Characteristics Series P-20, No.443 (Washington, DC: U.S. Government Printing Office); for 1990, *School Enrollment--Social and Economic Characteristics of Students: 1990*, Current Population Reports, Population Characteristics Series P-20, No. 460 (Washington, DC: U.S. Government Printing Office).

Appendix Table Intro-4

Children ages 5-17 speaking a language other than English at home, by English proficiency level: 1980 and 1990

Language proficiency level	Number 1980	Number 1990	Percent of all children ages 5-17 1980	Percent of all children ages 5-17 1990
All children ages 5-17	47,493,975	45,342,448	100	100
Children who speak a language other than English	4,568,329	6,322,934	10	14
English proficiency level /1				
Very well	2,670,957	3,934,691	59	62
Well	1,235,088	1,480,680	27	23
Not well	509,665	761,778	11	12
Not at all	125,161	145,785	3	2

1/ Includes only children in households and excludes children in group quarters. Proficiency level reported by the householder completing the census form.

SOURCES: For 1980, Bureau of the Census, U.S. Department of Commerce, *1980 Census of Population, Detailed Population Characteristics: United States Summary*, PC 80-1-D1-A; for 1990, Bureau of the Census, U.S. Department of Commerce, *1990 Census of Population*, CPH-L-96.

Indicators of Science and Mathematics Education 1992

Appendix Table Intro-5

Number and percent of white, black, and Hispanic children ages 6-17 below the poverty level: 1970 to 1990

Race and ethnicity	Number (in thousands) 1970	Number (in thousands) 1980	Number (in thousands) 1990	Percent below poverty level 1970	Percent below poverty level 1980	Percent below poverty level 1990
Total	6,932	7,128	6,848	14.3	16.8	17.6
White	4,101	4,336	4,254	9.9	12.4	13.4
Black	2,708	2,544	2,206	41.3	40.4	39.8
Hispanic	NA	NA	1,545	NA	NA	36.7

NOTE: Poverty status of 1970, 1980, and 1990 as surveyed on a sample in March of 1971, 1981, and 1991, respectively.

NA Not available.

SOURCES: For 1970, Bureau of the Census, U.S. Department of Commerce, *Characteristics of the Low-Income Population 1970*, Current Population Reports, CPS P-60 No. 18, 1971; for 1980, Bureau of the Census, U.S. Department of Commerce, *Characteristics of the Population Below the Poverty Level: 1980*, Current Population Reports, CPS P-60 No. 133, 1981; for 1990, Bureau of the Census, U.S. Department of Commerce, *Poverty in the United States: 1990*, Current Population Reports, CPS P-60 No. 175, 1991.

Indicators of Science and Mathematics Education 1992

Appendix Table Intro-6

Number and percent of one- or two-parent families with children under age 18, by race and ethnicity: 1970 to 1991

Family characteristic	Number (in thousands) 1970	1980	1991	Percent 1970	1980	1991
Total familes	29.631	32.150	34.973	100	100	100
White	26.115	27.294	28.443	100	100	100
Black	3.219	4.705	5.173	100	100	100
Hispanic /1	NA	2.194	3.582	100	100	100
One-parent family						
Total	3.808	6.920	10.110	13	22	29
White	2.638	4.664	6.550	10	17	23
Black	1.148	2.114	3.240	36	52	63
Hispanic /1	NA	568	1.187	NA	26	33
Two-parent family						
Total	25.823	25.231	24.863	87	78	71
White	23.477	22.628	21.893	90	83	77
Black	2.071	1.961	1.933	64	48	37
Hispanic /1	NA	1.626	2.395	NA	74	67

1/ Of any race.
NA Not available.
SOURCE: Bureau of the Census. U.S. Department of Commerce. *Household and Family Characteristics: March 1991.* Current Population Reports. Population Characteristics Series P-20. No. 458. 10. table G.

Number and percent of dependent family member elementary and secondary school students, by educational level of family householder and student race and ethnicity: 1970 to 1990

Student race and ethnicity, and educational level of householder	Number (in thousands)			Percent		
	1970	1980	1990	1970	1980	1990
Students of all races						
Total	48.016	41.369	39.923	99.9	100.0	100.1
0-8 years of school	9.812	5.921	3.518	20.4	14.3	8.8
9-11 years of school	9,079	6,232	4,691	18.9	15.1	11.8
High school graduate	16,871	15.743	14,894	35.1	38.0	37.3
College 1-3 years	5.107	6,127	7.930	10.6	14.8	19.9
College graduate or more	7.147	7.346	8,890	14.9	17.8	22.3
White students						
Total	40.825	34.050	32.021	100.0	100.0	100.0
0-8 years of school	7.258	4.412	2.628	17.8	13.0	8.2
9-11 years of school	7.094	4.358	3.238	17.4	12.8	10.1
High school graduate	15.262	13.277	11.905	37.4	39.0	37.2
College 1-3 years	4.655	5.260	6.479	11.4	15.4	20.2
College graduate or more	6.556	6.743	7.771	16.0	19.8	24.3
Black students						
Total	6.602	6.358	6.155	100.1	100.0	100.0
0-8 years of school	2.401	1.326	645	36.4	20.9	10.5
9-11 years of school	1.910	1.769	1.335	28.9	27.8	21.7
High school graduate	1.411	2.175	2.492	21.4	34.2	40.5
College 1-3 years	421	744	1.090	6.4	11.7	17.7
College graduate or more	459	344	593	7.0	5.4	9.6
Hispanic students /1						
Total	NA	3,347	4.420	NA	100.0	99.9
0-8 years of school	NA	1.634	1.677	NA	48.8	37.9
9-11 years of school	NA	493	735	NA	14.7	16.6
High school graduate	NA	774	1.184	NA	23.1	26.8
College 1-3 years	NA	293	539	NA	8.8	12.2
College graduate or more	NA	153	285	NA	4.6	6.4

1/ Of any race.

NA Not available.

SOURCES: For 1970, Bureau of the Census, U.S. Department of Commerce, *Population Characteristics, School Enrollment: October 1970*, Current Population Reports, Population Characteristics Series P-20, No. 222, 1971; for 1980, Bureau of the Census, U.S. Department of Commerce, *School Enrollment--Social and Economic Characteristics of Students: October 1981 and 1980*, Current Population Reports, Population Characteristics Series P-20, No. 400; for 1990, Bureau of the Census, U.S. Department of Commerce, *School Enrollment--Social and Economic Characteristics of Students: October 1990*, Current Population Reports, Population Characteristics Series P-20, No. 460.

Appendix Table 1-1

Percent of students at each scale score range in mathematics, by sex, race and ethnicity, and parent's education: 1990

Grade and score range	Total	Sex		Race and ethnicity			Parent's education			
		Male	Female	White	Black	Hispanic	Less than high school	High school graduate	Some college	College graduate
Grade 4										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	28.2	27.4	29.0	18.6	59.5	48.3	40.8	31.7	15.6	21.2
200-249	60.8	60.9	60.8	67.3	39.1	48.6	55.8	62.7	65.2	61.2
250-299	11.0	11.7	10.2	14.1	1.4	3.1	3.4	5.6	19.0	17.6
300-349	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
350 or more	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grade 8										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	2.3	2.2	2.4	0.7	8.1	5.1	4.1	2.8	1.1	1.0
200-249	30.3	31.1	29.4	22.5	55.9	48.4	54.9	39.8	22.2	18.0
250-299	53.2	50.8	55.7	59.2	33.3	42.4	38.0	51.4	62.2	57.1
300-349	14.0	15.6	12.4	17.4	2.7	4.1	3.0	6.0	14.4	23.5
350 or more	0.2	0.3	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.4
Grade 12										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	0.1	0.0	0.1	0.0	0.1	0.4	0.0	0.1	0.0	0.0
200-249	9.4	8.3	10.5	5.4	26.2	20.7	22.9	15.0	6.6	4.2
250-299	45.1	44.1	46.1	42.5	57.8	53.9	60.7	56.9	45.5	34.4
300-349	40.7	41.3	40.1	46.5	15.7	23.7	15.9	27.0	44.8	52.5
350 or more	4.7	6.3	3.2	5.6	0.2	1.3	0.5	1.0	3.1	8.9

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 484, 496, 510.

Appendix Table 1-2

Percent of students at each scale score range in science, by sex, race and ethnicity, and parent's education: 1990

Grade and score range	Total	Sex		Race and ethnicity			Parent's education			
		Male	Female	White	Black	Hispanic	Less than high school	High school graduate	Some college	College graduate
Grade 4										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	15.5	15.4	15.6	6.9	41.9	34.1	22.0	19.1	9.0	10.1
200-249	53.9	52.3	55.7	53.5	52.9	56.1	61.6	60.0	48.6	45.7
250-299	29.6	31.2	27.9	38.3	5.1	9.8	16.4	20.5	41.4	42.2
300-349	1.0	1.1	0.8	1.3	0.1	0.0	0.0	0.4	1.0	2.0
350 or more	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grade 8										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	6.4	6.5	6.3	2.6	20.1	13.4	11.4	8.0	4.1	3.1
200-249	29.5	28.8	30.3	23.3	48.6	44.9	47.6	35.8	24.3	20.7
250-299	46.2	43.6	48.7	51.0	28.8	36.9	37.4	46.3	53.0	47.7
300-349	17.2	20.1	14.4	22.2	2.4	4.7	3.5	9.8	18.0	27.2
350 or more	0.7	1.0	0.3	0.9	0.1	0.1	0.1	0.1	0.6	1.3
Grade 12										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 200	1.4	1.1	1.8	0.4	6.5	2.5	2.5	2.1	0.7	0.6
200-249	14.5	13.0	15.7	8.9	36.7	27.2	29.9	20.8	11.5	8.2
250-299	39.4	36.5	42.2	37.9	44.8	47.2	46.6	47.2	42.7	31.8
300-349	35.3	36.2	34.4	41.3	10.9	20.2	19.3	26.7	37.5	43.3
350 or more	9.4	13.2	5.9	11.5	1.1	2.9	1.7	3.2	7.6	16.1

SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 148-50.

Mean proficiencies in mathematics, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 4					
Total	100.0	215.8 (0.7)	179.0 (1.4)	216.8 (0.8)	251.4 (0.9)
Sex					
Male	51.7	216.7 (0.8)	179.1 (1.6)	218.0 (1.2)	252.3 (1.3)
Female	48.3	214.9 (0.8)	179.0 (1.4)	215.3 (0.8)	250.3 (1.1)
Race and ethnicity					
White	70.2	222.7 (0.7)	189.9 (1.4)	223.0 (0.9)	255.1 (1.0)
Black	15.3	194.1 (1.3)	162.6 (3.5)	194.5 (1.3)	226.2 (1.4)
Hispanic	10.7	200.5 (1.4)	165.5 (1.6)	201.2 (1.5)	236.0 (1.7)
Asian	2.0	228.2 (2.8)	191.2 (5.1)	229.3 (6.2)	263.2 (3.7)
American Indian	1.7	210.5 (2.5)	179.4 (3.6)	211.0 (4.1)	239.6 (1.5)
Parent's education					
Less than high school	5.3	205.2 (2.0)	172.8 (3.3)	205.7 (2.1)	237.3 (3.2)
High school graduate	14.9	211.3 (1.2)	178.8 (2.2)	212.9 (2.2)	242.9 (2.3)
Some college	8.2	226.5 (1.6)	192.5 (3.6)	227.9 (1.2)	259.7 (2.5)
College graduate	36.0	222.9 (0.9)	184.3 (1.6)	224.5 (1.2)	258.7 (0.9)

Continued

NOTE: Standard errors are presented in parentheses.

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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 484-85, 496-97, 510-11.

Mean proficiencies in mathematics, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990, continued

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 8					
Total	100.0	265.0 (1.0)	222.8 (1.0)	265.8 (1.1)	306.5 (1.2)
Sex					
Male	50.0	265.5 (1.3)	222.5 (0.9)	265.3 (1.3)	309.4 (1.9)
Female	50.0	264.4 (1.1)	223.0 (1.2)	266.2 (1.2)	303.7 (1.6)
Race and ethnicity					
White	70.6	272.1 (1.2)	233.8 (1.1)	272.7 (1.1)	310.6 (1.4)
Black	15.1	240.8 (1.6)	203.8 (2.1)	239.3 (1.6)	281.0 (1.7)
Hispanic	10.0	247.9 (1.6)	210.1 (2.5)	247.9 (2.1)	287.5 (2.6)
Asian	2.7	284.8 (4.1)	241.1 (3.8)	285.6 (7.0)	328.0 (5.6)
American Indian	1.4	247.9 (3.4)	210.6 (6.8)	247.5 (7.4)	286.7 (5.5)
Parent's education					
Less than high school	8.9	245.8 (1.4)	213.3 (3.7)	244.1 (2.2)	281.5 (3.4)
High school graduate	24.5	255.5 (0.9)	218.2 (2.8)	255.5 (1.3)	292.6 (2.3)
Some college	17.9	270.2 (1.0)	231.8 (4.3)	271.6 (1.6)	305.9 (1.0)
College graduate	40.3	277.2 (1.5)	236.1 (1.9)	278.8 (1.4)	315.9 (1.8)

Continued

NOTE: Standard errors are presented in parentheses.
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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 484-85, 496-97, 510-11.

Mean proficiencies in mathematics, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990, continued

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 12					
Total	100.0	295.3 (1.1)	250.8 (1.0)	295.9 (1.3)	339.3 (1.3)
Sex					
Male	48.8	297.7 (1.3)	252.9 (0.9)	297.7 (2.0)	342.8 (1.9)
Female	51.2	293.1 (1.1)	248.9 (1.5)	294.5 (1.5)	335.1 (1.4)
Race and ethnicity					
White	73.9	301.1 (1.2)	259.2 (1.7)	301.6 (1.4)	341.9 (1.2)
Black	14.0	270.2 (1.3)	234.5 (1.8)	268.7 (2.2)	309.4 (5.1)
Hispanic	7.9	277.6 (2.4)	238.7 (3.9)	274.9 (1.8)	320.4 (3.0)
Asian	3.4	315.0 (4.0)	268.9 (10.0)	318.3 (3.9)	355.4 (4.1)
American Indian /1	0.8	290.4 (5.4)	254.0 (7.7)	290.3 (6.5)	331.9 (5.4)
Parent's education					
Less than high school	7.9	272.4 (1.4)	237.5 (3.6)	271.0 (4.5)	310.9 (5.2)
High school graduate	23.5	282.2 (1.2)	243.3 (1.5)	281.2 (1.7)	322.4 (2.5)
Some college	25.3	296.9 (0.9)	255.9 (1.7)	298.4 (1.7)	335.6 (1.5)
College graduate	40.9	308.1 (1.3)	263.5 (2.4)	309.7 (1.4)	348.2 (1.8)

NOTE: Standard errors are presented in parentheses.
1/ Interpret with caution. The nature of the sample does not allow accurate determination of the variability of this estimated statistic.
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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 484-85, 496-97, 510-11.

Mean proficiencies in science, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 4					
Total	100.0	232.8 (0.9)	191.3 (1.2)	233.9 (1.5)	272.1 (1.1)
Sex					
Male	51.2	233.8 (1.1)	191.4 (1.5)	235.0 (1.5)	274.0 (1.4)
Female	48.8	231.7 (1.0)	191.0 (1.2)	232.9 (0.9)	269.9 (1.0)
Race and ethnicity					
White	70.2	242.1 (1.0)	206.3 (1.8)	242.8 (1.0)	276.5 (0.9)
Black	15.2	205.4 (1.5)	172.2 (2.2)	204.8 (1.6)	239.2 (1.8)
Hispanic	11.0	212.0 (1.5)	173.9 (5.1)	211.7 (1.9)	250.0 (1.7)
Asian	1.9	233.0 (3.0)	195.2 (7.9)	230.7 (4.9)	274.9 (6.2)
American Indian	1.6	226.1 (2.7)	191.2 (2.6)	226.9 (9.9)	262.8 (6.9)
Parent's education					
Less than high school	5.1	221.4 (2.2)	185.1 (4.6)	222.0 (2.7)	258.1 (6.1)
High school graduate	15.7	225.7 (1.4)	188.3 (2.0)	226.4 (1.6)	262.9 (2.0)
Some college	8.6	241.9 (1.8)	201.8 (1.4)	244.9 (3.4)	276.9 (1.5)
College graduate	35.2	242.7 (1.2)	199.8 (2.6)	245.2 (1.6)	281.2 ([illegible].3)

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 145-47, 152, 154, 156.

Mean proficiencies in science, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990, continued

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 8					
Total	100.0	263.1	210.3	265.3	312.5
		(1.2)	(1.8)	(1.3)	(1.8)
Sex					
Male	50.1	265.1	210.2	266.9	317.7
		(1.6)	(2.9)	(2.0)	(1.5)
Female	49.9	261.0	210.5	263.8	306.9
		(1.2)	(1.7)	(1.5)	(1.4)
Race and ethnicity					
White	70.8	272.9	225.4	274.7	317.6
		(1.4)	(1.9)	(1.8)	(1.3)
Black	14.8	231.0	185.3	230.2	277.8
		(2.2)	(2.6)	(2.8)	(2.7)
Hispanic	10.1	241.2	193.6	242.4	286.7
		(2.1)	(3.2)	(3.7)	(2.1)
Asian	2.7	270.5	221.6	270.8	317.0
		(4.0)	(4.6)	(8.8)	(5.9)
American Indian /1	1.4	251.9	207.4	253.1	295.5
		(8.5)	(11.4)	(13.3)	(6.7)
Parent's education					
Less than high school	8.8	241.1	197.8	242.1	283.3
		(2.3)	(5.2)	(5.7)	(2.3)
High school graduate	24.8	254.1	205.0	256.2	299.9
		(1.3)	(2.3)	(1.2)	(1.6)
Some college	18.7	268.4	221.6	270.5	313.0
		(1.4)	(2.3)	(1.4)	(4.0)
College graduate	39.6	276.4	224.5	279.8	322.5
		(1.7)	(2.8)	(1.8)	(1.6)

Continued

NOTE: Standard errors are presented in parentheses.
1/ Interpret with caution. The nature of the sample does not allow accurate determination of the variability of this estimated statistic.
SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 145-47, 152, 154, 156.

Mean proficiencies in science, and 10th, 50th, and 90th percentiles for the Nation, by sex, race and ethnicity, and parent's education: 1990, continued

Grade, sex, race and ethnicity, and parent's education	Percent of total	Mean	10th percentile	50th percentile	90th percentile
Grade 12					
Total	100.0	293.5	237.5	294.1	348.5
		(1.2)	(1.9)	(1.2)	(1.7)
Sex					
Male	48.2	298.9	240.6	299.3	356.4
		(1.5)	(2.1)	(1.6)	(1.7)
Female	51.8	288.6	235.1	290.0	339.7
		(1.2)	(1.9)	(1.7)	(1.5)
Race and ethnicity					
White	73.2	302.5	251.5	302.6	353.1
		(1.3)	(1.9)	(1.5)	(2.6)
Black	14.2	256.3	208.1	256.5	304.3
		(2.4)	(3.0)	(1.9)	(2.8)
Hispanic	8.2	272.5	223.1	272.3	322.9
		(2.8)	(6.3)	(4.2)	(3.8)
Asian	3.6	308.2	249.6	311.0	360.9
		(7.1)	(8.4)	(10.0)	(10.3)
American Indian /1	0.7	285.7	246.6	284.7	329.7
		(4.6)	(12.3)	(24.9)	(9.7)
Parent's education					
Less than high school	7.5	269.0	222.5	266.9	319.1
		(2.5)	(3.0)	(3.9)	(4.3)
High school graduate	23.7	278.9	228.9	280.0	328.2
		(1.3)	(2.4)	(1.9)	(1.9)
Some college	26.0	295.2	245.6	295.5	344.6
		(1.3)	(3.5)	(1.3)	(2.3)
College graduate	40.4	308.2	252.9	309.8	360.5
		(1.4)	(1.8)	(1.5)	(3.1)

NOTE: Standard errors are presented in parentheses.
1/ Interpret with caution. The nature of the sample does not allow accurate determination of the variability of this estimated statistic.
SOURCE: National Center for Education Statistics. *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 145-47, 152, 154, 156.

Mean proficiency scores in mathematics and science for grades 4, 8, and 12, by region: 1990

Subject and region	Grade 4	Grade 8	Grade 12
Mathematics			
Northeast	219.2 (1.7)	270.1 (2.6)	301.6 (2.1)
Southeast	208.7 (1.6)	256.2 (1.7)	283.9 (2.2)
Central	217.5 (1.3)	268.8 (1.6)	297.6 (2.0)
West	217.8 (1.8)	265.3 (2.7)	296.4 (2.2)
Science			
Northeast	235.6 (1.9)	269.2 (3.2)	300.3 (3.3)
Southeast	226.7 (2.3)	256.3 (2.0)	278.7 (2.7)
Central	234.3 (2.2)	264.5 (2.0)	295.4 (2.0)
West	234.4 (2.0)	263.1 (2.8)	296.7 (2.9)

NOTE: Standard errors are presented in parentheses.

SOURCES: National Center for Education Statistics. *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States*. Report No. 21-ST-04 (Washington. DC: U.S. Department of Education. 1991). 485. 497. 511; National Center for Education Statistics. *The 1990 Science Report Card: NAEP's Assessment of Fourth. Eighth. and Twelfth Graders* (Washington. DC: U.S. Department of Education. 1991), 145-47.

Percent of students at each scale score range in mathematics and science, by region, grades 4, 8, and 12: 1990

Subject, grade, and region	Percent of total	Scale score range				
		Less than 200	200-249	250-299	300-349	350 and over
Mathematics						
Grade 4						
Northeast	100	24	63	13	0	0
Southeast	100	38	55	7	0	0
Central	100	24	66	10	0	0
West	100	26	61	13	0	0
Grade 8						
Northeast	100	1	25	56	18	0
Southeast	100	4	39	48	9	0
Central	100	1	26	58	15	0
West	100	2	30	53	15	0
Grade 12						
Northeast	100	0	7	39	48	6
Southeast	100	0	16	53	29	2
Central	100	0	8	44	43	5
West	100	0	9	44	42	5
Science						
Grade 4						
Northeast	100	14	50	35	1	0
Southeast	100	20	57	22	1	0
Central	100	13	56	30	1	0
West	100	15	52	32	1	0
Grade 8						
Northeast	100	5	24	49	21	1
Southeast	100	8	34	45	12	1
Central	100	6	27	49	18	0
West	100	6	31	44	18	1
Grade 12						
Northeast	100	1	12	35	40	12
Southeast	100	2	23	44	27	4
Central	100	1	13	39	38	9
West	100	1	13	40	34	12

SOURCES: National Center for Education Statistics. *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 484, 496, 510; National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education), 148-50.

Indicators of Science and Mathematics Education 1992

Mathematics proficiency of highest and lowest deciles for states, 8th-grade public school students, ordered by average proficiency: 1990

State	10th percentile	Average proficiency scores	90th percentile
North Dakota	247 (2.4)	281 (1.2)	314 (1.2)
Montana	247 (1.0)	280 (0.8)	313 (1.2)
Iowa	243 (1.8)	278 (1.0)	313 (1.4)
Minnesota	239 (1.6)	276 (0.9)	312 (1.6)
Nebraska	237 (2.4)	276 (0.9)	312 (1.1)
Wisconsin	235 (1.7)	274 (1.3)	312 (1.6)
New Hampshire	237 (1.4)	273 (0.8)	310 (1.7)
Wyoming	238 (1.3)	272 (0.6)	306 (1.2)
Idaho	237 (1.1)	272 (0.7)	306 (1.5)
Oregon	233 (1.4)	271 (1.0)	311 (1.9)
Connecticut	226 (1.2)	270 (1.1)	313 (1.2)
New Jersey	227 (2.5)	269 (1.0)	313 (2.5)
Colorado	228 (1.9)	267 (1.0)	306 (1.6)
Indiana	229 (1.6)	267 (1.1)	306 (1.3)
Pennsylvania	225 (2.5)	266 (1.8)	306 (1.4)
Michigan	223 (2.1)	264 (1.1)	305 (1.6)
Virginia	220 (1.6)	264 (1.5)	310 (3.6)
Ohio	226 (1.1)	264 (1.0)	303 (1.2)
Oklahoma	225 (1.5)	263 (1.2)	300 (1.8)
New York	215 (1.9)	261 (1.3)	305 (1.7)
Delaware	220 (1.1)	261 (0.7)	305 (1.6)
Maryland	214 (1.7)	260 (1.4)	308 (2.2)
Rhode Island	216 (1.5)	260 (0.5)	303 (1.5)
Illinois	216 (3.0)	260 (1.7)	303 (1.5)
Arizona	220 (1.3)	259 (1.2)	300 (1.6)
Georgia	214 (1.4)	258 (1.3)	303 (1.8)
Texas	217 (2.1)	258 (1.3)	300 (1.9)
Arkansas	217 (0.9)	256 (0.9)	294 (1.4)
Kentucky	218 (1.3)	256 (1.1)	296 (1.8)
New Mexico	218 (1.4)	256 (0.8)	295 (1.9)
California	212 (1.4)	256 (1.3)	301 (1.5)
West Virginia	220 (1.1)	256 (0.9)	295 (1.7)
Florida	213 (2.2)	255 (1.2)	300 (1.7)
Alabama	212 (2.0)	252 (1.2)	293 (1.1)
Hawaii	205 (1.1)	251 (0.6)	300 (0.9)
North Carolina	208 (0.9)	250 (1.0)	293 (1.9)
Louisiana	207 (2.0)	246 (1.2)	285 (1.9)
District of Columbia	196 (1.0)	231 (0.7)	268 (1.6)

NOTE: The standard errors of the estimated proficiencies appear in parentheses. It can be said that for each population of interest, the value of the whole population is within plus or minus two standard errors of the estimate with 95 percent certainty for the sample.
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.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 241.

Appendix Table 1-8

Average mathematics proficiency of 8th-grade students in North Dakota, New York, Louisiana, and Washington, DC, by sex, race and ethnicity, and parent's education: 1990

Student characteristic	North Dakota		New York		Louisiana		Washington, DC	
	Percent of students	Average proficiency	Percent of students	Average proficiency	Percent of students	Average proficiency	Percent of students	Average proficiency
Sex								
Male	51 (1.6)	284 (1.4)	49 (1.3)	262 (1.5)	50 (1.1)	247 (1.3)	47 (0.9)	229 (1.1)
Female	49 (1.6)	278 (1.5)	51 (1.3)	259 (1.6)	50 (1.1)	244 (1.5)	53 (0.9)	232 (0.9)
Race and ethnicity								
White	91 (1.4)	284 (0.9)	60 (1.9)	273 (1.1)	55 (2.1)	258 (1.4)	3 (0.4)	***
Black	1 (0.3)	***	17 (1.6)	236 (2.6)	38 (1.9)	229 (1.3)	84 (1.4)	229 (0.6)
Hispanic	3 (0.4)	251 (4.7)	17 (1.7)	237 (2.6)	5 (0.6)	226 (3.1)	10 (0.6)	219 (2.2)
Asian /1	1 (0.4)	***	4 (0.8)	279 (5.0)	1 (0.2)	***	1 (0.2)	***
American Indian /2	5 (1.2)	242 (3.5)	1 (0.3)	***	***	***	2 (0.3)	***
Parent's education								
Less than high school	4 (0.7)	255 (3.5)	8 (0.7)	242 (2.6)	13 (0.8)	234 (1.9)	8 (0.7)	225 (1.9)
High school graduate	24 (1.3)	273 (2.4)	22 (0.9)	253 (1.7)	33 (1.1)	241 (1.5)	31 (1.0)	224 (1.1)
Some college	19 (0.8)	283 (1.9)	17 (0.9)	264 (2.0)	19 (0.9)	254 (1.2)	17 (0.8)	237 (1.5)
College graduate	49 (1.3)	288 (1.3)	40 (1.2)	273 (1.4)	28 (1.2)	254 (2.0)	34 (1.2)	238 (1.7)

NOTE: Standard errors are presented in parentheses.
1/ Interpret New York's average proficiency with caution. The nature of the sample does not allow accurate determination of the variability of this estimated statistic.
2/ Interpret North Dakota's average proficiency with caution. The nature of the sample does not allow accurate determination of the variability of this estimated statistic.
*** Sample size insufficent to permit reliable estimate. There were fewer than 62 students.
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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 266, 282, 288.

Appendix Table 1-9

Mean proficiency scores in mathematics and science, by community type, grades 4, 8, and 12: 1990

Community type	Mathematics			Science		
	Grade 4	Grade 8	Grade 12	Grade 4	Grade 8	Grade 12
Total						
Score	216	265	295	233	263	294
	(0.8)	(0.9)	(0.9)	(0.9)	(1.1)	(1.2)
Sample size	6,467	6,473	6,311	6,314	6,531	6,337
Extreme rural						
Score	218	261	290	235	258	291
	(2.3)	(2.6)	(3.2)	(2.6)	(3.2)	(3.9)
Sample size	450	605	673	491	641	647
Disadvantaged urban						
Score	200	252	283	209	243	273
	(2.7)	(2.5)	(4.4)	(2.6)	(4.2)	(5.3)
Sample size	783	834	833	767	810	821
Advantaged urban						
Score	231	283	308	252	283	304
	(2.2)	(4.0)	(3.2)	(2.4)	(4.1)	(4.4)
Sample size	820	814	772	753	808	786
Main big city						
Score	213	261	306	224	255	306
	(1.9)	(2.3)	(3.2)	(2.7)	(3.3)	(4.5)
Sample size	894	768	471	769	770	488
Urban fringe						
Score	218	267	300	236	267	303
	(2.4)	(2.8)	(2.4)	(2.3)	(3.0)	(3.2)
Sample size	636	713	794	689	812	794
Medium city						
Score	213	266	293	229	260	293
	(1.7)	(2.3)	(2.4)	(2.2)	(3.2)	(3.1)
Sample size	1,094	802	802	1,108	803	824
Small places						
Score	216	264	296	236	267	294
	(1.5)	(1.7)	(1.8)	(1.6)	(1.9)	(2.1)
Sample size	1,790	1,937	1,966	1,737	1,887	1,977

NOTE: Standard errors for three community categories (extreme rural, disadvantaged urban, and advantaged urban) are as given in two NCES publications on the 1990 NAEP (*The State of Mathematics Achivement* and *The 1990 Science Report Card*). For the other four community categories and total, standard errors are computed by multiplying simple random estimates of standard errors by the design effect (2.25).

SOURCE: RAND special tabulations of 1990 National Assessment of Educational Progress, 267-69.

Average mathematics proficiency, by sex, race and ethnicity, and parent's education: 1973 to 1990

Age and year	Total	Sex: Male	Sex: Female	Race and ethnicity: White	Race and ethnicity: Black	Race and ethnicity: Hispanic
Age 9						
1973	219 (0.8)	218 (0.7)	220 (1.1)	225 (1.0)	190 (1.8)	202 (2.4)
1978	219 (0.8)	217 (0.7)	220 (1.0)	224 (0.9)	192 (1.1)	203 (2.2)
1982	219 (1.1)	217 (1.2)	221 (1.2)	224 (1.1)	195 (1.6)	204 (1.3)
1986	222 (1.0)	222 (1.1)	222 (1.2)	227 (1.1)	202 (1.6)	205 (2.1)
1990	230 (0.8)	229 (0.9)	230 (1.1)	235 (0.8)	208 (2.2)	214 (2.1)
Age 13						
1973	266 (1.1)	265 (1.3)	267 (1.1)	274 (0.9)	228 (1.9)	239 (2.2)
1978	264 (1.1)	264 (1.3)	265 (1.1)	272 (0.8)	230 (1.9)	238 (2.0)
1982	269 (1.1)	269 (1.4)	268 (1.1)	274 (1.0)	240 (1.6)	252 (1.7)
1986	269 (1.2)	270 (1.1)	268 (1.5)	274 (1.3)	249 (2.3)	254 (2.9)
1990	270 (0.9)	271 (1.2)	270 (0.9)	276 (1.1)	249 (2.3)	255 (1.8)
Age 17						
1973	304 (1.1)	309 (1.2)	301 (1.1)	310 (1.1)	270 (1.3)	277 (2.2)
1978	300 (1.0)	304 (1.0)	297 (1.0)	306 (0.9)	268 (1.3)	276 (2.3)
1982	299 (0.9)	302 (1.0)	296 (1.0)	304 (0.9)	272 (1.2)	277 (1.8)
1986	302 (0.9)	305 (1.2)	299 (1.0)	308 (1.0)	270 (2.1)	283 (2.9)
1990	305 (0.9)	306 (1.1)	303 (1.1)	310 (1.0)	289 (2.8)	284 (2.9)

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statisitcs, *Trends in Academic Progress*, Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991), 267-69.

Average mathematics proficiency, by sex, race and ethnicity, and parent's education: 1973 to 1990, continued

Age and year	Parent's education: Less than high school	High school graduate	Some college	College graduate	Unknown
Age 9					
1973	NA	NA	NA	NA	NA
1978	200	219	230	231	211
	(1.5)	(1.1)	(1.7)	(1.1)	(1.1)
1982	199	218	225	229	213
	(1.7)	(1.1)	(2.1)	(1.5)	(1.5)
1986	201	218	229	231	214
	(2.5)	(1.6)	(2.0)	(1.1)	(1.4)
1990	210	226	236	238	223
	(2.3)	(1.2)	(2.7)	(1.3)	(1.0)
Age 13					
1973	NA	NA	NA	NA	NA
1978	245	263	273	284	240
	(1.2)	(1.0)	(1.2)	(1.2)	(1.3)
1982	251	263	275	282	252
	(1.4)	(0.8)	(0.9)	(1.5)	(3.2)
1986	252	263	274	280	247
	(2.3)	(1.2)	(0.8)	(1.4)	(2.3)
1990	253	263	277	280	248
	(1.8)	(1.2)	(1.0)	(1.0)	(2.1)
Age 17					
1973	NA	NA	NA	NA	NA
1978	280	294	305	317	276
	(1.2)	(0.8)	(0.9)	(1.0)	(1.9)
1982	279	294	304	310	272
	(1.0)	(0.8)	(0.9)	(1.1)	(2.0)
1986	279	293	305	314	281
	(2.3)	(1.0)	(1.2)	(1.4)	(2.4)
1990	285	294	308	316	277
	(2.2)	(0.9)	(1.0)	(1.3)	(2.8)

NOTE: Standard errors are presented in parentheses.
NA Not available.
SOURCE: National Center for Education Statistics, *Trends in Academic Progress*, Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991), 267-69.

Appendix Table 1-11

Percent of 17-year-old students at each scale score range in mathematics, by sex, and race and ethnicity: 1978 to 1990

Sex, race and ethnicity, and score range	1978	1982	1986	1990
Total				
Less than 200	0.2	0.1	0.1	0.0
200-249	7.8	6.9	4.3	4.0
250-299	40.5	44.5	43.9	39.9
300-349	44.2	43.0	45.2	48.9
350 or more	7.3	5.5	6.5	7.2
Sex				
Male				
Less than 200	0.1	0.0	0.1	0.1
200-249	6.9	6.1	3.8	4.1
250-299	37.9	42.0	41.5	38.2
300-349	45.6	45.0	46.2	48.8
350 or more	9.5	6.9	8.4	8.8
Female				
Less than 200	0.3	0.1	0.0	0.0
200-249	8.7	7.8	4.9	3.8
250-299	42.8	46.8	46.2	41.5
300-349	43.0	41.2	44.2	49.1
350 or more	5.2	4.1	4.7	5.6
Race and ethnicity				
White				
Less than 200	0.0	0.0	0.0	0.0
200-249	4.4	3.8	2.0	2.4
250-299	38.0	41.5	38.9	34.4
300-349	49.1	48.3	51.2	54.9
350 or more	8.5	6.4	7.9	8.3
Black				
Less than 200	1.2	0.3	0.0	0.1
200-249	28.1	23.3	14.4	7.6
250-299	53.9	59.3	64.8	59.6
300-349	16.3	16.6	20.6	30.8
350 or more	0.5	0.5	0.2	2.0
Hispanic				
Less than 200	0.7	0.2	0.6	0.4
200-249	21.0	18.4	10.1	13.8
250-299	54.9	59.8	62.8	55.7
300-349	22.0	20.9	25.4	28.2
350 or more	1.4	0.7	1.1	1.9

SOURCE: National Center for Education Statistics. *Trends in Academic Progress*. Report No. 21-T-01 (Washington, DC: U.S. Department of Education. 1991). 280-84.

Average science proficiency, by sex, race and ethnicity, and parent's education: 1970 to 1990

Age and year	Total	Sex: Male	Sex: Female	Race and ethnicity: White	Race and ethnicity: Black	Race and ethnicity: Hispanic
Age 9						
1970	225 (1.2)	228 (1.3)	223 (1.2)	236 (0.9)	179 (1.9)	NA
1973	220 (1.2)	223 (1.3)	218 (1.2)	231 (0.9)	177 (1.9)	NA
1977	220 (1.2)	222 (1.3)	218 (1.2)	230 (0.9)	175 (1.8)	192 (2.7)
1982	221 (1.8)	221 (2.3)	221 (2.0)	229 (1.9)	187 (3.0)	189 (4.2)
1986	224 (1.2)	227 (1.4)	221 (1.4)	232 (1.2)	196 (1.9)	199 (3.1)
1990	229 (0.8)	230 (1.1)	227 (1.0)	238 (0.8)	196 (2.0)	206 (2.2)
Age 13						
1970	255 (1.1)	257 (1.3)	253 (1.2)	263 (0.8)	215 (2.4)	NA
1973	250 (1.1)	252 (1.3)	247 (1.2)	259 (0.8)	205 (2.4)	NA
1977	247 (1.1)	251 (1.3)	244 (1.2)	256 (0.8)	208 (2.4)	213 (1.9)
1982	250 (1.3)	256 (1.5)	245 (1.3)	257 (1.1)	217 (1.3)	226 (3.9)
1986	251 (1.4)	256 (1.6)	247 (1.5)	259 (1.4)	222 (2.5)	226 (3.1)
1990	255 (0.9)	259 (1.1)	252 (1.1)	264 (0.9)	226 (3.1)	232 (2.6)
Age 17						
1970	305 (1.0)	314 (1.2)	297 (1.1)	312 (0.8)	258 (1.5)	NA
1973	296 (1.0)	304 (1.2)	288 (1.1)	304 (0.8)	250 (1.5)	NA
1977	290 (1.0)	297 (1.2)	288 (1.1)	298 (0.7)	240 (1.5)	262 (2.2)
1982	283 (1.2)	292 (1.4)	275 (1.3)	293 (1.0)	235 (1.7)	249 (2.3)
1986	289 (1.4)	295 (1.9)	282 (1.5)	298 (1.7)	253 (2.9)	259 (3.8)
1990	290 (1.1)	296 (1.3)	285 (1.6)	301 (1.1)	253 (4.5)	262 (4.4)

Continued

NOTE: Standard errors are presented in parentheses.
NA Not available.
SOURCE: National Center for Education Statistics. *Trends in Academic Progress*. Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991), 225-27.

Average science proficiency, by sex, race and ethnicity, and parent's education: 1970 to 1990, continued

	Parent's education				
Age and year	Less than high school	High school graduate	Some college	College graduate	Unknown
Age 9					
1970	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA
1977	199	223	237	232	211
	(2.2)	(1.4)	(1.5)	(1.4)	(1.4)
1982	198	218	229	231	211
	(6.0)	(3.3)	(3.2)	(2.3)	(2.8)
1986	204	220	236	235	215
	(2.9)	(1.5)	(2.6)	(1.4)	(1.5)
1990	210	226	238	236	222
	(2.7)	(1.7)	(2.1)	(1.3)	(1.2)
Age 13					
1970	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA
1977	224	245	260	266	222
	(1.3)	(1.1)	(1.3)	(1.0)	(1.8)
1982	225	243	259	264	229
	(1.9)	(1.3)	(1.5)	(1.5)	(2.8)
1986	229	245	258	264	227
	(2.7)	(1.4)	(1.4)	(1.9)	(2.7)
1990	233	247	263	268	224
	(2.1)	(1.3)	(1.2)	(1.1)	(2.1)
Age 17					
1970	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA
1977	265	284	296	309	253
	(1.3)	(0.8)	(1.1)	(1.0)	(3.2)
1982	259	275	290	300	252
	(2.4)	(1.6)	(1.7)	(1.7)	(3.9)
1986	258	277	295	304	245
	(3.1)	(2.0)	(2.5)	(2.1)	(5.5)
1990	261	276	297	306	248
	(2.8)	(1.4)	(1.6)	(1.7)	(5.5)

NOTE: Standard errors are presented in parentheses.
NA Not available.
SOURCE: National Center for Education Statistics. *Trends in Academic Progress*. Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991). 225-27.

Appendix Table 1-13

Percent of 17-year-old students at each scale score range in science, by sex, and race and ethnicity: 1977 to 1990

Sex, race and ethnicity, and score range	1977	1982	1986	1990
Total				
Less than 200	2.9	4.3	2.9	3.3
200-249	15.5	19.1	16.4	15.5
250-299	39.9	39.3	39.4	37.8
300-349	33.2	30.2	33.4	34.2
350 or more	8.5	7.1	7.9	9.2
Sex				
Male				
Less than 200	2.2	3.2	2.6	3.2
200-249	12.6	15.6	15.0	14.3
250-299	36.4	36.0	33.6	34.3
300-349	37.0	34.8	37.4	35.2
350 or more	11.8	10.4	11.4	13.0
Female				
Less than 200	3.6	5.4	3.1	3.4
200-249	18.4	22.4	17.8	16.7
250-299	43.2	42.3	45.0	41.2
300-349	29.5	26.0	29.6	33.2
350 or more	5.3	3.9	4.5	5.5
Race and ethnicity				
White				
Less than 200	0.8	1.4	1.2	1.0
200-249	11.0	13.7	11.0	9.4
250-299	40.7	41.0	39.1	38.4
300-349	37.5	35.3	39.1	39.8
350 or more	10.0	8.6	9.6	11.4
Black				
Less than 200	16.4	20.3	9.1	11.7
200-249	43.1	44.7	38.7	36.9
250-299	32.8	28.5	39.7	35.7
300-349	7.3	6.3	11.6	14.2
350 or more	0.4	0.2	0.9	1.5
Hispanic				
Less than 200	6.9	13.1	6.7	8.1
200-249	31.6	38.9	33.3	32.0
250-299	43.0	36.9	45.2	38.8
300-349	16.7	9.7	13.7	19.0
350 or more	1.8	1.4	1.1	2.1

SOURCE: National Center for Education Statistics. *Trends in Academic Progress*. Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991), 238-42.

Appendix Table 1-14

Mathematics and science achievement gains for students who were age 9 in 1986 and age 13 in 1990, by proficiency level

Subject, race and ethnicity	Proficiency level: 10th percentile	50th percentile	90th percentile
Mathematics			
Age 9, 1986			
White	184	228	267
	(1.7)	(1.1)	(1.2)
Black	158	203	241
	(4.9)	(1.6)	(1.7)
Hispanic	164	206	245
	(1.8)	(2.4)	(3.8)
Age 13, 1990			
White	239	277	313
	(1.0)	(1.0)	(1.3)
Black	212	249	285
	(2.2)	(2.0)	(2.8)
Hispanic	216	255	292
	(3.1)	(1.9)	(2.9)
Change in scores between 1986 and 1990			
White	55	49	46
Black	54	46	44
Hispanic	52	49	47
Science			
Age 9, 1986			
White	181	233	282
	(1.5)	(1.6)	(1.7)
Black	147	196	246
	(3.5)	(2.2)	(3.7)
Hispanic	148	200	252
	(5.2)	(6.7)	(5.4)
Age 13, 1990			
White	220	265	307
	(1.2)	(1.1)	(1.4)
Black	182	226	269
	(6.1)	(3.0)	(4.2)
Hispanic	185	231	280
	(4.5)	(3.3)	(4.2)
Change in scores between 1986 and 1990			
White	39	32	25
Black	35	30	23
Hispanic	37	31	28

NOTE: Standard errors are presented in parentheses.

SOURCE: National Center for Education Statistics, *Trends in Academic Progress*, Report No. 21-T-01 (Washington, DC: U.S. Department of Education, 1991), 243-44, 285-86.

Appendix Table 1-15

Mathematics achievement scores, by race and ethnicity and parent's education: 1978 to 1990

Age and parent's education	White 1978	White 1982	White 1986	White 1990	Black 1978	Black 1982	Black 1986	Black 1990	Hispanic 1978	Hispanic 1982	Hispanic 1986	Hispanic 1990
Total, Age 9	224.1	224.0	226.9	235.2	192.4	194.9	201.6	208.4	202.9	204.0	205.4	213.8
	(0.9)	(1.1)	(1.0)	(0.8)	(1.1)	(1.6)	(1.6)	(2.2)	(2.2)	(1.3)	(2.1)	(2.1)
Less than high school	207.6	204.0	201.5	212.3	179.6	178.4	191.6	203.4	193.9	201.4	212.1	205.5
	(1.6)	(1.5)	(3.2)	(2.7)	(2.9)	(4.0)	(5.2)	(6.0)	(3.3)	(5.5)	(8.8)	(6.3)
High school graduate	224.6	222.6	224.4	231.9	193.8	196.9	198.4	205.9	216.0	204.3	198.5	218.6
	(1.1)	(1.1)	(2.0)	(1.1)	(1.7)	(2.2)	(2.6)	(3.5)	(4.4)	(2.8)	(3.2)	(4.5)
Some college	234.6	230.0	232.7	242.5	197.3	197.8	206.4	216.5	216.8	209.1	212.2	214.9
	(1.9)	(2.3)	(2.0)	(2.4)	(3.2)	(3.0)	(9.2)	(4.9)	(8.2)	(9.0)	(6.4)	(6.4)
College graduate	235.8	233.8	236.9	243.3	203.2	203.0	207.5	213.8	200.8	208.8	213.0	216.9
	(1.2)	(1.2)	(1.3)	(1.2)	(2.1)	(3.0)	(1.8)	(3.2)	(4.9)	(2.8)	(4.5)	(4.8)
Sample size	6,612	5,950	5,085	4,358	1,520	1,545	1,035	1,073	406	455	553	541
Total, Age 13	271.6	274.4	273.6	276.3	229.6	240.4	249.2	249.1	238.0	252.4	254.3	254.6
	(0.8)	(1.0)	(1.3)	(1.1)	(1.9)	(1.6)	(2.3)	(2.3)	(2.0)	(1.7)	(2.9)	(1.8)
Less than high school	252.0	256.6	256.0	259.1	222.3	232.0	239.7	234.1	238.1	247.7	248.2	249.6
	(1.2)	(1.4)	(3.0)	(2.0)	(2.0)	(3.5)	(2.8)	(6.1)	(2.8)	(1.8)	(4.5)	(2.5)
High school graduate	268.5	267.2	266.3	266.6	232.3	241.8	246.3	246.7	244.0	250.4	251.8	253.2
	(0.7)	(0.8)	(1.3)	(1.3)	(2.0)	(1.3)	(2.1)	(3.1)	(3.4)	(2.5)	(2.7)	(3.5)
Some college	277.5	277.5	276.6	279.7	240.3	242.6	255.4	263.9	251.8	264.9	265.9	272.9
	(1.0)	(0.8)	(1.0)	(1.1)	(2.7)	(2.4)	(2.9)	(4.5)	(4.4)	(4.1)	(4.1)	(3.5)
College graduate	287.7	287.7	284.4	286.7	245.9	248.4	254.8	251.3	263.7	268.2	265.8	262.0
	(1.1)	(1.1)	(1.2)	(1.0)	(3.2)	(2.9)	(3.1)	(2.7)	(5.0)	(2.8)	(4.2)	(2.7)
Sample size	18,559	10,641	3,956	4,977	3,983	1,907	1,425	749	1,447	850	557	602
Total, Age 17	305.9	303.7	307.5	309.5	268.4	271.8	278.6	288.5	276.3	276.7	283.1	283.5
	(0.9)	(0.9)	(1.0)	(1.0)	(1.3)	(1.2)	(1.2)	(2.8)	(2.3)	(1.8)	(2.9)	(2.9)
Less than high school	286.7	284.6	283.9	288.9	262.7	265.0	266.0	277.3	270.6	270.1	272.5	279.5
	(1.3)	(1.4)	(3.2)	(2.7)	(1.7)	(1.7)	(3.0)	(4.4)	(2.8)	(1.7)	(3.8)	(4.4)
High school graduate	298.5	298.0	298.6	298.3	264.7	268.4	272.8	277.9	279.3	276.8	287.9	278.7
	(0.8)	(0.6)	(1.0)	(1.1)	(1.5)	(1.5)	(3.0)	(2.3)	(2.2)	(3.2)	(2.7)	(4.0)
Some college	308.3	307.3	308.5	310.6	280.0	279.8	285.3	294.0	289.6	290.2	291.6	302.4
	(1.0)	(0.8)	(1.2)	(1.1)	(2.6)	(2.4)	(3.1)	(3.3)	(4.8)	(3.3)	(5.0)	(4.3)
College graduate	319.4	315.4	317.7	320.2	280.2	284.5	287.7	297.1	297.8	292.8	297.3	291.9
	(1.0)	(1.0)	(1.5)	(1.3)	(3.3)	(2.4)	(3.5)	(4.2)	(5.0)	(3.7)	(4.9)	(7.7)
Sample size	20,421	13,135	2,974	3,388	3,086	2,068	547	600	988	817	220	249

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, unpublished tabulations.

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Appendix Table 1-16

Science achievement scores, by race and ethnicity and parent's education: 1977 to 1990

Age and parent's education	White				Black				Hispanic			
	1977	1982	1986	1990	1977	1982	1986	1990	1977	1982	1986	1990
Total, Age 9	229.6	229.0	231.9	237.5	174.8	187.0	196.2	196.4	191.9	189.0	199.4	206.2
	(0.9)	(1.9)	(1.2)	(0.8)	(1.8)	(3.0)	(1.9)	(2.0)	(2.7)	(4.2)	(3.1)	(2.2)
Less than high school	211.4	212.8	209.8	217.0	159.7	157.8	183.4	186.0	186.3	177.4	195.3	197.4
	(1.8)	(6.6)	(3.5)	(3.2)	(4.5)	(8.0)	(5.1)	(6.8)	(5.0)	(6.9)	(6.9)	(7.3)
High school graduate	231.6	225.8	228.0	233.2	179.5	187.1	191.8	201.8	196.5	191.1	191.2	208.4
	(1.2)	(4.0)	(1.3)	(1.9)	(2.3)	(5.9)	(3.8)	(3.7)	(4.3)	(5.8)	(6.0)	(5.9)
Some college	243.3	236.7	241.9	248.2	189.3	191.1	205.2	206.3	204.9	174.4	207.6	203.7
	(1.3)	(3.1)	(2.5)	(1.8)	(7.4)	(9.0)	(8.8)	(5.8)	(10.9)	(16.2)	(12.4)	(8.4)
College graduate	239.9	238.4	242.6	244.8	186.7	195.2	204.2	200.4	206.3	197.0	207.1	213.1
	(1.3)	(2.4)	(1.6)	(1.1)	(3.0)	(3.8)	(2.7)	(3.6)	(4.7)	(7.4)	(7.5)	(4.7)
Sample size	13,380	1,350	5,098	4,358	2,736	438	1,041	1,073	975	129	554	541
Total, Age 13	256.1	257.3	259.2	264.1	208.1	217.1	221.6	225.7	213.4	225.5	226.1	231.6
	(0.8)	(1.1)	(1.4)	(0.9)	(2.4)	(1.3)	(2.5)	(3.1)	(1.9)	(3.9)	(3.1)	(2.6)
Less than high school	234.0	233.3	237.6	243.1	196.2	202.0	209.2	211.0	202.9	212.1	215.3	219.8
	(1.2)	(2.0)	(3.7)	(2.3)	(1.9)	(3.0)	(4.3)	(6.6)	(3.6)	(3.7)	(3.6)	(2.3)
High school graduate	252.1	248.5	251.2	254.7	209.5	215.0	217.9	220.9	221.7	223.6	225.6	228.6
	(0.9)	(1.1)	(1.6)	(1.1)	(2.5)	(3.[illegible])	(2.9)	(2.9)	(3.7)	(5.0)	(4.8)	(5.4)
Some college	265.7	264.5	263.0	268.9	222.9	227.4	229.9	235.1	230.7	236.5	239.6	251.4
	(1.1)	(1.0)	(1.5)	(1.3)	(3.4)	(4.0)	(2.7)	(4.2)	(3.6)	(6.5)	(4.4)	(5.3)
College graduate	271.1	269.3	271.6	274.9	224.5	225.9	229.4	234.1	238.7	246.1	239.5	250.7
	(0.8)	(1.2)	(1.8)	(0.9)	(2.7)	(2.5)	(3.2)	(2.5)	(6.9)	(4.4)	(4.5)	(3.4)
Sample size	20,558	6,225	4,655	4,991	3,374	1,092	888	751	1302	419	414	603
Total, Age 17	297.7	293.1	297.5	300.9	240.2	234.7	252.8	253.0	262.3	248.7	259.3	261.5
	(0.7)	(1.0)	(1.7)	(1.1)	(1.5)	(1.7)	(2.9)	(4.5)	(2.2)	(2.3)	(3.8)	(4.4)
Less than high school	277.1	273.9	267.8	272.6	229.4	224.4	233.5	229.4	255.5	243.7	243.9	252.5
	(1.2)	(2.5)	(2.9)	(3.3)	(2.1)	(3.4)	(5.8)	(8.6)	(2.7)	(6.3)	(5.3)	(6.5)
High school graduate	290.9	283.6	286.5	288.9	239.8	228.3	243.8	236.9	266.5	248.1	263.3	244.5
	(0.7)	(1.4)	(2.3)	(0.8)	(1.9)	(2.9)	(3.2)	(4.1)	(2.5)	(6.6)	(4.0)	(5.9)
Some college	300.6	297.2	301.4	303.0	253.7	248.1	259.3	264.3	277.2	252.8	273.7	296.8
	(1.0)	(1.4)	(2.5)	(1.5)	(2.2)	(3.9)	(6.0)	(5.4)	(5.7)	(7.9)	(6.2)	(8.6)
College graduate	312.9	307.0	309.2	313.7	262.2	247.6	271.5	266.7	290.6	268.9	278.1	272.7
	(0.8)	(1.6)	(2.3)	(1.5)	(3.0)	(3.5)	(4.8)	(6.5)	(4.9)	(6.3)	(5.1)	(9.1)
Sample size	26,099	6,398	2,974	3,390	3,700	1,017	558	602	1,198	384	220	251

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, unpublished tabulations.

Percent of students who did not report parent's education, by age, and race and ethnicity: 1977 to 1990

Subject, age, and response	White				Black				Hispanic			
	1978	1982	1986	1990	1978	1982	1986	1990	1978	1982	1986	1990
Mathematics												
Age 9												
Total respondents (sample size)	11,078	8,726	5,098	4,358	2,646	2,238	1,041	1,073	794	815	554	541
Score	224.1 (0.9)	224.0 (1.1)	226.9 (1.1)	235.2 (0.8)	192.4 (1.1)	194.9 (1.6)	201.6 (1.6)	208.4 (2.2)	202.9 (2.2)	204.0 (1.3)	205.4 (2.1)	213.8 (2.1)
Non-response on parent's education												
Number	4,188	2,549	1,817	1,469	724	445	350	271	349	241	203	147
Percent	38	29	36	34	27	20	34	25	44	30	37	27
NAEP score	216.0 (1.3)	217.4 (1.7)	218.6 (1.4)	228.0 (1.2)	184.0 (1.8)	189.6 (2.1)	197.6 (2.6)	200.3 (2.1)	199.2 (2.8)	200.8 (2.2)	202.3 (2.4)	212.3 (3.1)
Age 13												
Total respondents (sample size)	18,559	11,795	4,038	4,991	3,983	2,300	1,442	751	1,447	1,195	561	603
Score	271.6 (0.8)	274.4 (1.0)	273.6 (1.3)	276.3 (1.1)	229.6 (1.9)	240.4 (1.6)	249.2 (2.3)	249.1 (2.3)	238.0 (2.0)	252.4 (1.7)	254.3 (2.9)	254.6 (1.8)
Non-response on parent's education												
Number	2,395	954	314	260	860	302	128	126	508	176	94	94
Percent	13	8	8	5	22	13	9	17	35	15	17	16
NAEP score	250.8 (1.3)	261.3 (3.4)	250.3 (3.4)	255.3 (2.2)	216.0 (2.6)	227.7 (3.8)	240.7 (3.6)	236.5 (4.6)	224.3 (2.0)	241.0 (3.2)	240.8 (5.3)	241.2 (3.4)
Age 17												
Total respondents (sample size)	21,556	12,307	2,749	3,390	3,672	2,571	671	602	1,212	1,016	332	251
Score	305.9 (0.9)	303.7 (0.9)	307.5 (1.0)	309.5 (1.0)	268.4 (1.3)	271.8 (1.2)	278.6 (2.1)	288.5 (2.8)	276.3 (2.3)	276.7 (1.8)	283.1 (2.9)	283.5 (2.9)
Non-response on parent's education												
Number	789	403	60	53	397	215	30	19	125	82	16	23
Percent	4	3	2	2	11	8	4	3	10	8	5	9
NAEP score	285.6 (2.3)	280.7 (2.1)	290.6 (3.6)	283.9 (3.5)	260.2 (2.7)	258.3 (2.7)	266.4 (6.2)	284.3 (6.7)	257.1 (3.7)	258.8 (3.3)	271.4 (6.7)	252.2 (7.4)

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U S Department of Education, special tabulations of NAEP mathematics achievement trend data

Percent of students who did not report parent's education, by age, and race and ethnicity: 1977 to 1990, continued

Subject, age, and response	White				Black				Hispanic			
	1977	1982	1986	1990	1977	1982	1986	1990	1977	1982	1986	1990
Science												
Age 9												
Total respondents (sample size)	13,380	1,350	5,098	4,358	2,736	438	1,041	1,073	975	129	554	541
Score	229.6 (0.9)	229.0 (1.9)	231.9 (1.2)	237.5 (2.8)	174.8 (1.8)	187.0 (3.0)	196.2 (1.9)	196.4 (2.0)	191.9 (2.7)	189.0 (4.2)	199.4 (3.1)	206.2 (2.2)
Non-response on parent's education												
Number	4,466	458	1,817	1,469	851	78	350	271	396	41	203	147
Percent	33	34	36	34	31	18	34	25	41	31	37	27
NAEP score	221.2 (1.0)	217.3 (2.9)	222.0 (1.3)	230.6 (1.3)	168.2 (2.3)	182.4 (4.9)	190.1 (3.2)	185.2 (3.5)	187.9 (2.7)	187.4 (7.6)	198.2 (3.9)	203.7 (2.0)
Age 13												
Total respondents (sample size)	19,397	5,781	4,038	4,991	4,733	1,211	1,442	751	1,182	650	561	603
Score	256.1 (0.8)	257.3 (1.1)	259.2 (1.4)	264.1 (0.9)	208.1 (2.4)	217.1 (1.3)	221.6 (2.5)	225.7 (3.1)	213.4 (1.9)	225.5 (3.9)	226.1 (3.1)	231.6 (2.6)
Non-response on parent's education												
Number	2,239	574	314	260	751	175	128	126	396	122	94	94
Percent	12	10	8	5	16	14	9	17	36	19	17	16
NAEP score	234.8 (2.0)	239.2 (3.3)	237.9 (3.0)	237.5 (2.6)	194.3 (2.1)	204.3 (3.8)	209.5 (4.3)	205.4 (4.7)	202.0 (3.1)	216.1 (4.5)	210.4 (4.9)	213.5 (3.4)
Age 17												
Total respondents (sample size)	25,370	5,904	2,749	3,390	4,436	1,328	671	602	1,220	508	332	251
Score	297.7 (0.7)	293.1 (1.0)	297.5 (1.7)	300.9 (1.1)	240.2 (1.5)	234.7 (1.7)	252.8 (2.9)	253.0 (4.5)	263.2 (2.2)	248.7 (2.3)	259.3 (3.8)	261.5 (4.4)
Non-response on parent's education												
Number	827	264	60	53	463	89	30	19	180	38	16	23
Percent	3	4	2	2	10	7	4	3	15	7	5	9
NAEP score	273.2 (3.2)	266.3 (3.6)	262.8 (6.3)	259.1 (8.3)	217.6 (2.1)	216.5 (4.9)	224.9 (6.4)	231.2 (15.6)	244.9 (5.8)	232.4 (10.6)	233.2 (10.1)	231.8 (14.1)

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, special tabulations of NAEP science achievement trend data.

Appendix Table 1-18

Percent of mathematics and science test items answered correctly for selected countries participating in The First and Second International Mathematics and Science Studies: 1964 to 1984

	Mathematics, age 13				
	First International Mathematics Study, 1964		Second International Mathematics Study, 1982 /1		
Country	Percent correct of 70 test items	Standard error	Country	Percent correct of 139 test items /2	Standard error
Japan	46	(0.5)	Japan	62	(- - -)
Belgium /3	43	(0.5)	Netherlands	56	(- - -)
Finland	37	(0.6)	France /3	53	(- - -)
England	34	(0.6)	Belgium /3	52	(- - -)
Scotland /3	31	(0.6)	Scotland /3	48	(- - -)
Netherlands	30	(0.6)	England/Wales	47	(- - -)
France /3	26	(0.7)	Finland	47	(- - -)
United States	**26**	(0.3)	**United States**	**45**	(- - -)
Sweden	21	(0.5)	Sweden	42	(- - -)

	Science, age 14				
	First International Science Study, 1970		Second International Science Study, 1984		
Country	Percent correct of 80 test items	Standard error	Country	Percent correct of 30 test items	Standard error
Japan	39	(0.8)	Hungary /3	73	(0.3)
Hungary /3	36	(0.4)	Japan	67	(0.1)
Sweden	28	(0.6)	Netherlands	67	(0.3)
United States	**28**	(0.3)	Finland	63	(0.1)
England	26	(0.6)	Sweden	60	(0.2)
Finland	26	(0.5)	England	57	(0.2)
Italy /3	24	(0.3)	Italy /3	57	(0.3)
Netherlands	23	(0.7)	**United States**	**57**	(0.3)

NOTE: Published values for the first mathematics and science studies and second science study were converted to average percent correct by dividing the number of items correct by the total number of items.

(- - -) Standard errors unavailable for weighted averages.

1/ The percents listed for each country under the second mathematics study reflect a weighted average of the mean percent correct in algebra, arithmetic, geometry, and measurement.

2/ Total of 139 represents the following: 30 algebra, 46 arithmetic, 39 geometry, and 24 measurement test items.

3/ Did not participate in all four IEA studies.

SOURCES: National Center for Education Statistics, *Digest of Education Statistics* (Washington, DC: U.S. Department of Education, 1989); E. A. Medrich and J. E. Griffith, *International Science and Mathematics Assessments: What Have We Learned?* NCES 92-011 (Washington, DC: U.S. Department of Education, 1992), 67, 70-73, 80, 83.

Appendix Table 1-19

Change in science achievement scores of 14-year-old students in 8 countries: 1970-71 to 1983-84

Country	Mean scale score: First IEA Science Study	Mean scale score: Second IEA Science Study	Change	Change adjusted /1
Japan	587	597	10	5
Hungary	584	621	37	42
United States	**538**	**513**	**(-25)**	**(-47)**
Finland	537	559	22	11
Sweden /2	536	556	20	18
England	532	539	7	18
Italy /2	531	540	9	17
Netherlands	521	578	57	30

1/ Adjusted changes in scores were calculated to reflect differences in the samples across studies.
2/ The grade samples in the second study for Italy and Sweden were combined to provide a 14-year-old age sample, as in the first study.
SOURCE: J. P. Keeves, ed., *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984* (Pergamon Press, 1992), 278.

Indicators of Science and Mathematics Education 1992

Appendix Table 1-20

Percent of items correct for the United States, selected countries, and the highest achieving country: The Second IEA Mathematics Study, 1981-82

Grade and topic	United States	Selected countries /1	Highest achieving country
8th Grade			
Statistics	**57**	60	71
Arithmetic	**51**	53	60
Algebra	**43**	47	60
Measurement	**42**	56	69
Geometry	**38**	46	58
12th Grade			
Sets and relations	**56**	66	79
Algebra	**43**	63	78
Number systems	**40**	55	68
Probability/statistics	**40**	58	70
Geometry	**31**	48	60
Elementary functions/calculus	**29**	51	66

1/ Figures are based on the countries that participated in both the First and Second IEA Mathematics Studies.
Countries included are: for the 8th grade, Japan, Belgium, Finland, England, Scotland, the Netherlands, France, and Sweden; for the 12th grade, Japan, Belgium, Finland, England, Scotland, and Sweden.
SOURCE: C. C. McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, IL: Stipes Publishing Company, 1987), 124-25.

Indicators of Science and Mathematics Education 1992

Mean percent correct and opportunity-to-learn (OTL) rating for 13-year-old students in high- and low-achieving countries: The Second IEA Mathematics Study, 1981-82

Mathematics topics and OTL	Country by rank order of achievement for each topic					
Country	Japan	Netherlands	**United States**	England/Wales	Finland	Sweden
Arithmetic	60	59	**51**	48	46	41
OTL rating	85	82	**87**	78	76	66
Country	Japan	Netherlands	Finland	**United States**	England/Wales	Sweden
Algebra	60	51	44	**43**	40	32
OTL rating	83	73	70	**69**	63	45
Country	Japan	Netherlands	England/Wales	Finland	Sweden	**United States**
Geometry	58	52	45	43	39	**38**
OTL rating	51	67	54	39	35	**44**
Country	Japan	Netherlands	England/Wales	Finland	**United States**	Sweden
Statistics	71	66	60	58	**57**	56
OTL rating	76	32	69	52	**73**	47
Country	Japan	Netherlands	Finland	England/Wales	Sweden	**United States**
Measurement	69	62	51	49	49	**42**
OTL rating	95	82	70	80	67	**72**

NOTES: Mean percents correct and OTL ratings are for the average number of items on the international test whose mathematical content was reported by the classes' mathematics teachers to have been taught either before or during the school year. Countries in table are not necessarily the highest or lowest achieving in each topic. Countries without OTL have been excluded from this table.

SOURCE: C. C. McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, IL: Stipes Publishing Company, 1987), 124-25.

Appendix Table 1-22

Participation rates for students in the final year of secondary school: The Second IEA Mathematics and Science Studies

Country	Percent of age-group in school	Percent of students in 1981-82 taking mathematics	Percent of students in 1983-85 taking: Biology	Chemistry	Physics
Mathematics					
Belgium	65	25-30	--	--	--
England/Wales	17	35	--	--	--
Finland	59	38	--	--	--
Japan	92	13	--	--	--
Scotland	43	42	--	--	--
Sweden	24	50	--	--	--
United States	**82**	**15**	--	--	--
Science					
Australia	39	--	18	12	11
England	20	--	4	5	6
Finland /1	63	--	41	16	14
Hungary /1	40	--	3	1	4
Israel	65	--	20	8	12
Italy	34	--	4	1	13
Japan /1	89	--	12	16	11
Norway	40	--	4	6	10
Sweden	28	--	5	6	13
United States	**83**	--	**12**	**2**	**1**

-- Not applicable:
1/ Enrollments include students in vocational schools.
SOURCES: T. N. Postlethwaite and D. E. Wiley. *The IEA Study of Science II: Science Achievement in Twenty-Three Countries* (Pergamon Press, 1992), 6; D. F. Robitaille and R. A. Garden. *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics* (Pergamon Press, 1989), 126.

Indicators of Science and Mathematics Education 1992

Appendix Table 1-23

Mean percent correct and opportunity-to-learn (OTL) rating for final-year secondary students in high- and low-achieving countries: The Second IEA Mathematics Study, 1981-82

Mathematics topics and OTL	Country by rank order of achievement for each topic				
Country	Japan	Finland	England/Wales	Sweden	**United States**
Sets and relations	79	77	61	59	**56**
OTL rating	95	88	48	60	**83**
Country	Japan	Sweden	England/Wales	Finland	**United States**
Number systems	68	62	59	57	**40**
OTL rating	80	87	74	90	**83**
Country	Japan	Finland	England/Wales	Sweden	**United States**
Algebra	78	69	66	60	**43**
OTL rating	100	92	86	90	**88**
Country	Japan	England/Wales	Sweden	Finland	**United States**
Geometry	60	51	49	48	**31**
OTL rating	89	69	66	79	**62**
Country	Japan	England/Wales	Finland	Sweden	**United States**
Elementary functions and calculus	66	58	55	51	**29**
OTL rating	92	85	87	85	**54**
Country	Japan	England/Wales	Sweden	Finland	**United States**
Probability and statistics	70	64	64	58	**40**
OTL rating	82	87	75	87	**45**

NOTES: Mean percents correct and OTL ratings are for the average number of items on the international test whose mathematical content was reported by the classes' mathematics teachers to have been taught either before or during the school year. Countries shown in this table are not necessarily the highest or lowest achieving in each topic. Countries without OTL data have been excluded from this table.

SOURCE: C. C. McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, IL: Stipes Publishing Company, 1987), 124-25.

Appendix Table 1-24

Mean percent correct for 10- and 14-year-old students, and students in their final year of secondary school, in selected countries: The Second IEA Science Study, 1983-85

10-year-old students		14-year-old students		Final-year secondary students	
Country	Mean	Country	Mean	Country	Mean /1
Japan	64	Hungary	72	England	63
Finland	64	Japan	67	Hungary	56
Hungary	60	Israel	62	Japan	54
Sweden	57	Finland	62	Norway	51
Italy	56	Australia	60	Israel	50
United States	55	Norway	60	Australia	48
Australia	54	Sweden	59	Sweden	48
Norway	53	Italy	56	Finland	41
Israel	50	England	56	**United States**	**40**
England	49	**United States**	**55**	Italy	36

1/ Weighted average of mean percent correct in biology, chemistry, and physics, as measured on the reduced number of items taken by students in the United States.

SOURCE: T. N. Postlethwaite and D. E. Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries* (Pergamon Press, 1992), 55, 66, 69.

Indicators of Science and Mathematics Education 1992

Appendix Table 1-25

Percent of test items answered correctly in biology, chemistry, and physics for students in their final year of secondary school, in selected countries: The Second IEA Science Study, 1983-85

Country	Biology (25 items)	Chemistry (25 items)	Physics (26 items)
England	62	69	58
Hungary	60	50	59
Norway	55	44	54
Sweden	53	44	46
Israel	52	45	55
Finland	50	36	38
Australia	47	49	49
Japan	46	56	59
Italy	42	38	29
United States	**38**	**38**	**45**

NOTE: Achievement as measured on the reduced number of items taken by the United States.

SOURCE: T. N. Postlethwaite and D. E. Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries* (Pergamon Press, 1992), 69

Indicators of Science and Mathematics Education 1992

Appendix Table 1-26

Percent of items correct in mathematics topics for 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age and country /1	All topics	Numbers and operations	Measurement	Geometry	Data analysis, statistics, and probability	Algebra and functions	Conceptual understanding	Procedural knowledge	Problem solving
9-year-old students									
Canada	60	55	65	65	72	56	60	61	57
Hungary	68	68	72	69	63	72	68	71	64
Ireland	60	58	64	58	65	59	59	64	56
Israel	64	64	70	59	64	67	63	68	62
South Korea	75	75	73	75	79	72	75	79	69
Slovenia	56	53	62	53	54	58	56	58	52
Spain	62	61	61	60	69	58	61	66	57
Taiwan	68	67	69	69	73	64	69	76	56
United States	**58**	**54**	**63**	**57**	**73**	**55**	**60**	**60**	**55**
13-year-old students									
Canada	62	66	50	68	76	53	65	62	59
France	64	65	53	73	79	57	67	66	59
Hungary	68	69	55	73	76	70	70	71	64
Ireland	61	65	49	60	72	56	62	62	58
Israel	63	65	47	66	75	65	64	65	60
Jordan	40	43	32	44	46	38	45	39	38
South Korea	73	77	60	77	81	71	78	73	69
Scotland	61	60	51	70	79	53	62	59	61
Slovenia	57	62	43	63	64	52	59	59	54
Spain	55	60	38	60	68	52	58	56	52
Taiwan	73	75	64	77	81	69	75	75	69
United States	**55**	**61**	**40**	**54**	**72**	**49**	**57**	**56**	**52**

1/ For Scotland, the age-9 group was assessed but is not included because of low participation rates; France and Jordan did not assess the age-9 group.

SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 146, 151.

Appendix Table 1-27

Percent of items correct in science topics for 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age and country /1	All topics	Life sciences	Physical sciences	Earth and space sciences	Nature of science	Knows	Uses	Integrates
9-year-old students								
Canada	63	63	58	67	67	63	65	56
Hungary	63	65	56	68	62	66	61	57
Ireland	57	55	54	63	60	57	57	53
Israel	61	61	60	61	64	61	63	58
South Korea	68	69	68	62	71	67	70	65
Slovenia	58	59	56	58	54	60	57	53
Spain	62	66	54	63	65	67	60	54
Taiwan	67	65	68	67	67	65	70	61
United States	**65**	**65**	**58**	**71**	**71**	**67**	**66**	**58**
13-year-old students								
Canada	69	69	65	68	79	72	66	71
France	69	68	67	67	76	71	66	70
Hungary	73	77	70	72	75	83	71	70
Ireland	63	61	61	66	71	66	62	63
Israel	70	65	70	68	79	71	68	71
Jordan	57	59	54	61	56	65	57	49
South Korea	78	80	76	75	79	84	77	73
Scotland	68	67	66	64	77	72	66	68
Slovenia	70	73	67	70	73	80	68	66
Spain	68	70	64	69	70	76	65	64
Taiwan	76	78	75	72	76	81	75	72
United States	**67**	**69**	**62**	**67**	**76**	**73**	**65**	**65**

1/ For Scotland, the age-9 group was assessed but is not included because of low participation rates; France and Jordan did not assess the age-9 group.

SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 144, 151.

Appendix Table 1-28

Percent of mathematics items correct for 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age, topics and processes	All countries /1	United States	Highest country score	Lowest country score
9-year-old students				
All topics and processes	64	**58** (1.0)	- -	- -
Numbers and operations	63	**54** (1.1)	75 (0.6)	53 (0.6)
Measurement	67	**63** (1.0)	73 (0.8)	61 (0.8)
Geometry	65	**57** (1.0)	75 (0.7)	57 (1.0)
Data analysis, statistics, and probability	67	**73** (1.1)	79 (0.6)	54 (0.8)
Algebra and functions	63	**55** (1.0)	72 (0.7)	55 (1.0)
Conceptual understanding	64	**60** (1.0)	75 (0.6)	56 (0.6)
Procedural knowledge	68	**60** (1.1)	79 (0.6)	58 (0.6)
Problem solving	59	**55** (1.0)	69 (0.6)	52 (0.7)
13-year-old students				
All topics and processes	62	**55** (1.0)	- -	- -
Numbers and operations	64	**61** (1.0)	77 (0.6)	43 (1.0)
Measurement	49	**40** (1.0)	64 (0.9)	32 (1.0)
Geometry	66	**54** (1.0)	77 (0.6)	44 (1.1)
Data analysis, statistics, and probability	72	**72** (1.0)	81 (0.7)	46 (1.0)
Algebra and functions	58	**49** (1.6)	71 (0.8)	38 (1.3)
Conceptual understanding	64	**57** (0.9)	78 (0.5)	45 (0.9)
Procedural knowledge	62	**56** (1.3)	75 (0.7)	39 (1.2)
Problem solving	58	**52** (1.0)	69 (0.8)	38 (1.0)

NOTE: Standard errors are presented in parentheses. For 9-year-old students, countries included are Canada, Hungary, Ireland, Israel, South Korea, Slovenia, Spain, Taiwan, and the United States; for 13-year-old students, countries included are Canada, France, Hungary, Ireland, Israel, Jordan, South Korea, Scotland, Slovenia, Spain, and Taiwan.

- - Not applicable.

1/ The all-country mean is an arithmetic mean for selected countries and standard errors are not available.

SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 146, 151.

Appendix Table 1-29

Percent of mathematics items correct for the highest and lowest 10 percent of 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age and country	10th percentile	Mean	90th percentile
9-year-old students			
South Korea	51	75	93
Hungary	41	68	90
Taiwan	41	68	92
Israel	39	64	87
Spain	33	62	87
Ireland	31	60	85
Canada	36	60	84
United States	**30**	**58**	**84**
Slovenia	34	56	79
13-year-old students			
South Korea	41	73	96
Taiwan	35	73	97
Hungary	39	68	93
France	37	64	89
Israel	37	63	88
Canada	37	62	87
Ireland	33	61	87
Scotland	35	61	87
Slovenia	32	57	83
Spain	33	55	78
United States	**29**	**55**	**83**
Jordan	21	40	65

SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 145, 150.

Indicators of Science and Mathematics Education 1992

Appendix Table 1-30

Percent of science items correct for 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age, topics and processes	All countries /1	United States	Highest country score	Lowest country score
9-year-old students				
All topics and processes	62	**65** (0.9)	--	--
Life sciences	63	**65** (0.9)	69 (0.5)	55 (0.8)
Physical sciences	59	**58** (0.8)	68 (0.5)	54 (0.7)
Earth and space sciences	64	**71** (1.1)	71 (1.1)	58 (0.7)
Nature of science	64	**71** (1.0)	71 (1.0)	54 (0.6)
Knows	63	**67** (1.0)	67 (0.5)	57 (0.8)
Uses	63	**66** (0.9)	70 (0.5)	57 (0.5)
Integrates	57	**58** (0.8)	65 (0.5)	53 (0.7)
13-year-old students				
All topics and processes	69	**67** (1.0)	--	--
Life sciences	70	**69** (1.0)	80 (0.5)	59 (0.7)
Physical sciences	67	**62** (1.1)	76 (0.5)	54 (0.8)
Earth and space sciences	68	**67** (0.9)	75 (0.6)	61 (0.9)
Nature of science	74	**76** (1.3)	79 (0.6)	56 (0.9)
Knows	75	**73** (1.0)	84 (0.5)	65 (0.7)
Uses	67	**65** (0.9)	77 (0.4)	57 (0.8)
Integrates	67	**65** (1.3)	73 (0.6)	49 (0.9)

NOTES: Standard errors are presented in parentheses. Countries included are Canada, Hungary, Ireland, Israel, South Korea, Slovenia, Spain, and Taiwan.

1/ The all-country mean is an arithmetic mean for selected countries and standard errors are not available.

-- Not applicable.

SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 144, 151.

Appendix Table 1-31

Percent of science items correct for the highest and lowest 10 percent of 9- and 13-year-old students in selected countries: The International Assessment of Educational Progress, 1991

Age and country	10th percentile	Mean	90th percentile
9-year-old students			
South Korea	50	68	85
Taiwan	45	67	86
United States	**43**	**65**	**85**
Canada	43	63	81
Hungary	45	63	79
Spain	42	62	81
Israel	41	61	81
Slovenia	40	58	75
Ireland	36	57	76
13-year-old students			
South Korea	58	78	94
Taiwan	52	76	94
Hungary	52	73	92
Slovenia	50	70	89
Israel	48	70	89
Canada	48	69	88
France	45	69	89
Scotland	45	68	88
Spain	48	68	86
United States	**44**	**67**	**86**
Ireland	41	63	84
Jordan	36	57	78

SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 143, 150.

Indicators of Science and Mathematics Education 1922

Appendix Table 1-32

Sampling frames and response rates for participants in the IAEP mathematics study: 1991

Age and participant	Estimated percent of age-eligible children in country included in sampling frame	Combined overall response rate
Age 9		
Five highest scoring systems		
South Korea	95	98
Hungary	99	94
Taiwan	97	99
Italy	4	61
Soviet Union	63	84
Five lowest scoring systems		
United States	**97**	**74**
Ontario (English) /1	74	92
Slovenia	97	94
Portugal	81	86
Ontario (French) /1	74	92

Age and participant	Estimated percent of age-eligible children in country included in sampling frame	Combined overall response rate
Age 13		
Five highest scoring systems		
China	38	96
South Korea	97	99
Taiwan	100	98
Switzerland	76	80
Soviet Union	60	86
United States	**98**	**71**
Five lowest scoring systems		
Portugal	68	77
Jordan	96	84
Brazil, Sao Paulo	3	88
Brazil, Fortaleza	< 1	89
Mozambique	1	66

1/ Number reflects sampling frame and response rates for Canada as a whole.
SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22 CAEP-01 (Princeton: Educational Testing Service, 1992), 131-35.

Sampling frames and response rates for participants in the IAEP science study: 1991

Age and participant	Estimated percent of age-eligible children in country included in sampling frame	Combined overall response rate
Age 9		
Five highest scoring systems		
South Korea	95	98
Italy	4	62
Taiwan	97	98
British Columbia /1	74	92
United States	**97**	**74**
Five lowest scoring systems		
Israel	71	96
Slovenia	97	93
Ireland	94	92
Ontario (French) /1	74	92
Portugal	81	87

Age and participant	Estimated percent of age-eligible children in country included in sampling frame	Combined overall response rate
Age 13		
Five highest scoring systems		
South Korea	97	99
Taiwan	100	99
Alberta /1	94	91
Switzerland	76	80
Hungary	99	92
United States	**98**	**71**
Five lowest scoring systems		
Portugal	68	77
Ontario (French) /1	94	91
Jordan	96	84
Brazil, Sao Paulo	3	88
Brazil, Fortaleza	< 1	90

1/ Number reflects sampling frame and response rates for Canada as a whole.
SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22 CAEP 02 (Princeton: Educational Testing Service, 1992), 129-33.

Appendix Table 1-34

U.S. and European adult knowledge of scientific terms and concepts: 1990

Country	Mean correct /1	Standard deviation	Percent with 6 or more of 8 items correct: Total all adults /2	Percent with 6 or more of 8 items correct: Persons under 35 years of age	Sample size
United States	**5.0**	**1.87**	**36.2** (1.1)	**36.1** (1.1)	**2,033**
European Community	4.7	1.94	36.5 (NA)	45.5 (0.5)	11,677
France	5.0	1.76	39.9 (1.5)	49.4 (1.6)	1,004
West Germany*	4.9	1.74	36.7 (1.5)	51.1 (1.6)	1,024
Italy	4.7	1.90	36.3 (1.5)	55.1 (1.6)	1,022
Netherlands	4.9	1.85	38.9 (1.5)	51.6 (1.6)	1,025
Denmark	4.8	1.92	38.4 (1.5)	48.9 (1.6)	1,013
Belgium	4.4	1.93	30.8 (1.5)	41.4 (1.6)	1,000
Luxembourg	5.1	0.50	44.9 (NA)	54.5 (2.9)	303
Ireland	4.2	2.01	26.1 (1.4)	35.9 (1.5)	1,006
Greece	3.9	1.99	23.4 (1.3)	37.2 (1.5)	1,000
Spain	4.2	2.14	30.3 (1.5)	45.0 (1.6)	1,001
Portugal	3.6	2.25	22.8 (1.3)	33.1 (1.5)	1,000
Great Britain	5.0	1.97	42.3 (1.4)	24.7 (1.2)	1,308

NOTE: Standard errors are presented in parentheses.
NA Not available.
1/ The measure ranges from 0 to 8, receiving one point for each correct response. The eight true/false items asked are:
1) "The oxygen we breathe comes from plants."
2) "Electrons are smaller than atoms."
3) "The continents on which we live have been moving for millions of years and will continue to move in the future."
4) "Human beings, as we know them today, developed from earlier species of animals."
5) "Lasers are made up of focused sound waves."
6) "The earliest human beings lived at the same time as the dinosaurs."
7) "Which is faster: light or sound?"
8) "Does the Earth go around the Sun, or does the Sun go around the Earth?" And, for those who responded that the Earth goes around the Sun: "Does the Earth go around the Sun once a day, once a month, or once a year?"
2/ Adults were defined as 18 years old or older in the United States and 15 years old or older in Europe.
* Survey conducted prior to unification.
SOURCES: J. D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991) and unpublished tabulations; Commission of the European Communities, unpublished tabulations.

Appendix Table 2-1

Percent of states imposing regular graduation requirements in mathematics: 1974 to 1990

Years required	1974	1980	1983	1985	1987	1989	1990
0.0	29	27	24	12	12	10	12
1.0	51	53	18	4	4	2	2
1.5	4	2	0	0	0	0	0
2.0	14	16	49	65	61	59	63
2.5 /1	0	0	2	2	4	6	2
3.0	2	2	8	18	20	22	22
Total	100	100	101	101	101	99	101

NOTE: All 50 States and the District of Columbia are included in this table.

1/ Some States required an additional year of coursework in either mathematics or science. For the purpose of this table, such a requirement was counted as one half-year in each subject.

SOURCES: RAND tabulations of data from the National Association of Secondary School Principals, 1975 and 1980; Education Commission of the States, 1983 and 1990; Center for Education Statistics, 1987; National Center for Education Statistics, 1989; Clune, 1989; as cited in B. Stecher, "Describing Secondary Curriculum in Mathematics and Science: Current Conditions and Future Indicators," a RAND note presented to the National Science Foundation (N-3406-NSF) 1991, 134, table C.1.

Indicators of Science and Mathematics Education 1992

250

Percent of students in schools (with 12th grade) requiring science and mathematics courses, by sex, race and ethnicity, and community type: 1990

Number of semesters required from grades 9 to 12	Sex		Race and ethnicity				Community type			
	Male	Female	White	Black	Hispanic	Asian/ Pacific Islander	Extreme rural	Disadvantaged urban	Advantaged urban	Other
Science:										
1-3	24.0	24.3	23.7	23.1	24.7	40.6	13.8	24.8	5.1	28.5
1	4.3 (2.0)	3.6 (1.5)	4.1 (1.8)	3.6 (1.7)	2.3 (1.0)	5.7 (6.0)	0.0 (0.0)	1.5 (1.0)	0.0 (0.0)	5.6 (2.6)
2	14.0 (3.9)	14.9 (3.7)	14.5 (4.3)	13.0 (4.1)	10.1 (3.1)	28.6 (15.2)	12.9 (6.7)	16.1 (12.2)	4.5 (4.6)	15.8 (5.0)
3	5.7 (1.8)	5.8 (1.9)	5.1 (1.8)	6.5 (2.5)	12.3 (4.8)	6.3 (3.9)	0.9 (0.9)	7.2 (6.0)	0.6 (0.8)	7.1 (2.5)
4-5	60.8	59.8	61.5	58.5	60.4	39.0	79.5	55.4	83.3	54.6
4	59.8 (4.4)	58.1 (4.0)	60.9 (4.6)	52.0 (6.7)	60.0 (6.1)	39.0 (11.8)	79.5 (8.7)	55.4 (10.4)	72.8 (8.6)	53.9 (4.8)
5	1.0 (0.6)	1.7 (1.0)	0.6 (0.5)	6.5 (4.3)	0.4 (0.3)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	10.5 (7.1)	0.7 (0.7)
6 or more	15.1	15.8	14.8	18.5	14.9	20.4	6.7	19.7	11.6	16.9
6	14.9 (2.8)	15.7 (2.7)	14.6 (2.7)	18.3 (5.2)	14.9 (4.6)	20.4 (6.7)	6.7 (4.5)	19.7 (7.1)	9.5 (5.5)	16.9 (3.5)
7	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
8	0.2 (0.2)	0.1 (0.1)	0.2 (0.2)	0.2 (0.2)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	2.1 (2.2)	0.0 (0.0)
Nonresponse	1.6	1.3	0.7	2.4	7.8	0.0	1.6	5.5	0.0	0.9
Total percentage	101	101	101	101	100	100	101	100	100	101
Sample size 5,448 (total)	2,648	2,800	4,004	742	472	185	590	717	665	3,476

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Percent of students in schools (with 12th grade) requiring science and mathematics courses, by sex, race and ethnicity, and community type: 1990, continued

Number of semesters required from grades 9 to 12	Sex		Race and ethnicity				Community type			
	Male	Female	White	Black	Hispanic	Asian/ Pacific Islander	Extreme rural	Disadvantaged urban	Advantaged urban	Other
Mathematics:										
1-3	12.2	13.9	11.8	14.0	14.4	34.8	8.3	7.0	5.1	16.1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
2	7.1	8.4	7.3	5.5	5.9	30.4	4.0	0.0	4.5	10.3
	(2.1)	(2.4)	(2.1)	(2.7)	(2.0)	(15.5)	(3.9)	(0.0)	(4.6)	(3.3)
3	5.1	5.5	4.5	8.5	8.5	4.4	4.3	7.0	0.6	5.8
	(1.5)	(1.7)	(1.4)	(2.8)	(3.6)	(2.4)	(2.6)	(5.8)	(0.8)	(2.0)
4-5	54.9	53.3	57.1	46.0	47.5	33.7	66.1	60.9	74.8	47.9
4	53.9	51.6	56.5	39.5	47.2	33.7	66.1	60.9	64.3	47.2
	(3.3)	(3.2)	(3.7)	(4.9)	(7.3)	(8.2)	(11.5)	(9.2)	(9.4)	(4.8)
5	1.0	1.7	0.6	6.5	0.3	0.0	0.0	0.0	10.5	0.7
	(0.6)	(1.0)	(0.5)	(4.3)	(0.3)	(0.0)	(0.0)	(0.0)	(7.1)	(0.7)
6 or more	32.8	32.8	31.2	40.0	38.1	31.5	25.6	32.2	20.1	36.0
6	32.1	32.2	30.4	39.8	37.9	30.2	25.6	32.2	12.7	36.0
	(3.4)	(3.5)	(3.8)	(4.8)	(7.6)	(10.2)	(10.1)	(8.3)	(5.0)	(4.6)
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
8	0.7	0.6	0.8	0.2	0.2	1.3	0.0	0.0	7.4	0.0
	(0.5)	(0.5)	(0.6)	(0.2)	(0.1)	(1.3)	(0.0)	(0.0)	(5.7)	(0.0)
Nonresponse	0.9	0.8	0.5	2.3	1.5	0.0	0.0	2.0	0.0	0.9
Total percentage	100	101	100	100	100	100	100	100	100	100
Sample size 5,493 (total)	2,675	2,818	4,014	743	506	185	604	748	665	3,476

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Appendix Table 2-3

Percent of science and mathematics classes with various instructional objectives emphasized by teachers, by grade range: 1985-86

Instructional objective	Grades: K-6	7-9	10-12
Science			
Become aware of the importance of science in daily life	68	68	59
Learn basic science concepts	67	85	86
Develop inquiry skills	55	62	57
Become interested in science	54	51	45
Develop a systematic approach to solving problems	48	63	67
Learn to effectively communicate ideas in science	45	46	47
Prepare for further study in science	42	52	56
Learn about applications of science in technology	27	40	39
Develop awareness of safety issues in lab	23	52	54
Learn about the career relevance of science	22	30	31
Develop skills in lab techniques	15	45	55
Learn about the history of science	9	12	12
Sample size	710	658	1,050
Mathematics			
Know mathematical facts. principles. algorithms. or procedures	81	80	71
Develop a systematic approach to solving problems	72	76	75
Perform computations with speed and accuracy	72	59	41
Become aware of the importance of mathematics in daily life	71	61	41
Prepare for further study in mathematics	60	67	61
Become interested in mathematics	60	40	31
Develop inquiry skills	51	50	51
Learn to effectively communicate ideas in mathematics	49	54	42
Learn about the applications of mathematics in technology	20	27	31
Learn about the career relevance of mathematics	15	28	29
Learn about the history of mathematics	4	5	5
Sample size	686	671	565

NOTE: Teachers were given a scale from 1 to 6 for each objective. with number 1 indicating no emphasis; number 2. minimal emphasis; number 4. moderate emphasis; number 5. heavy emphasis; and number 6. very heavy emphasis. The numbers in this table represent the total of those indicating only numbers 5 or 6.

SOURCE: I. R. Weiss. *Report of the 1985-86 National Survey of Science and Mathematics Education*. RTI/2938/00-FR (Research Triangle Park. NC: Research Triangle Institute. 1987). 44-45. tables 22 and 23.

Public school students' perceptions of parent attitudes toward science and mathematics, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990

Student characteristic	Sample size	Expect me to do well in science: 1987 grade 7	Expect me to do well in science: 1990 grade 10	Expect me to do well in mathematics: 1987 grade 7	Expect me to do well in mathematics: 1990 grade 10	Think that science is a very important subject: 1987 grade 7	Think that science is a very important subject: 1990 grade 10	Think that mathematics is a very important subject: 1987 grade 7	Think that mathematics is a very important subject: 1990 grade 10	Want me to learn about computers: 1987 grade 7	Want me to learn about computers: 1990 grade 10
		Percent of students reporting that parents--									
Cohort 2											
Total	1,760	60	62	70	67	49	48	69	60	30	32
		(1.4)	(1.5)	(1.7)	(1.6)	(1.1)	(1.1)	(1.6)	(1.4)	(0.7)	(0.8)
Sex											
Male	902	61	62	72	68	50	48	69	60	34	31
		(2.0)	(2.1)	(2.4)	(2.3)	(1.6)	(1.5)	(2.3)	(2.0)	(1.1)	(1.0)
Female	858	59	63	69	67	48	47	69	59	25	32
		(2.0)	(2.1)	(2.3)	(2.3)	(1.6)	(1.5)	(2.3)	(2.0)	(0.8)	(1.1)
Community type											
Urban	329	57	57	69	62	49	44	73	58	28	26
		(3.1)	(3.1)	(3.8)	(3.4)	(2.6)	(2.3)	(4.0)	(3.2)	(1.5)	(1.4)
Suburban	766	59	65	71	70	49	50	69	63	33	36
		(2.1)	(2.4)	(2.6)	(2.5)	(1.7)	(1.7)	(2.5)	(2.3)	(1.2)	(1.3)
Rural	665	64	62	70	66	49	47	66	57	27	30
		(2.5)	(2.4)	(2.7)	(2.5)	(1.9)	(1.8)	(2.5)	(2.2)	(1.0)	(1.1)
Parent's education											
Less than high school	114	59	46	68	55	36	40	59	48	27	27
		(5.5)	(4.3)	(6.3)	(5.1)	(3.2)	(3.6)	(5.5)	(4.5)	(2.5)	(2.5)
High school only	1,057	60	60	69	64	47	43	67	56	26	30
		(1.8)	(1.8)	(2.1)	(2.0)	(1.4)	(1.3)	(2.0)	(1.7)	(0.8)	(0.9)
B A. or more	547	63	71	74	75	56	58	75	69	38	38
		(2.7)	(3.0)	(3.1)	(3.2)	(2.4)	(2.4)	(3.2)	(2.9)	(1.6)	(1.6)

Continued

NOTE. Standard errors are presented in parentheses
SOURCE. Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University

Public school students' perceptions of parent attitudes toward science and mathematics, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990, continued

Student characteristic	Sample size	Expect me to do well in science: 1987 grade 10	Expect me to do well in science: 1989 grade 12	Expect me to do well in mathematics: 1987 grade 10	Expect me to do well in mathematics: 1989 grade 12	Think that science is a very important subject: 1987 grade 10	Think that science is a very important subject: 1989 grade 12	Think that mathematics is a very important subject: 1987 grade 10	Think that mathematics is a very important subject: 1989 grade 12	Want me to learn about computers: 1987 grade 10	Want me to learn about computers: 1989 grade 12
		Percent of students reporting that parents--									
Cohort 1											
Total	1,468	54 (1.4)	36 (0.9)	62 (1.6)	41 (1.1)	45 (1.1)	32 (0.8)	63 (1.6)	41 (1.1)	32 (0.8)	28 (0.7)
Sex											
Male	696	56 (2.1)	39 (1.5)	64 (2.4)	43 (1.6)	48 (1.7)	35 (1.3)	66 (2.5)	43 (1.6)	32 (1.2)	25 (0.9)
Female	771	52 (1.9)	33 (1.2)	60 (2.1)	39 (1.4)	42 (1.4)	28 (1.0)	60 (2.1)	38 (1.4)	32 (1.1)	30 (1.1)
Community type											
Urban	285	54 (3.2)	35 (2.0)	63 (3.7)	37 (2.2)	44 (2.4)	30 (1.7)	65 (3.8)	42 (2.5)	32 (1.9)	28 (1.6)
Suburban	694	52 (2.0)	37 (1.4)	62 (2.3)	44 (1.7)	45 (1.6)	34 (1.2)	62 (2.3)	43 (1.6)	32 (1.2)	26 (1.0)
Rural	489	56 (2.5)	35 (1.6)	62 (2.8)	38 (1.7)	46 (2.0)	30 (1.3)	62 (2.8)	37 (1.7)	31 (1.4)	30 (1.3)
Parent's education											
Less than high school	73	51 (5.9)	14 (1.6)	60 (7.0)	20 (2.3)	31 (3.4)	20 (2.2)	48 (5.6)	34 (3.9)	32 (3.7)	25 (2.9)
High school only	867	51 (1.7)	29 (1.0)	60 (2.0)	35 (1.2)	40 (1.3)	25 (0.8)	60 (2.0)	34 (1.1)	31 (1.0)	25 (0.8)
B.A. or more	520	59 (2.6)	50 (2.2)	67 (2.9)	54 (2.4)	55 (2.3)	45 (1.9)	69 (3.0)	52 (2.3)	34 (1.5)	33 (1.4)

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University

Percent of schools with selected science and mathematics course offerings, by grade range: 1977 and 1985-86

Course	Grades:	1977		1985-86		Change from 1977 to 1985-86	
		7-9	10-12	7-9	10-12	7-9	10-12
Science							
Life science		22	18	57	46	35	28
Earth science		28	37	57	52	29	15
Physical science		23	40	53	68	30	28
General science, grade 7		65	23	43	25	-22	2
General science, grade 8		57	26	41	26	-16	0
General science, grade 9		21	46	17	31	-4	-15
General science, grades 10-12		6	11	6	18	0	7
Biology, 1st year		30	95	41	99	11	4
Chemistry, 1st year		23	89	34	91	11	2
Physics, 1st year		22	78	32	81	10	3
Mathematics							
Mathematics, grade 7		82	34	79	46	-3	12
Mathematics, grade 8		78	36	74	45	-4	9
General mathematics, grade 9		36	59	33	64	-3	5
General mathematics, grades 10-12		12	42	17	46	5	4
Business mathematics		17	52	19	49	2	-3
Geometry		33	97	41	95	8	-2
Trigonometry		14	54	23	59	9	5
Probability/statistics		3	7	6	14	3	7
Calculus		7	31	14	31	7	0
Sample size		291	253	348	360	--	--

NOTE: In both the 1977 and 1985-86 surveys, grades 7-9 and 10-12 schools were defined as schools that contained at least one of those grades. The fact that many schools cut across those boundaries, e.g., grades 7-12 or 9-12, explains why 12 percent of grades 7-9 schools offer general mathematics for grades 10-12.

-- Not applicable.

SOURCE: I. R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), 21, table 5.

Percent of schools (with 12th grade) offering science, mathematics, and computer courses, by selected school characteristics: 1985-86

	Science							
School characteristic	Biology II	School sample size	Chemistry II	School sample size	Physics I	School sample size	Physics II	School sample size
Percent students participating in subsidized lunch program at school								
Total schools	58	339	29	329	86	344	13	318
0-19	61	226	34	220	90	229	16	210
20-39	55	65	20	64	84	67	11	64
40 or more	41	48	10	45	67	48	2	44
Percent non-Asian minority attendance								
Total schools	59	356	29	345	86	362	13	334
0-24	65	211	30	205	90	214	14	199
25-49	48	55	37	54	78	57	14	52
50-74	46	52	23	48	74	52	7	47
75-100	35	38	19	38	77	39	8	36

Continued

NOTE: Percentages are based on schools that responded to the four questions on school characteristics out of a total number of 412 schools included in the survey.
SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress.

Percent of schools (with 12th grade) offering science, mathematics, and computer courses, by selected school characteristics: 1985-86, continued

	Science							
School characteristic	Biology II	School sample size	Chemistry II	School sample size	Physics I	School sample size	Physics II	School sample size
Community type								
Total schools	59	360	29	349	86	366	13	338
Extreme rural	45	36	7	35	79	36	0	34
Disadvantaged urban	27	30	18	29	63	29	7	29
Advantaged urban	95	37	61	35	100	37	56	34
Big city	26	35	15	36	79	36	8	35
Urban fringe	59	43	41	43	80	43	10	43
Medium city	62	57	55	55	90	57	17	53
Small place	64	122	23	116	90	128	10	110
Student enrollment per grade								
Total schools	59	360	29	349	86	366	13	338
1-30	38	40	7	39	69	40	3	37
31-90	54	62	8	59	79	64	14	57
91-240	67	81	36	76	98	81	9	73
241 or more	75	177	64	175	98	181	28	171

Continued

NOTE: Percentages are based on schools that responded to the four questions on school characteristics out of a total number of 412 schools included in the survey.

SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress.

Indicators of Science and Mathematics Education 1992

Percent of schools (with 12th grade) offering science, mathematics, and computer courses, by selected school characteristics: 1985-86, continued

School characteristic	Mathematics: Algebra II	School sample size	Trigonometry	School sample size	Precalculus/ calculus	School sample size	Computer science: Computer literacy	School sample size	Computer programming	School sample size
Percent students participating in subsidized lunch program at school										
Total schools	96	347	87	341	71	334	91	340	77	333
0-19	99	232	91	228	76	222	93	227	82	223
20-39	93	67	79	65	77	64	89	65	73	64
40 or more	86	48	75	48	35	48	81	48	55	46
Percent non-Asian minority attendance										
Total schools	96	365	87	358	71	352	90	358	77	349
0-24	99	216	93	212	77	209	91	210	81	208
25-49	87	57	74	56	64	55	89	57	73	55
50-74	88	52	65	52	48	50	86	51	59	48
75-100	92	40	71	38	49	38	86	40	57	38

Continued

NOTE: Percentages are based on schools that responded to the four questions on school characteristics out of a total number of 412 schools included in the survey.
SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress.

Percent of schools (with 12th grade) offering science, mathematics, and computer courses, by selected school characteristics: 1985-86, continued

School characteristic	Mathematics: Algebra II	School sample size	Trigonometry	School sample size	Precalculus/ calculus	School sample size	Computer science: Computer literacy	School sample size	Computer programming	School sample size
Community type										
Total schools	96	369	87	362	70	356	90	362	76	353
Extreme rural	100	37	95	34	49	34	86	37	81	36
Disadvantaged urban	81	31	52	29	32	28	83	29	50	30
Advantaged urban	100	37	100	37	90	37	94	36	98	36
Big city	89	36	85	35	74	36	100	35	50	35
Urban fringe	95	43	82	43	70	43	97	42	90	43
Medium city	94	57	83	57	79	55	86	56	84	56
Small place	98	128	88	127	75	123	89	127	72	117
Student enrollment per grade										
Total schools	96	369	87	362	70	356	90	362	76	353
1-30	92	41	77	39	40	39	95	40	57	38
31-90	94	65	83	63	68	61	82	64	81	59
91-240	99	81	93	80	80	78	92	80	76	76
241 or more	100	182	95	180	91	178	93	178	90	180

NOTE: Percentages are based on schools that responded to the four questions on school characteristics out of a total number of 412 schools included in the survey.
SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress.

Indicators of Science and Mathematics Education 1992

Percent of students in schools (with 12th grade) offering selected science and mathematics courses, by sex, race and ethnicity, and community type: 1990

Course offered in school	Student sample size	Sex: Male Percent	Male Sample size	Female Percent	Female Sample size	Race and ethnicity: White Percent	White Sample size	Black Percent	Black Sample size	Hispanic Percent	Hispanic Sample size	Asian/Pacific Islander Percent	Asian/Pacific Islander Sample size
Science													
General science	5,285	60 (3.3)	2,577	56 (3.4)	2,708	61 (3.5)	3,907	56 (5.7)	689	43 (7.2)	462	26 (8.3)	183
Earth science	5,248	65 (3.8)	2,570	64 (4.3)	2,678	65 (4.1)	3,855	64 (6.1)	678	56 (7.4)	461	51 (11.6)	182
Physical science	5,238	79 (3.5)	2,527	78 (3.7)	2,711	78 (4.0)	3,804	76 (6.0)	718	86 (4.7)	490	83 (5.0)	183
Biology, 1st year	5,500	100 (0.0)	2,679	100 (0.0)	2,821	100 (0.0)	4,019	100 (0.0)	740	100 (0.0)	511	100 (0.0)	185
Chemistry, 1st year	5,500	99 (0.3)	2,679	99 (0.3)	2,821	99 (0.3)	4,019	99 (0.4)	740	98 (0.8)	511	99 (0.5)	185
Physics, 1st year	5,462	98 (0.7)	2,650	98 (0.6)	2,812	98 (0.8)	3,993	99 (0.4)	738	98 (0.8)	502	99 (0.5)	184
Biology, 2nd year	5,252	72 (3.4)	2,545	73 (3.2)	2,707	74 (3.7)	3,803	70 (4.9)	721	73 (6.2)	501	58 (15.5)	183
Chemistry, 2nd year	5,123	57 (3.7)	2,493	56 (3.6)	2,630	60 (3.8)	3,745	47 (6.2)	681	50 (7.1)	477	43 (12.7)	179
Physics, 2nd year	4,899	25 (3.4)	2,372	26 (3.9)	2,527	26 (4.0)	3,636	18 (4.3)	605	31 (7.3)	440	23 (8.9)	179

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Percent of students in schools (with 12th grade) offering selected science and mathematics courses, by sex, race and ethnicity, and community type: 1990, continued

Course offered in school	Type of community: Extreme rural		Disadvantaged urban		Advantaged urban		Other	
	Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size
Science								
General science	69 (9.9)	596	51 (10.8)	675	68 (8.9)	653	56 (4.7)	3,361
Earth science	60 (10.3)	592	67 (12.0)	657	60 (9.2)	665	65 (5.1)	3,334
Physical science	80 (9.6)	592	74 (10.4)	730	73 (9.3)	597	80 (4.2)	3,319
Biology, 1st year	100 (0.0)	604	100 (0.0)	748	100 (0.0)	665	100 (0.0)	3,483
Chemistry, 1st year	100 (0.0)	604	97 (1.5)	748	100 (0.0)	665	100 (0.0)	3,483
Physics, 1st year	98 (1.7)	604	97 (1.5)	748	99 (0.8)	650	98 (0.9)	3,460
Biology, 2nd year	65 (8.6)	596	47 (10.7)	748	78 (7.6)	653	78 (4.1)	3,255
Chemistry, 2nd year	36 (13.9)	558	52 (13.0)	701	75 (10.2)	653	59 (4.6)	3,211
Physics, 2nd year	7 (7.2)	511	6 (4.6)	628	57 (10.7)	653	27 (4.9)	3,107

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Percent of students in schools (with 12th grade) offering selected science and mathematics courses, by sex, race and ethnicity, and community type: 1990, continued

Course offered in school	Student sample size	Sex: Male Percent	Male Sample size	Female Percent	Female Sample size	Race and ethnicity: White Percent	White Sample size	Black Percent	Black Sample size	Hispanic Percent	Hispanic Sample size	Asian/Pacific Islander Percent	Asian/Pacific Islander Sample size
Mathematics													
General mathematics	5,358	84 (2.8)	2,609	83 (2.8)	2,749	86 (2.5)	3,969	74 (5.1)	687	69 (9.5)	472	80 (5.2)	185
Business/consumer mathematics	5,505	78 (3.9)	2,676	78 (3.6)	2,829	76 (4.3)	4,018	88 (3.6)	747	76 (6.6)	511	78 (5.7)	184
Remedial mathematics	5,465	78 (3.1)	2,655	77 (3.7)	2,810	77 (3.7)	3,987	79 (4.2)	737	78 (5.5)	511	79 (5.5)	185
Algebra, introductory	5,505	88 (2.7)	2,676	87 (2.7)	2,829	87 (3.0)	4,018	89 (2.9)	747	85 (4.4)	511	89 (3.7)	184
Algebra, 1st year	5,531	100 (0.0)	2,692	100 (0.0)	2,839	100 (0.0)	4,042	100 (0.0)	748	100 (0.0)	511	100 (0.0)	185
Algebra, 2nd year	5,531	97 (1.2)	2,692	97 (1.1)	2,839	97 (1.3)	4,042	95 (2.2)	748	99 (0.5)	511	99 (0.5)	185
Geometry	5,531	100 (0.3)	2,692	100 (0.2)	2,839	100 (0.3)	4,042	100 (0.0)	748	100 (0.0)	511	100 (0.0)	185
Trigonometry	5,449	95 (1.5)	2,655	95 (1.3)	2,794	96 (1.4)	3,979	94 (2.0)	747	90 (4.0)	502	98 (1.3)	181
Probability/statistics	4,970	31 (3.7)	2,414	31 (3.7)	2,556	32 (3.8)	3,684	28 (5.5)	641	31 (7.5)	432	33 (12.4)	178
Precalculus	5,268	74 (3.4)	2,561	74 (3.2)	2,707	75 (3.5)	3,882	73 (5.5)	707	76 (5.1)	455	66 (13.7)	184
Calculus	5,318	79 (3.1)	2,587	78 (2.9)	2,731	77 (3.5)	3,928	82 (4.1)	680	85 (3.8)	485	87 (7.3)	183
Both precalculus and calculus	5,443	57 (3.9)	2,653	58 (3.9)	2,790	57 (4.3)	4,004	60 (5.9)	715	63 (5.6)	497	63 (13.0)	184

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress

Percent of students in schools (with 12th grade) offering selected science and mathematics courses, by sex, race and ethnicity, and community type: 1990, continued

Course offered in school	Type of community: Extreme rural		Disadvantaged urban		Advantaged urban		Other	
	Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size
Mathematics								
General mathematics	86 (6.5)	589	72 (12.1)	675	78 (7.4)	665	86 (2.9)	3,429
Business/consumer mathematics	65 (16.1)	596	83 (8.6)	748	57 (9.5)	665	82 (3.6)	3,496
Remedial mathematics	91 (5.3)	604	82 (8.9)	748	58 (11.2)	648	77 (3.9)	3,465
Algebra, introductory	89 (5.8)	596	68 (11.7)	748	97 (2.7)	665	89 (2.5)	3,496
Algebra, 1st year	100 (0.0)	604	100 (0.0)	748	100 (0.0)	665	100 (0.0)	3,514
Algebra, 2nd year	100 (0.0)	604	94 (3.9)	748	100 (0.0)	665	97 (1.6)	3,514
Geometry	100 (0.0)	604	100 (0.0)	748	100 (0.0)	665	100 (0.4)	3,514
Trigonometry	88 (3.9)	596	95 (2.7)	748	99 (0.9)	641	96 (1.8)	3,464
Probability/statistics	19 (9.3)	558	47 (14.1)	657	43 (11.8)	612	29 (4.4)	3,143
Precalculus	57 (10.2)	566	63 (12.1)	699	84 (9.0)	648	78 (3.4)	3,355
Calculus	56 (10.0)	578	90 (6.8)	730	93 (3.7)	665	79 (4.4)	3,345
Both precalculus and calculus	33 (13.1)	578	58 (11.1)	730	78 (8.9)	665	59 (5.4)	3,470

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Appendix Table 2-8

Percent of students with different levels of availability of mathematics instructional materials for teachers, by grade and community type, as reported by teachers of grades 4 and 8: 1990

Grade and community type	Total	All the resources available	Most of the resources available	Some or none of the resources available
Grade 4, Total		13 (1.5)	49 (1.8)	38 (2.0)
Advantaged urban	100	22 (5.0)	63 (6.1)	15 (4.5)
Disadvantaged urban	100	13 (3.7)	39 (4.8)	48 (5.2)
Extreme rural	100	14 (5.1)	42 (8.0)	44 (6.9)
Other	100	11 (1.7)	50 (2.5)	39 (2.8)
Grade 8, Total		19 (2.4)	53 (2.9)	28 (2.8)
Advantaged urban	100	44 (11.2)	46 (8.8)	10 (4.2)
Disadvantaged urban	100	8 (3.8)	52 (7.0)	40 (7.6)
Extreme rural	100	12 (6.5)	57 (10.1)	31 (8.6)
Other	100	17 (2.6)	54 (3.7)	29 (3.7)

NOTE: Standard errors are presented in parentheses.

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.* Report No. 21-ST-04 (Washington, DC: U.S Department of Education, 1991), 169, table 6.9.

Percent of 12th-grade students in schools with different levels of facility availability, by sex, race and ethnicity, and community type: 1990

School facilities	Student sample size	Sex				Race and ethnicity							
		Male		Female		White		Black		Hispanic		Asian/Pacific Islander	
		Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size
Science laboratories:													
in 1 or more classrooms	5,435	95 (1.5)	2,636	94 (1.6)	2,799	95 (1.4)	3,973	91 (3.9)	733	92 (2.9)	499	96 (1.8)	185
1 or more general science labs	5,275	82 (3.3)	2,573	81 (3.5)	2,702	83 (3.9)	3,853	79 (5.9)	723	79 (5.0)	473	82 (6.6)	182
1 or more specialized science labs	5,458	93 (1.5)	2,656	93 (1.3)	2,802	93 (1.6)	3,976	94 (1.9)	746	95 (1.6)	508	92 (3.0)	184
Computers for mathematics class:													
always available in room	5,443	10 (2.6)	2,650	11 (2.8)	2,793	11 (2.9)	4,016	9 (3.2)	702	10 (3.6)	508	16 (6.7)	172
always available in computer lab	5,445	78 (4.0)	2,644	79 (3.8)	2,801	79 (4.3)	3,995	82 (5.7)	730	74 (6.7)	503	79 (7.6)	172
brought to class when needed	5,415	65 (3.9)	2,634	64 (3.7)	2,781	65 (4.2)	4,005	65 (5.1)	692	57 (7.2)	500	68 (9.0)	173

Continued

NOTE: Standard errors are presented in parentheses.

SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress

Percent of 12th-grade students in schools with different levels of facility availability, by sex, race and ethnicity, and community type: 1990, continued

	Type of community							
	Extreme rural		Disadvantaged urban		Advantaged urban		Other	
School facilities	Percent	Sample size	Percent	Sample size	Percent	Sample size	Percent	Sample size
Science laboratories:								
in 1 or more classrooms	90 (5.9)	590	94 (2.9)	748	84 (9.0)	665	97 (1.4)	3,432
1 or more general science labs	78 (14.4)	581	77 (7.2)	715	85 (6.8)	665	83 (4.2)	3,314
1 or more specialized science labs	90 (5.4)	595	94 (2.6)	748	96 (3.0)	650	93 (1.7)	3,465
Computers for mathematics class:								
always available in room	6 (2.8)	604	9 (6.7)	706	21 (11.1)	648	10 (3.3)	3,485
always available in computer lab	73 (11.5)	590	91 (5.4)	748	91 (4.6)	665	76 (4.6)	3,442
brought to class when needed	62 (10.6)	590	44 (11.0)	706	68 (10.9)	648	68 (4.4)	3,471

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress

Science and mathematics classroom organization, teaching resources, and usage, for 13-year-old students, by country, ranked by achievement: 1990-91

Country	Percent of schools where science classes are based on ability	Percent of schools with no science laboratories	Percent of schools with general or specialized science laboratories in one or more classrooms
Science			
South Korea	1 (0.6)	0 (0.0)	87 (7.4)
Taiwan	57 (7.4)	1 (1.0)	99 (1.1)
Switzerland	17 (7.3)	45 (8.8)	48 (8.3)
Hungary	0 (0.0)	32 (5.5)	34 (3.8)
Soviet Union	13 (3.0)	3 (2.1)	94 (3.1)
Slovenia	0 (0.0)	7 (3.8)	50 (5.5)
Israel	14 (3.5)	7 (4.1)	76 (5.6)
Canada	5 (0.8)	25 (3.1)	62 (2.9)
France	11 (3.8)	4 (2.6)	93 (3.5)
Scotland	3 (2.4)	0 (0.0)	100 (0.0)
Spain	0 (0.0)	16 (4.4)	69 (5.9)
United States	29 (***)	14 (5.2)	76 (6.8)
Ireland	38 (5.1)	23 (5.9)	77 (5.9)
Jordan	10 (3.8)	22 (6.5)	65 (7.2)

Continued

NOTES: Jackknifed standard errors are presented in parentheses. Four out of the 14 reporting nations had limited participation of schools and students in the sampling frame. These are Switzerland (14 out of 15 cantons. 76 percent of the age-eligible students participating), the Soviet Union (Russian-speaking schools in 14 out of 15 republics, 60 percent), Israel (Hebrew-speaking schools, 71 percent), and Spain (Spanish-speaking schools except in Cataluna, 80 percent).

*** Jackknifed standard errors are greater than 9.9.

SOURCES: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 57, 59; A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 56, 58

Science and mathematics classroom organization, teaching resources, and usage, for 13-year-old students, by country, ranked by achievement: 1990-91, continued

Country	Percent of schools where mathematics classes are based on ability	Percent of students who ever use calculators in school	Percent of students who use computers for schoolwork or homework
Mathematics			
South Korea	0 (0.0)	4 (0.5)	10 (0.8)
Taiwan	63 (7.6)	62 (1.0)	6 (0.7)
Switzerland	18 (7.3)	51 (3.1)	25 (1.2)
Soviet Union	18 (3.0)	19 (2.1)	6 (0.8)
Hungary	0 (0.0)	71 (1.6)	31 (1.5)
France	27 (7.3)	94 (0.5)	57 (1.4)
Israel	74 (7.2)	49 (2.3)	59 (1.7)
Canada	10 (1.3)	75 (1.3)	42 (1.1)
Scotland	16 (4.1)	82 (1.2)	38 (1.5)
Ireland	67 (6.1)	25 (2.2)	13 (1.3)
Slovenia	2 (1.6)	46 (2.5)	61 (1.3)
Spain	3 (1.8)	45 (2.8)	12 (1.1)
United States	56 (***)	54 (3.5)	37 (1.7)
Jordan	5 (2.6)	5 (0.8)	5 (0.6)

NOTES: Jackknifed standard errors are presented in parentheses. Four out of the 14 reporting nations had limited participation of schools and students in the sampling frame. These are Switzerland (14 out of 15 cantons, 76 percent of the age-eligible students participating), the Soviet Union (Russian-speaking schools in 14 out of 15 republics, 60 percent), Israel (Hebrew-speaking schools, 71 percent), and Spain (Spanish-speaking schools except in Cataluna, 80 percent).

*** Jackknifed standard errors are greater than 9.9.

SOURCES: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 57, 59; A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 56, 58.

Appendix Table 2-11

Average home science resources of public school students, by sex, community type, and parent's education, grades 7 and 10: 1987

Student characteristic	Grade 7		Grade 10	
	Average	Sample size	Average	Sample size
Total	3.08 (.03)	2,844	3.03 (.03)	2,392
Sex				
Male	3.26 (.05)	1,471	3.15 (.05)	1,141
Female	2.90 (.04)	1,373	2.93 (.04)	1,248
Community type				
Urban	2.54 (.07)	617	2.78 (.07)	474
Suburban	3.44 (.05)	1,248	3.20 (.05)	1,110
Rural	2.99 (.05)	979	2.94 (.05)	809
Parent's education				
Less than high school	2.08 (.10)	203	2.09 (.11)	156
High school	2.95 (.04)	1,596	2.87 (.04)	1,457
B.A. or more	3.69 (.06)	767	3.55 (.05)	756

NOTE: Standard errors are presented in parentheses. A home science resource scale is created by counting the number of science and mathematics resources the students report having in their homes. Six resources are included (a computer, an atlas or globe, a pocket calculator, more than 50 books, a microscope, and a telescope); therefore, the range of the resource scale is 0 to 6.

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-12

Percent of science and mathematics classes using lecture, discussion, and hands-on activities in most recent lesson, by subject and grade range: 1977 and 1985

	1977				1985				Change from 1977 to 1985			
Classroom activity Grades:	K-3	4-6	7-9	10-12	K-3	4-6	7-9	10-12	K-3	4-6	7-9	10-12
Science												
Lecture	60	69	72	76	71	79	82	84	11	10	10	8
Discussion	87	90	82	77	88	86	82	80	1	4	0	3
Hands-on	67	54	59	53	57	45	43	39	-10	-9	-18	-14
Sample size	287	271	535	586	431	273	658	1.050	--	--	--	--
Mathematics												
Lecture	58	68	83	89	65	82	89	89	7	14	6	0
Discussion	88	89	83	91	81	92	90	86	-7	3	7	-5
Hands-on	58	38	23	24	63	31	20	12	5	-7	-3	-12
Sample size	297	277	550	548	433	246	671	565	--	--	--	--

-- Not applicable.

SOURCE: I. R. Weiss. Report of the 1985-86 National Survey of Science and Mathematics Education. RTI/2938/00-FR (Research Triangle Park: Research Triangle Institute. 1987). 49. table 25.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-13

Percent of high school graduates completing selected science and mathematics courses, by sex, and race and ethnicity: 1982 and 1987

Course	1982 Male	1982 Female	1987 Male	1987 Female	Change from 1982 to 1987 Male	Change from 1982 to 1987 Female
Science						
Never taken biology	27	23	13	10	-14 (1.4)	-13 (1.1)
Never taken chemistry	68	70	54	56	-14 (1.7)	-14 (1.5)
Never taken physics	82	90	75	85	-7 (1.4)	-5 (1.0)
Taken biology and chemistry	28	28	44	42	16 (1.7)	14 (1.5)
Taken biology, chemistry, and physics	13	8	21	13	8 (1.3)	5 (1.0)
Mathematics						
Never taken algebra	37	33	25	23	-12 (1.8)	-10 (1.4)
Never taken geometry	55	54	39	38	-16 (2.0)	-16 (1.6)
Never taken trigonometry	87	89	80	82	-7 (1.5)	-7 (1.1)
Never taken calculus	95	96	92	95	-3 (1.0)	-1 (0.7)
Taken algebra I and II	27	26	37	40	10 (1.9)	14 (1.5)
Taken algebra II and geometry	28	27	42	43	14 (1.9)	16 (1.5)
Taken algebra II, geometry, and trigonometry	8	6	15	14	7 (1.3)	8 (1.0)
Taken algebra II, geometry, trigonometry, and calculus	1	1	3	2	2 (0.6)	1 (0.4)

Continued

NOTE: Standard errors are presented in parentheses.

SOURCE: J. Thorne, *High School Transcript Analysis: The 1987 Graduates* (Washington, DC: U.S. Department of Education, 1988), 111, 113, 125, 127, tables 33, 34, 41, 42.

Percent of high school graduates completing selected science and mathematics courses, by sex, and race and ethnicity: 1982 and 1987, continued

Course	1982 White	1982 Black	1982 Hispanic	1982 Asian	1987 White	1987 Black	1987 Hispanic	1987 Asian	Change from 1982 to 1987 White	Change Black	Change Hispanic	Change Asian
Science												
Never taken biology	23	29	33	18	11	14	15	8	-12 (1.0)	-15 (2.0)	-18 (1.8)	-10 (3.6)
Never taken chemistry	66	79	85	49	52	70	71	30	-14 (1.5)	-9 (2.2)	-14 (1.8)	-19 (5.3)
Never taken physics	84	93	94	66	79	90	90	53	-5 (1.4)	-3 (1.4)	-4 (1.2)	-13 (5.4)
Taken biology and chemistry	31	18	14	47	46	29	28	66	15 (1.5)	11 (2.1)	14 (1.8)	19 (5.4)
Taken biology, chemistry, and physics	12	5	4	27	18	9	8	42	6 (1.1)	4 (1.3)	4 (1.1)	15 (5.6)
Mathematics												
Never taken algebra	32	42	45	34	22	29	27	31	-10 (1.6)	-13 (2.1)	-18 (2.1)	-3 (4.0)
Never taken geometry	49	71	74	36	35	56	60	19	-14 (1.8)	-15 (2.1)	-14 (2.1)	-17 (3.7)
Never taken trigonometry	86	94	94	72	79	89	90	58	-7 (1.5)	-5 (1.2)	-4 (1.2)	-14 (4.0)
Never taken calculus	94	99	98	87	94	98	96	70	0 (0.8)	-1 (0.5)	-2 (0.7)	-17 (3.4)
Taken algebra I and II	29	20	16	35	43	28	26	45	14 (1.8)	8 (1.8)	10 (1.8)	10 (4.2)
Taken algebra II and geometry	31	16	13	42	47	29	24	62	16 (1.8)	13 (1.8)	11 (1.7)	20 (4.3)
Taken algebra II, geometry, and trigonometry	8	3	4	15	17	8	7	31	9 (1.3)	5 (0.9)	3 (1.0)	16 (3.5)
Taken algebra II, geometry, trigonometry, and calculus	1	0	1	3	2	1	2	15	1 (0.5)	1 (0.3)	1 (0.5)	12 (2.3)

NOTE: Standard errors are presented in parentheses

SOURCE: J. Thorne, *High School Transcript Analysis: The 1987 Graduates* (Washington, DC: U.S. Department of Education, 1988), 111, 113, 125, 127, tables 33, 34, 41, 42.

Appendix Table 2-14

Percent of 12th-grade students taking science, mathematics, and computer courses through grade 11, by selected school characteristics: 1985-86

School characteristic	Science			Mathematics				Computer		Weighted frequency (in thousands)
	Biology I	Chemistry I	Physics I	Algebra II	Geometry	Trigonometry	Calculus	Computer literacy	Computer programming	
Percent of students participating in subsidized lunch program at school										
0-19	89	44	10	52	66	21	7	24	32	2,085
20-39	86	33	13	43	52	14	4	21	28	432
40 or more	87	35	11	38	47	11	3	15	22	199
Total students	89	42	11	50	62	19	6	23	30	2,717
Percent of non-Asian minority attendance										
0-24	88	44	11	52	66	21	7	25	31	2,200
25-49	90	40	11	47	57	17	5	21	30	436
50-74	85	32	12	39	50	14	5	20	28	311
75-100	90	38	13	38	48	10	3	19	29	215
Total students	88	42	11	49	62	19	6	23	30	3.162

Continued

SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress

Percent of 12th-grade students taking science, mathematics, and computer courses through grade 11, by selected school characteristics: 1985-86, continued

	Science			Mathematics				Computer		Weighted
School characteristic	Biology I	Chemistry I	Physics I	Algebra II	Geometry	Trigonometry	Calculus	Computer literacy	Computer programming	frequency (in thousands)
Community type										
Extreme rural	92	29	9	42	49	7	2	25	32	140
Disadvantaged urban	83	33	16	35	43	14	3	19	29	169
Advantaged urban	93	58	17	65	81	37	14	31	34	437
Big city	90	38	13	44	59	15	4	19	28	256
Urban fringe	89	45	11	49	66	16	5	23	33	497
Medium city	88	43	8	52	63	19	5	22	32	503
Small place	87	38	9	46	58	16	5	23	28	1,187
Total students	89	42	11	49	62	19	6	23	31	3,188
Student enrollment per grade										
1-30	91	32	15	42	57	5	2	26	NA	105
31-90	91	39	13	53	62	18	9	35	NA	370
91-240	88	45	10	52	65	21	6	23	NA	892
241 or more	88	41	11	47	61	19	6	21	NA	1,821
Total students	89	42	11	49	62	19	6	23	NA	3,188

NA Not available.
SOURCE: RAND special tabulations of the 1985-86 National Assessment of Educational Progress.

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Appendix Table 2-15

Percent of 8th- and 12th-grade students assigned to science and mathematics classes by ability, by sex, race and ethnicity, and community type: 1990

	Sex		Race and ethnicity				Type of community			
Subject	Male	Female	White	Black	Hispanic	Asian/ Pacific Islander	Extreme rural	Disadvantaged urban	Advantaged urban	Other
Grade 8										
Science	31 (4.0)	30 (4.0)	29 (4.2)	35 (8.3)	30 (4.4)	41 (9.5)	16 (8.4)	40 (11.1)	36 (16.9)	30 (4.4)
Sample size (5,659 total)	2,799	2,860	3,781	773	769	227	536	712	746	3,665
Mathematics	77 (3.8)	78 (3.5)	77 (4.2)	79 (6.6)	77 (3.4)	82 (6.0)	72 (10.3)	81 (7.1)	71 (21.7)	79 (3.7)
Sample size (5,720 total)	2,827	2,893	3,817	776	784	234	536	712	769	3,703
Grade 12										
Science	74 (3.5)	73 (3.9)	72 (4.3)	74 (4.9)	81 (5.8)	78 (8.1)	60 (9.4)	71 (11.9)	69 (11.3)	77 (4.1)
Sample size (5,463 total)	2,660	2,803	3,977	746	510	185	589	748	650	3,476
Mathematics	80 (3.0)	79 (3.6)	78 (3.9)	80 (4.6)	87 (4.5)	84 (7.3)	64 (8.9)	88 (7.9)	75 (10.8)	81 (4.3)
Sample size (5,463 total)	2,660	2,803	3,977	746	510	185	589	748	650	3,476

NOTE: Standard errors are presented in parentheses.
SOURCE: Almanac tabulations of data from the 1990 National Assessment of Educational Progress.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-16

Percent of 8th-grade students with science and mathematics subjects covered as major topics, as reported by teachers: 1988

Subject	Percent	Sample size	Subject	Percent	Sample size
Science			**Mathematics**		
Earth science	57.2 (2.3)	10.625	Ratios and percents	78.1 (1.2)	8,982
Weather/astronomy	54.8 (2.2)	10.631	Problem solving	72.7 (1.6)	9,159
Environmental science/oceanography	47.9 (2.0)	10.628	Integers	69.3 (1.5)	8.981
Chemistry	46.1 (2.2)	10.586	Fractions (common and decimals)	67.7 (1.5)	8,988
Various physics subjects /1	41.3 (2.2)	10.630	Algebra	59.8 (1.6)	8.978
Atomic theory	41.6 (2.1)	10.617	Geometry	50.7 (1.8)	8.984
Science in society	21.8 (1.7)	10.611	Measurement	36.9 (1.7)	8.983
Human biology/genetics	18.6 (2.0)	10.620	Probability and statistics	19.8 (1.5)	8,945
Plants/animals	15.7 (1.8)	10.633			
Personal health	9.2 (1.3)	10.526			

NOTE: Standard errors are presented in parentheses.

1/ Electricity, mechanics, and heat or optics.

SOURCE: National Center for Education Statistics, *A Profile of American Eighth-Grade Mathematics and Science Instruction* (NELS:88) NCES 92-486 (Washington, DC: U.S. Department of Education, 1992), 11, 16, 75, 78, tables 2.4, 2.7.

Percent of students in classes with different degrees of mathematics topic emphasis, by grade and topic: 1990

Topic	Teachers reported their emphasis on each topic was-- /1					
	Heavy		Moderate		Little or none	
	Grade 4	Grade 8	Grade 4	Grade 8	Grade 4	Grade 8
Numbers and operations	42	51	33	35	25	14
	(2.1)	(2.7)	(2.2)	(2.4)	(2.1)	(1.3)
Algebra and functions	8	50	8	33	84	17
	(- -)	(2.1)	(- -)	(2.1)	(2.4)	(1.8)
Geometry	8	27	53	49	39	23
	(1.1)	(2.2)	(2.6)	(2.5)	(2.6)	(2.4)
Measurement	18	17	67	50	15	33
	(2.0)	(1.7)	(2.3)	(2.6)	(2.0)	(2.5)
Data analysis, statistics, and probability	11	14	29	30	59	56
	(1.3)	(1.7)	(2.5)	(2.2)	(2.4)	(2.8)

NOTE: Standard errors are presented in parentheses.
- - Not applicable.
1/ Based on teachers' estimations of their instructional emphasis placed on the five content areas covered by the NAEP assessment.
SOURCE: National Center for Education Statistics. *The State of Mathematics Achievement: NAEP's 1990 Asessment of the Nation and the Trial Assessment of the States.* Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 191-96, tables 8.4-8.8.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-18

Percent of class time devoted to various mathematics topics for grades 8 and 12, as reported by teachers, by country: 1982

Country	Fractions	Ratio/ proportions	Algebra	Measurement	Geometry	Statistics
Grade 8						
Belgium (Flemish)	15	3	10	1	26	0
Canada (British Columbia)	16	14	25	7	15	3
France	21	4	16	2	33	0
Japan	2	4	37	2	18	1
United States	18	14	20	7	8	3

Country	Set functions. complex numbers	Algebra	Geometry	Calculus	Finite math. computer science	Probability statistics
Grade 12						
Belgium (Flemish)	20	16	19	37	15	10
Canada (British Columbia)	18	42	14	3	1	0
Hungary	10	14	17	22	3	0
Japan	16	10	6	56	9	11
New Zealand	22	14	8	34	4	0
United States	18	16	6	24	5	3

SOURCE. C. C. McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, IL: Stipes Publishing Co., 1987), 94-95.

Percent of students using calculators in mathematics class, as reported by students, by grade: 1990

Grade	Total	At least several times a week	Weekly or less	Never
Grade 4	100	9	29	62
		(0.7)	(1.5)	(1.9)
C ıde 8	100	30	31	39
		(1.9)	(1.1)	(2.3)
Grade 12 - all students	102	58	20	24
		(1.2)	(0.9)	(1.1)
Grade 12 - taking math	100	70	16	14
		(1.1)	(0.9)	(0.9)

NOTES: Standard errors are presented in parentheses. Percents may not total 100 because of rounding.
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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 175, table 7.7.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-20

Percent of students using computers in mathematics class, by grade, ability level, and time spent: 1990

Grade and ability level of mathematics class	Total	At least once a week	Less than once a week	Never
Reported by students				
Grade 4	100	38 (1.3)	12 (0.8)	50 (1.3)
Grade 8	100	16 (0.8)	15 (1.1)	69 (1.3)
Grade 12 - all students	100	20 (0.7)	14 (0.8)	66 (1.1)
Grade 12 - taking math	100	18 (0.9)	16 (1.1)	66 (1.4)
Reported by teachers				
Grade 4	100	49 (2.2)	25 (2.1)	26 (1.5)
High ability	100	50 (7.5)	29 (6.3)	21 (5.5)
Average ability	100	47 (3.7)	31 (3.4)	22 (2.9)
Low ability	101	53 (5.4)	17 (4.7)	31 (5.0)
Mixed ability	101	51 (3.5)	25 (2.9)	25 (3.5)
Grade 8	100	13 (2.4)	35 (3.4)	52 (2.8)
High ability	100	11 (3.0)	39 (4.4)	50 (4.5)
Average ability	100	7 (2.1)	38 (4.0)	55 (3.5)
Low ability	101	17 (3.4)	30 (5.0)	54 (5.2)
Mixed ability	101	21 (7.8)	33 (7.7)	47 (5.5)

Grade	Total	Time spent weekly		
		None	15 minutes	30 minutes or more
Reported by teachers				
Grade 4	101	31 (2.3)	29 (2.5)	41 (2.7)
Grade 8	100	73 (2.6)	15 (2.2)	12 (2.1)

NOTES: Standard errors are presented in parentheses. Percents may not total 100 because of rounding.

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*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 182-83, tables 7.12-14.

Percent of public school students engaged in selected out-of-school educational activities, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990

Student characteristic	Ever visited a science museum		Visited a science museum, natural history museum, or planetarium in the school year			Used a computer 10 hours or more (other than in class) in the school year		Read a newspaper at least three times a week in the school year		
	Student sample size	1987 grade 7	Student sample size	1987 grade 7	1990 grade 10	1987 grade 7	1990 grade 10	Student sample size	1987 grade 7	1990 grade 10
Cohort 2										
Total	3,114	61 (1.1)	1,711	35 (0.8)	20 (0.5)	29 (0.7)	19 (0.5)	1,823	38 (0.9)	48 (1.1)
Sex										
Male	1,635	62 (1.5)	876	36 (1.2)	19 (0.6)	37 (1.2)	24 (0.8)	925	39 (1.3)	46 (1.5)
Female	1,479	61 (1.6)	834	34 (1.2)	21 (0.7)	20 (0.7)	13 (0.4)	899	37 (1.2)	49 (1.6)
Community type										
Urban	701	66 (2.5)	316	33 (1.8)	15 (0.8)	24 (1.3)	16 (0.9)	344	35 (1.9)	45 (2.4)
Suburban	1,379	67 (1.8)	744	37 (1.3)	25 (0.9)	34 (1.2)	24 (0.9)	813	36 (1.2)	48 (1.7)
Rural	1,035	50 (1.5)	651	33 (1.3)	18 (0.7)	25 (1.0)	14 (0.5)	667	41 (1.6)	48 (1.8)
Parent's education										
Less than high school	222	48 (3.2)	107	23 (2.2)	12 (1.1)	14 (1.3)	20 (1.9)	108	24 (2.3)	34 (3.2)
High school	1,719	60 (1.4)	1,024	32 (1.0)	17 (0.5)	26 (0.8)	15 (0.5)	1,096	36 (1.1)	48 (1.4)
B.A or more	810	70 (2.4)	537	43 (1.8)	29 (1.2)	37 (1.6)	26 (1.1)	575	44 (1.8)	51 (2.1)

Continued

NOTE: Standard errors are presented in parentheses

SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

ercent of public school students engaged in selected out-of-school educational activities, by sex, community type, nd parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990, continued

tudent characteristic	Ever visited a science museum		Visited a science museum, natural history museum, or planetarium in the school year			Used a computer 10 hours or more (other than in class) in the school year		Read a newspaper at least three times a week in the school year		
	Student sample size	1987 grade 10	Student sample size	1987 grade 10	1989 grade 12	1987 grade 10	1989 grade 12	Student sample size	1987 grade 10	1989 grade 12
ohort 1										
Total	2,823	62 (1.2)	1,389	23 (0.6)	25 (0.7)	21 (0.6)	24 (0.6)	1,734	50 (1.2)	59 (1.4)
Sex										
Male	1,389	65 (1.7)	646	24 (0.9)	25 (1.0)	28 (1.1)	27 (1.0)	947	53 (1.9)	58 (2.1)
Female	1,431	59 (1.6)	742	21 (0.8)	26 (0.9)	14 (0.5)	22 (0.8)	784	47 (1.5)	59 (1.9)
Community type										
Urban	634	68 (2.7)	251	22 (1.4)	22 (1.4)	22 (1.4)	23 (1.4)	328	49 (2.7)	61 (3.3)
Suburban	1,252	67 (1.9)	684	26 (1.0)	26 (1.0)	21 (0.8)	25 (0.9)	820	45 (1.6)	52 (1.8)
Rural	938	50 (1.6)	455	18 (0.9)	27 (1.2)	20 (0.9)	23 (1.1)	587	57 (2.3)	67 (2.7)
Parent's education										
Less than high school	209	48 (3.3)	68	8 (0.9)	17 (2.0)	16 (1.9)	18 (2.1)	91	49 (5.1)	57 (5.9)
High school	1,687	57 (1.4)	820	19 (0.7)	21 (0.7)	18 (0.6)	21 (0.7)	1,050	48 (1.5)	60 (1.8)
B.A. or more	888	75 (2.5)	494	31 (1.4)	33 (1.5)	25 (1.1)	30 (1.3)	587	53 (2.2)	59 (2.4)

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Percent of public school students who report watching various science and mathematics television programs, by sex, community type, and parent's education, grades 8 and 11: 1988

Student characteristic	NOVA				National Geographic Specials				3-2-1 Contact			
	Often	Sometimes	Never	Sample size	Often	Sometimes	Never	Sample size	Often	Sometimes	Never	Sample size
Grade 8												
Total	9 (0.2)	28 (0.5)	63 (1.2)	2,585	15 (0.3)	44 (0.9)	40 (0.8)	2,570	6 (0.1)	24 (0.5)	70 (1.4)	2,412
Sex												
Male	13 (0.3)	33 (0.9)	54 (1.5)	1,343	20 (0.5)	50 (1.4)	30 (0.8)	1,330	8 (0.2)	25 (0.7)	67 (1.9)	1,243
Female	4 (0.1)	22 (0.6)	73 (2.1)	1,242	10 (0.3)	39 (1.1)	51 (1.4)	1,240	5 (0.1)	22 (0.6)	73 (2.1)	1,169
Community type												
Urban	10 (0.4)	28 (1.2)	62 (2.6)	554	14 (0.6)	41 (1.7)	45 (1.9)	555	8 (0.3)	24 (1.1)	68 (3.0)	500
Suburban	8 (0.2)	27 (0.8)	65 (1.9)	1,144	14 (0.4)	46 (1.4)	40 (1.2)	1,140	4 (0.1)	22 (0.7)	73 (2.2)	1,073
Rural	10 (0.3)	28 (0.9)	62 (2.1)	887	17 (0.6)	45 (1.5)	38 (1.3)	875	8 (0.3)	25 (0.9)	67 (2.3)	839
Parent's education												
Less than high school	12 (0.8)	30 (2.1)	58 (4.1)	200	21 (1.5)	46 (3.2)	33 (2.3)	198	8 (0.6)	25 (1.8)	67 (5.0)	180
High school	9 (0.2)	27 (0.7)	64 (1.6)	1,555	15 (0.4)	44 (1.1)	42 (1.1)	1,542	6 (0.1)	23 (0.6)	70 (1.8)	1,460
B.A. or more	8 (0.3)	29 (1.0)	64 (2.3)	771	15 (0.5)	45 (1.6)	39 (1.4)	772	6 (0.2)	24 (0.9)	71 (2.6)	722

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

ercent of public school students who report watching various science and mathematics television programs, y sex, community type, and parent's education, grades 8 and 11: 1988, continued

tudent characteristic	Square One: Often	Square One: Sometimes	Square One: Never	Square One: Sample size	Television news shows: Often	Television news shows: Sometimes	Television news shows: Never	Television news shows: Sample size
rade 8								
Total	7 (0.1)	18 (0.4)	75 (1.5)	2,415	26 (0.5)	56 (1.1)	17 (0.3)	2,600
Sex								
Male	9 (0.2)	18 (0.5)	72 (2.0)	1,242	33 (0.9)	51 (1.4)	16 (0.4)	1,350
Female	5 (0.1)	17 (0.5)	78 (2.3)	1,173	19 (0.5)	62 (1.7)	19 (0.5)	1,250
Community type								
Urban	5 (0.2)	20 (0.9)	75 (3.3)	504	30 (1.3)	52 (2.2)	18 (0.7)	560
Suburban	7 (0.2)	17 (0.5)	76 (2.3)	1,075	24 (0.7)	59 (1.7)	17 (0.5)	1,152
Rural	9 (0.3)	18 (0.6)	73 (2.5)	836	27 (0.9)	56 (1.9)	17 (0.6)	888
Parent's education								
Less than high school	10 (0.7)	26 (1.9)	64 (4.7)	181	36 (2.5)	48 (3.4)	16 (1.1)	201
High school	7 (0.2)	17 (0.4)	76 (2.0)	1,466	23 (0.6)	57 (1.4)	20 (0.5)	1,565
B.A. or more	8 (0.3)	17 (0.6)	76 (2.8)	718	31 (1.1)	56 (2.0)	12 (0.4)	775

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Percent of public school students who report watching various science and mathematics television programs, by sex, community type, and parent's education, grades 8 and 11: 1988, continued

Student characteristic	NOVA				National Geographic Specials				3-2-1 Contact			
	Often	Sometimes	Never	Sample size	Often	Sometimes	Never	Sample size	Often	Sometimes	Never	Sample size
Grade 11												
Total	5 (0.1)	34 (0.8)	61 (1.4)	1,970	9 (0.2)	44 (1.0)	47 (1.1)	1,970	3 (0.1)	17 (0.4)	80 (1.8)	1,963
Sex												
Male	8 (0.2)	40 (1.3)	52 (1.7)	944	14 (0.4)	49 (1.6)	37 (1.2)	943	4 (0.1)	19 (0.6)	78 (2.5)	939
Female	3 (0.1)	28 (0.9)	69 (2.1)	1,022	6 (0.2)	39 (1.2)	55 (1.7)	1,024	2 (0.0)	15 (0.5)	83 (2.6)	1,021
Community type												
Urban	7 (0.3)	28 (1.4)	65 (3.4)	371	12 (0.6)	42 (2.2)	46 (2.4)	368	4 (0.2)	18 (0.9)	78 (4.0)	368
Suburban	5 (0.2)	34 (1.1)	61 (2.0)	925	8 (0.3)	44 (1.4)	48 (1.6)	928	2 (0.1)	15 (0.5)	83 (2.7)	923
Rural	4 (0.1)	36 (1.4)	59 (2.3)	673	10 (0.4)	45 (1.7)	44 (1.7)	674	4 (0.1)	18 (0.7)	78 (3.0)	672
Parent's education												
Less than high school	9 (0.8)	25 (2.2)	66 (6.0)	121	17 (1.5)	29 (2.6)	54 (4.9)	119	6 (0.5)	19 (1.7)	74 (6.8)	116
High school	4 (0.1)	33 (0.9)	63 (2.5)	1,196	9 (0.3)	43 (1.2)	48 (1.4)	1,197	3 (0.1)	17 (0.5)	80 (2.3)	1,195
B.A. or more	6 (0.2)	36 (1.4)	58 (2.3)	634	8 (0.3)	49 (1.9)	43 (1.7)	634	2 (0.1)	16 (0.6)	82 (3.2)	634

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

ercent of public school students who report watching various science and mathematics television programs, y sex, community type, and parent's education, grades 8 and 11: 1988, continued

	Square One				Television news shows			
udent characteristic	Often	Sometimes	Never	Sample size	Often	Sometimes	Never	Sample size
rade 11								
Total	2 (0.0)	11 (0.2)	87 (2.0)	1,964	30 (0.7)	58 (1.3)	12 (0.3)	1,980
iex								
Male	2 (0.1)	13 (0.4)	84 (2.7)	942	34 (1.1)	56 (1.8)	10 (0.3)	954
Female	1 (0.0)	9 (0.3)	90 (2.8)	1,018	27 (0.8)	60 (1.9)	13 (0.4)	1,023
Community type								
Urban	2 (0.1)	14 (0.7)	84 (4.4)	369	32 (1.6)	58 (3.0)	10 (0.5)	372
Suburban	1 (0.0)	9 (0.3)	89 (2.9)	925	30 (1.0)	59 (1.9)	11 (0.3)	935
Rural	2 (0.1)	11 (0.4)	87 (3.3)	670	29 (1.1)	58 (2.2)	13 (0.5)	673
Parent's education								
Less than high school	5 (0.4)	12 (1.1)	82 (7.5)	119	33 (3.0)	52 (4.7)	15 (1.3)	120
High school	1 (0.0)	11 (0.3)	88 (2.5)	1,191	26 (0.7)	61 (1.7)	13 (0.4)	1,202
B.A. or more	1 (0.0)	10 (0.4)	88 (3.5)	635	37 (1.4)	55 (2.2)	8 (0.3)	639

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Appendix Table 2-23

Percent of public school students engaged in selected out-of-school educational activities in the summer, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990

Student characteristic	Student sample size	Visited a science museum, natural history museum, or planetarium last summer: 1987 grade 7	1990 grade 10	Helped parents fix some things in the home last summer: 1987 grade 7	1990 grade 10
Cohort 2					
Total	1,908	33 (0.7)	18 (0.4)	59 (1.3)	65 (1.5)
Sex					
Male	962	34 (1.1)	20 (0.6)	64 (2.1)	73 (2.3)
Female	946	32 (1.0)	17 (0.5)	54 (1.7)	57 (1.8)
Community type					
Urban	374	33 (1.7)	13 (0.7)	58 (3.0)	59 (3.0)
Suburban	858	36 (1.2)	23 (0.8)	57 (1.9)	66 (2.2)
Rural	676	29 (1.1)	15 (0.6)	62 (2.4)	66 (2.5)
Parent's education					
Less than high school	119	21 (1.9)	9 (0.8)	63 (5.7)	72 (6.6)
High school only	1,155	32 (0.9)	16 (0.5)	60 (1.8)	65 (1.9)
B.A. or more	595	38 (1.5)	25 (1.0)	55 (2.2)	64 (2.6)
Cohort 1	Student sample size	1987 grade 10	1989 grade 12	1987 grade 10	1989 grade 12
Total	1,557	22 (0.5)	21 (0.5)	58 (1.5)	64 (1.6)
Sex					
Male	766	26 (0.9)	20 (0.7)	67 (2.4)	69 (2.5)
Female	790	20 (0.7)	22 (0.8)	49 (1.7)	58 (2.1)
Community type					
Urban	271	24 (1.4)	20 (1.2)	57 (3.4)	66 (4.0)
Suburban	795	24 (0.8)	24 (0.8)	56 (2.0)	62 (2.2)
Rural	492	18 (0.8)	18 (0.8)	62 (2.8)	64 (2.9)
Parent's education					
Less than high school	82	16 (1.7)	14 (1.5)	68 (7.5)	68 (7.5)
High school only	940	19 (0.6)	18 (0.6)	57 (1.8)	62 (2.0)
B.A. or more	522	30 (1.3)	28 (1.2)	58 (2.5)	65 (2.8)

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research In-‑‑ute of Northern Illinois University.

Percent of public school students who report talking to parents about science issues, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990

Student characteristic	Issues involving science and technology: Sample size	1987 grade 7: Often	1987 grade 7: Sometimes	1987 grade 7: Never	1990 grade 10: Often	1990 grade 10: Sometimes	1990 grade 10: Never	The space program: Sample size	1987 grade 7: Often	1987 grade 7: Sometimes	1987 grade 7: Never	1990 grade 10: Often	1990 grade 10: Sometimes	1990 grade 10: Never
Cohort 2														
Total	1,693	9 (0.2)	32 (0.8)	58 (1.4)	7 (0.2)	38 (0.9)	54 (1.3)	1,616	9 (0.2)	30 (0.7)	61 (1.5)	6 (0.1)	30 (0.7)	64 (1.6)
Sex														
Male	827	12 (0.4)	38 (1.3)	50 (1.7)	10 (0.3)	44 (1.5)	46 (1.6)	791	12 (0.4)	35 (1.2)	52 (1.8)	9 (0.3)	36 (1.3)	55 (1.9)
Female	866	7 (0.2)	27 (0.9)	66 (2.2)	5 (0.2)	33 (1.1)	62 (2.1)	824	6 (0.2)	25 (0.9)	69 (2.4)	3 (0.1)	24 (0.8)	73 (2.5)
Community type														
Urban	333	9 (0.5)	30 (1.6)	61 (3.3)	6 (0.3)	37 (2.0)	58 (3.2)	325	8 (0.4)	28 (1.5)	64 (3.5)	6 (0.3)	26 (1.4)	68 (3.7)
Suburban	752	9 (0.3)	36 (1.3)	55 (2.0)	8 (0.3)	41 (1.5)	50 (1.8)	734	11 (0.4)	32 (1.2)	57 (2.1)	7 (0.2)	31 (1.1)	61 (2.2)
Rural	607	10 (0.4)	29 (1.2)	61 (2.5)	7 (0.3)	35 (1.4)	57 (2.3)	557	8 (0.3)	28 (1.2)	64 (2.7)	5 (0.2)	30 (1.3)	66 (2.8)
Parent's education														
Less than high school	102	9 (0.8)	27 (2.6)	64 (6.3)	6 (0.5)	27 (2.6)	66 (6.5)	96	6 (0.6)	33 (3.3)	61 (6.2)	3 (0.3)	20 (2.0)	77 (7.8)
High school only	1,015	9 (0.3)	31 (1.0)	60 (1.9)	7 (0.2)	36 (1.1)	56 (1.7)	967	8 (0.2)	28 (0.9)	63 (2.0)	6 (0.2)	28 (0.9)	66 (2.1)
B.A. or more	542	10 (0.4)	37 (1.6)	53 (2.3)	8 (0.3)	44 (1.9)	47 (2.0)	520	11 (0.5)	35 (1.5)	54 (2.4)	8 (0.3)	35 (1.5)	58 (2.5)

Continued

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Percent of public school students who report talking to parents about science issues, by sex, community type, and parent's education, cohort 2 (grades 7-10) and cohort 1 (grades 10-12): 1987 to 1990, continued

Student characteristic	Issues involving science and technology: Sample size	1987 grade 7: Often	1987 grade 7: Sometimes	1987 grade 7: Never	1990 grade 10: Often	1990 grade 10: Sometimes	1990 grade 10: Never	The space program: Sample size	1987 grade 7: Often	1987 grade 7: Sometimes	1987 grade 7: Never	1990 grade 10: Often	1990 grade 10: Sometimes	1990 grade 10: Never
Cohort 1														
Total	1,447	6 (0.1)	34 (0.9)	60 (1.6)	6 (0.1)	37 (1.0)	56 (1.5)	1,445	5 (0.1)	31 (0.8)	64 (1.7)	4 (0.1)	31 (0.8)	65 (1.7)
Sex														
Male	702	8 (0.3)	42 (1.6)	49 (1.8)	9 (0.3)	44 (1.6)	47 (1.8)	701	8 (0.3)	36 (1.3)	56 (2.1)	6 (0.2)	36 (1.3)	58 (2.2)
Female	744	3 (0.1)	26 (0.9)	70 (2.6)	3 (0.1)	31 (1.1)	65 (2.4)	743	3 (0.1)	26 (0.9)	71 (2.6)	3 (0.1)	25 (0.9)	72 (2.6)
Community type														
Urban	248	7 (0.4)	29 (1.8)	63 (4.0)	7 (0.4)	36 (2.3)	57 (3.6)	248	3 (0.2)	26 (1.6)	71 (4.5)	3 (0.2)	30 (1.9)	67 (4.2)
Suburban	749	5 (0.2)	35 (1.3)	59 (2.1)	6 (0.2)	38 (1.4)	56 (2.0)	749	6 (0.2)	32 (1.2)	62 (2.3)	5 (0.2)	31 (1.1)	64 (2.3)
Rural	451	5 (0.2)	35 (1.6)	60 (2.8)	5 (0.2)	38 (1.8)	57 (2.7)	447	6 (0.3)	31 (1.4)	62 (2.9)	4 (0.2)	30 (1.4)	66 (3.1)
Parent's education														
Less than high school	69	6 (0.7)	28 (3.3)	66 (7.9)	8 (0.9)	26 (3.1)	66 (7.9)	68	6 (0.7)	22 (2.6)	72 (8.7)	4 (0.4)	15 (1.8)	81 (9.8)
High school only	877	6 (0.2)	30 (1.0)	64 (2.1)	5 (0.2)	33 (1.1)	61 (2.0)	875	4 (0.1)	28 (0.9)	68 (2.3)	4 (0.1)	28 (0.9)	68 (2.3)
B.A. or more	489	6 (0.3)	43 (1.9)	51 (2.3)	8 (0.3)	46 (2.1)	46 (2.1)	490	8 (0.3)	36 (1.6)	56 (2.5)	5 (0.2)	38 (1.7)	57 (2.6)

NOTE Standard errors are presented in parentheses.
SOURCE Special tabulations of the Longitudinal Study of American Youth conducted by the Social Science Research Institute of Northern Illinois University.

Appendix Table 2-25

Science achievement scores, by number of science experiments or projects students report conducting, grades 4, 8, and 12: 1990

Grade	Number of experiments conducted /1 5-6	3-4	1-2	0
Grade 4				
Achievement score	239	230	234	235
	(1.2)	(1.2)	(1.1)	(1.7)
Percent of students	15	46	32	7
	(0.6)	(0.6)	(0.6)	(0.5)
Grade 8				
Achievement score	277	262	250	238
	(1.4)	(1.3)	(1.6)	(2.4)
Percent of students	35	38	22	6
	(1.3)	(0.9)	(0.8)	(0.4)
Grade 12				
Achievement score	304	288	273	260
	(1.2)	(1.6)	(2.2)	(2.9)
Percent of students	55	29	12	4
	(1.2)	(0.8)	(0.6)	(0.3)

NOTE: Standard errors are presented in parentheses.

1/ Grouping of the number of experiments or projects was based on student responses to questions asking whether they had done experiments or projects at home or in school using six common types of science materials (plants or animals, electricity, chemicals, rocks or minerals, a telescope, and a thermometer or barometer).

SOURCE: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 84-85, table 4.5.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-26

Average science proficiency, by use of science equipment, grades 3 and 7: 1986

Use of science equipment	Science proficiency score Grade 3	Grade 7
Low	188.7	232.2
	(2.0)	(1.6)
Medium	210.8	244.8
	(1.4)	(1.4)
High	226.3	259.9
	(1.5)	(1.0)

NOTES: Jackknifed standard errors are presented in parentheses. The level of use of science equipment was defined based on responses to questions asking whether students had used the following science instruments: a meterstick, scale, magnifying glass, thermometer, yardstick, and calculator for grade 3; a telescope, microscope, barometer, and electricity meter for grade 7.

SOURCE: I. V. S. Mullis and L. B. Jenkins, *The Science Report Card: Elements of Risk and Recovery: Trends and Achievement Based on the 1986 National Assessment*, Report No. 17-S-01 (Princeton: Educational Testing Service, 1988), 106.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-27

Average science proficiency, by exposure to scientific experiments, as reported by teachers, grade 8: 1988

Number of science experiments conducted	Science proficiency	Unweighted sample size
Total	49.9 (0.3)	8,361
None, or less than one per month	48.0 (0.5)	1,618
About one per month	49.0 (0.5)	1,569
About one per week	50.8 (0.4)	3,877
Almost one a day	51.6 (0.6)	1,059

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, *A Profile of American Eighth-Grade Mathematics and Science Instruction* (NELS:88) (Washington, DC: U.S. Department of Education, 1992), 49, table 4.2.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-28

Percent of 8th-grade students who report entering science fairs, by sex, race and ethnicity, and achievement: 1988

Student characteristic	Percent
Sex	
Male	28.5
Female	28.1
Race and ethnicity	
White	27.9
Black	33.8
Hispanic	22.9
Asian/Pacific Islander	29.4
Achievement	
Lowest quartile	21.6
25-49%	26.5
50-74%	29.2
Highest quartile	34.4

SOURCE: National Center for Education Statistics, *A Profile of the American Eighth Grader: National Education Longitudinal Study, 1988 Student Descriptive Summary* (Washington, DC: U.S. Department of Education, 1991), 41, table 2.7.

Indicators of Science and Mathematics Education 1992

Appendix Table 2-29

Percent of students doing science and mathematics homework, and their achievement scores, by grade and time spent: 1990

		Time spent each week									
		None		30 minutes		1 hour		2 hours		More than 2 hours	
Grade	Total /1	Percent	Achievement	Percent	Achievement	Percent	Achievement	Percent	Achievement	Percent	Achievement
Science											
Grade 4	94	32 (1.0)	236 (1.1)	42 (1.2)	237 (1.1)	14 (0.6)	229 (1.5)	3 (0.2)	220 (2.6)	3 (0.2)	213 (2.7)
Grade 8	97	20 (1.2)	251 (1.8)	41 (0.7)	264 (1.2)	20 (0.7)	267 (1.6)	9 (0.5)	277 (1.9)	7 (0.5)	272 (2.6)
Grade 12	101	41 (1.3)	281 (1.5)	19 (0.8)	297 (1.9)	16 (0.7)	305 (2.2)	11 (0.6)	318 (2.4)	14 (0.9)	326 (2.1)

		Time spent each day									
		None		15 minutes		30 minutes		45 minutes		1 hour or more	
Grade	Total	Percent	Achievement	Percent	Achievement	Percent	Achievement	Percent	Achievement	Percent	Achievement
Mathematics											
Grade 4	100	8 (0.6)	221 (2.2)	39 (1.0)	219 (0.8)	21 (0.7)	219 (1.0)	12 (0.6)	210 (1.5)	14 (0.6)	205 (1.5)
Grade 8	101	10 (0.6)	256 (2.1)	32 (1.2)	267 (1.2)	32 (0.7)	267 (1.4)	15 (0.6)	268 (1.7)	12 (0.6)	262 (2.1)
Grade 12 - All students	99	21 (0.7)	283 (1.5)	14 (0.6)	301 (1.5)	20 (0.6)	306 (1.5)	11 (0.4)	305 (1.6)	13 (0.5)	305 (1.6)
Grade 12 - Taking math	100	12 (0.7)	296 (2.7)	21 (0.8)	304 (1.5)	31 (0.8)	308 (1.5)	17 (0.6)	308 (1.7)	19 (0.9)	308 (1.6)

NOTE: Standard errors are presented in parentheses.

1/ Percents of 4th- and 8th-grade science students do not total 100 because small percentages of students in both grades reported that they did not have a science class. Other percents do not total 100 because of rounding.

SOURCES: National Center for Education Statistics, *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 99, table 5.7; National Center for Education Statistics, *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 189, table 8.3.

Science and mathematics achievement scores of 13-year-old students by time spent on homework and television viewing, as reported by students, by country: 1988

Subject and country	Average achievement score	Weekly science homework: Less than 1 hour	Weekly science homework: 1-2 hours	Weekly science homework: 3 hours or more	Daily television viewing: 0-2 hours	Daily television viewing: 3-4 hours	Daily television viewing: 5 hours or more
Science, Age 13							
South Korea	549.9	545.5	554.7	564.4	562.4	543.1	517.9
	(2.9)	(3.4)	(3.6)	(7.6)	(3.9)	(3.1)	(7.1)
United Kingdom	519.5	499.9	547.4	565.5	537.7	531.1	483.2
	(3.7)	(3.7)	(4.1)	(9.5)	(5.1)	(3.9)	(5.3)
Canada /1	505.9	505.5	505.5	514.4	520.8	503.5	483.5
Spain	503.9	499.9	500.4	522.2	514.5	500.5	477.6
	(4.3)	(6.0)	(4.5)	(5.8)	(5.6)	(4.5)	(6.4)
United States	478.5	478.5	482.9	472.3	495.1	486.1	453.5
	(4.8)	(5.6)	(7.5)	(7.6)	(7.4)	(4.4)	(6.7)
Ireland	469.3	462.4	495.7	498.7	485.2	465.5	429.6
	(3.5)	(3.7)	(4.7)	(8.6)	(4.7)	(3.2)	(6.0)

Continued

NOTE: Jackknifed standard errors are presented in parentheses.
1/ Standard errors are not computable because the achievement scores reported were computed by averaging the figures of four Canadian provinces in the original tables.
SOURCE: A. E. Lapointe, N. A. Mead, and G. W. Phillips, *A World of Differences. An International Assessment of Mathematics and Science*, Report No. 19-CAEP-01 (Princeton: Educational Testing Service, 1989), 90-91.

Science and mathematics achievement scores of 13-year-old students by time spent on homework and television viewing, as reported by students, by country: 1988, continued

Country	Average achievement score	Weekly mathematics homework			Daily television viewing		
		Less than 1 hour	1-2 hours	3 hours or more	0-2 hours	3-4 hours	5 hours or more
Mathematics, Age 13							
South Korea	567.8	552.1	562.4	602.9	580.0	560.8	537.3
	(2.7)	(4.9)	(3.5)	(4.0)	(3.5)	(2.8)	(8.0)
Canada /1	522.8	519.8	521.6	532.0	536.6	521.3	500.9
Spain	511.7	499.7	505.8	533.9	523.9	507.6	480.6
	(4.6)	(6.7)	(5.2)	(4.8)	(6.5)	(4.1)	(5.5)
United Kingdom	509.9	491.3	533.8	535.8	529.1	520.1	475.1
	(3.5)	(4.6)	(3.6)	(7.8)	(4.6)	(3.9)	(4.6)
Ireland	504.3	497.2	511.8	532.0	523.4	500.3	455.3
	(3.7)	(3.9)	(5.3)	(6.6)	(3.8)	(3.6)	(8.6)
United States	473.9	467.8	476.8	506.6	494.1	482.7	442.8
	(4.5)	(5.2)	(9.1)	(10.8)	(8.2)	(5.9)	(7.8)

NOTE: Jackknifed standard errors are presented in parentheses.
1/ Standard errors are not computable because the achievement scores reported were computed by averaging the figures of four Canadian provinces in the original tables.
SOURCE: A. E. Lapointe, N. A. Mead, and G. W. Phillips, *A World of Differences: An International Assessment of Mathematics and Science*, Report No. 19-CAEP-01 (Princeton: Educational Testing Service, 1989), 90-91.

Science achievement scores of 9-year-old students by time spent on homework and television viewing, as reported by students, by country: 1990-91

Country	Mean percent correct	Weekly science homework			Daily television viewing		
		0-1 hour	2-3 hours	4 hours or more	0-1 hour	2-4 hours	5 hours or more
Science, Age 9							
South Korea	68 (0.5)	69 (0.4)	66 (0.9)	66 (1.6)	69 (0.7)	68 (0.5)	65 (1.4)
Taiwan	67 (0.5)	67 (0.6)	66 (0.7)	66 (1.8)	67 (0.8)	67 (0.7)	63 (0.9)
United States	65 (0.9)	66 (0.8)	62 (1.8)	57 (2.5)	63 (1.5)	67 (0.9)	60 (0.9)
Canada	63 (0.4)	64 (0.3)	59 (0.8)	60 (1.2)	63 (0.6)	64 (0.4)	60 (0.6)
Hungary	63 (0.5)	63 (0.6)	62 (0.8)	63 (1.3)	62 (1.0)	64 (0.5)	59 (1.0)
Spain	62 (0.7)	61 (0.8)	62 (0.8)	63 (1.2)	61 (0.8)	63 (0.7)	60 (1.1)
Soviet Union	62 (1.2)	62 (1.3)	61 (1.3)	58 (2.2)	62 (1.8)	62 (1.2)	60 (1.3)
Israel	61 (0.7)	62 (0.7)	59 (1.0)	55 (1.7)	58 (0.9)	62 (0.8)	61 (0.9)
Slovenia	58 (0.5)	58 (0.5)	58 (0.9)	58 (1.3)	58 (0.7)	59 (0.6)	55 (1.3)
Ireland	57 (0.7)	58 (0.7)	51 (1.7)	46 (2.3)	57 (1.1)	57 (0.8)	54 (1.1)

NOTE: Jackknifed standard errors are presented in parentheses.

SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 151-52.

Indicators of Science and Mathematics Education 1992

322

Science achievement scores of 13-year-old students by time spent on homework and television viewing, as reported by students, by country: 1990-91

Country	Mean percent correct	Weekly science homework: 0-1 hour	2-3 hours	4 hours or more	Daily television viewing: 0-1 hour	2-4 hours	5 hours or more
Science, Age 13							
South Korea	78 (0.5)	78 (0.6)	78 (0.6)	75 (1.2)	81 (0.7)	77 (0.5)	73 (1.3)
Taiwan	76 (0.4)	74 (0.4)	77 (0.9)	86 (1.1)	80 (0.6)	73 (0.7)	67 (1.6)
Switzerland	74 (0.9)	74 (0.8)	70 (1.7)	70 (1.2)	75 (0.8)	73 (1.1)	68 (1.3)
Hungary	73 (0.5)	71 (0.7)	76 (0.7)	78 (1.1)	73 (1.4)	75 (0.6)	67 (1.3)
Soviet Union	71 (1.0)	66 (1.5)	73 (0.8)	71 (1.2)	68 (1.6)	72 (0.9)	70 (1.7)
Slovenia	70 (0.5)	71 (0.6)	69 (0.8)	73 (1.4)	71 (0.7)	70 (0.7)	67 (2.0)
Israel	70 (0.7)	70 (0.7)	69 (1.0)	67 (1.8)	66 (1.5)	71 (0.8)	69 (0.9)
Canada	69 (0.4)	69 (0.3)	70 (1.1)	70 (1.1)	72 (0.8)	69 (0.4)	65 (0.9)
France	69 (0.6)	69 (0.6)	67 (1.4)	56 (4.7)	71 (0.7)	67 (0.7)	59 (1.8)
Scotland	68 (0.6)	67 (0.7)	73 (1.8)	69 (3.3)	71 (2.3)	68 (0.7)	65 (0.9)
Spain	68 (0.6)	67 (0.7)	68 (1.0)	71 (1.0)	69 (1.1)	68 (0.6)	66 (1.1)
United States	67 (1.0)	67 (0.9)	70 (1.9)	66 (2.1)	71 (1.3)	68 (1.0)	62 (1.3)
Ireland	63 (0.6)	62 (0.7)	67 (0.9)	70 (1.5)	65 (1.0)	63 (0.6)	57 (1.3)
Jordan	57 (0.7)	58 (0.7)	54 (1.2)	59 (1.7)	56 (1.1)	58 (0.8)	53 (1.4)

NOTE: Jackknifed standard errors are presented in parentheses.

SOURCE: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 145-46.

Appendix Table 2-33

Mathematics achievement scores of 9-year-old students by time spent on homework and television viewing, as reported by students, by country: 1990-91

Country	Mean percent correct	Weekly mathematics homework			Daily television viewing		
		0-1 hour	2-3 hours	4 hours or more	0-1 hour	2-4 hours	5 hours or more
Mathematics, Age 9							
South Korea	75 (0.6)	75 (0.6)	74 (0.9)	77 (1.2)	74 (1.0)	76 (0.7)	69 (1.6)
Hungary	68 (0.6)	67 (0.9)	66 (1.2)	74 (1.3)	67 (1.2)	70 (0.8)	61 (1.4)
Taiwan	68 (0.8)	68 (0.7)	67 (1.1)	70 (1.8)	68 (1.0)	70 (0.8)	57 (1.6)
Soviet Union	66 (1.3)	63 (1.3)	67 (2.0)	72 (1.0)	64 (1.4)	68 (1.5)	62 (1.3)
Israel	64 (0.7)	63 (0.7)	62 (1.2)	70 (1.4)	58 (0.9)	68 (0.9)	63 (1.3)
Spain	62 (1.0)	59 (1.0)	61 (1.2)	69 (1.5)	60 (1.4)	64 (1.0)	58 (1.5)
Ireland	60 (0.8)	59 (0.9)	64 (1.7)	61 (1.8)	59 (1.4)	62 (1.0)	56 (1.4)
Canada	60 (0.5)	61 (0.5)	59 (0.8)	61 (1.5)	60 (0.8)	63 (0.6)	54 (0.8)
United States	58 (1.0)	59 (1.1)	58 (1.6)	58 (2.5)	57 (1.7)	62 (1.1)	54 (1.2)
Slovenia	56 (0.6)	56 (0.7)	56 (1.0)	59 (1.5)	56 (0.7)	57 (0.7)	51 (1.6)

NOTE: Jackknifed standard errors are presented in parentheses.

SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*. IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 151-52.

Appendix Table 2-34

Mathematics achievement scores of 13-year-old students by time spent on homework and television viewing, as reported by students, by country: 1990-91

Country	Mean percent correct	Weekly mathematics homework			Daily television viewing		
		0-1 hour	2-3 hours	4 hours or more	0-1 hour	2-4 hours	5 hours or more
Mathematics, Age 13							
South Korea	73	71	74	75	81	72	63
	(0.6)	(1.3)	(0.8)	(0.9)	(1.0)	(0.7)	(1.4)
Taiwan	73	63	76	88	82	70	59
	(0.7)	(0.9)	(1.0)	(0.8)	(1.0)	(0.9)	(1.8)
Switzerland	71	71	73	69	72	70	72
	(1.3)	(1.5)	(1.2)	(1.6)	(1.1)	(1.5)	(2.3)
Soviet Union	70	66	72	73	70	71	67
	(1.0)	(1.3)	(1.2)	(1.4)	(1.8)	(1.0)	(0.8)
Hungary	68	67	72	75	70	69	61
	(0.8)	(0.9)	(1.1)	(1.4)	(1.9)	(0.7)	(1.7)
France	64	59	69	69	66	64	57
	(0.8)	(0.9)	(1.0)	(1.0)	(1.0)	(0.9)	(1.7)
Israel	63	61	64	67	60	65	60
	(0.8)	(0.9)	(1.1)	(1.1)	(1.9)	(0.8)	(1.3)
Canada	62	61	64	62	65	63	55
	(0.6)	(0.6)	(0.8)	(0.9)	(1.0)	(0.6)	(1.0)
Scotland	61	59	65	61	65	62	54
	(0.9)	(0.9)	(1.5)	(2.2)	(2.6)	(0.9)	(0.8)
Ireland	61	57	66	63	64	61	50
	(0.9)	(1.1)	(1.2)	(1.2)	(1.1)	(1.0)	(1.8)
Slovenia	57	57	59	57	58	57	54
	(0.8)	(0.7)	(1.3)	(1.4)	(1.0)	(0.9)	(2.1)
Spain	55	55	56	61	58	57	49
	(0.8)	(1.0)	(1.0)	(1.1)	(1.2)	(0.9)	(1.3)
United States	55	52	60	63	60	57	47
	(1.0)	(0.9)	(1.9)	(1.6)	(2.2)	(0.9)	(1.8)
Jordan	40	41	38	47	39	42	40
	(1.0)	(1.1)	(0.9)	(2.0)	(1.0)	(1.3)	(1.8)

NOTE: Jackknifed standard errors are presented in parentheses.
SOURCE: A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 151-52.

Indicators of Science and Mathematics Education 1992

Opportunity to learn (OTL) science and mathematics and achievement of 13-year-old students, by topic and country: 1988

Subject and country	Life sciences		Physics		Chemistry		Earth and space sciences		Nature of science	
	OTL	Achievement	OTL	Achievement	OTL	Achievement	OTL	Achievement	OTL	Achievement
Correlation with OTL /1	0.378		0.484		0.338		-0.003		0.015	
Science										
Canada	36.3 (***)	66.3 (***)	23.5 (***)	58.8 (***)	38.2 (***)	53.2 (***)	31.7 (***)	64.1 (***)	41.3 (***)	62.7 (***)
Ireland	25.4 (1.7)	60.0 (0.6)	25.1 (1.7)	53.0 (0.5)	40.3 (2.6)	46.7 (0.8)	18.0 (1.9)	61.0 (0.8)	37.9 (2.1)	54.5 (0.8)
South Korea	35.5 (1.7)	72.7 (0.5)	39.7 (1.6)	67.6 (0.5)	52.8 (1.6)	65.9 (0.6)	30.4 (1.6)	71.3 (0.5)	36.4 (1.7)	65.8 (0.6)
Spain	64.8 (3.3)	69.0 (0.6)	57.2 (3.6)	60.2 (0.8)	63.2 (3.3)	51.6 (1.0)	65.1 (2.7)	65.6 (1.2)	61.7 (2.7)	59.5 (0.8)
United Kingdom	36.0 (2.3)	68.4 (0.6)	32.2 (2.1)	62.2 (0.7)	55.6 (2.5)	52.4 (0.7)	23.9 (2.1)	68.8 (0.8)	49.9 (2.9)	64.2 (0.7)
United States	44.1 (2.5)	64.0 (1.0)	25.9 (2.5)	52.9 (0.9)	41.7 (2.5)	47.7 (1.0)	40.3 (3.4)	61.4 (1.1)	42.1 (2.9)	56.0 (1.0)

Continued

NOTE: Jackknifed standard errors are presented in parentheses.

*** Standard errors are not computable because the OTL ratings and mean percents correct reported were computed by averaging the figures of four Canadian provinces in the original tables.

1/ Pearson's correlation coefficient of achievement and OTL for the six countries in the table.

SOURCE: A. E. Lapointe, N. A. Mead, and G. W. Phillips, *A World of Differences: An International Assessment of Mathematics and Science*, Report No. 19-CAEP-01 (Princeton: Educational Testing Service, 1989), 90-92.

Opportunity to learn (OTL) science and mathematics and achievement of 13-year-old students, by topic and country: 1988, continued

Subject and country	Numbers and operations		Relations, functions, etc.		Geometry		Measurement		Data, organization, etc.		Logic and problem solving	
	OTL	Achievement	OTL	Achievement	OTL	Achievement	OTL	Achievement	OTL	Achievement	OTL	Achievement
Correlation with OTL /1	0.283		0.461		0.766		0.554		0.395		0.592	
Mathematics												
Canada	72.4 (***)	72.8 (***)	66.4 (***)	70.7 (***)	42.5 (***)	56.3 (***)	66.5 (***)	60.9 (***)	54.3 (***)	58.8 (***)	48.9 (***)	71.3 (***)
Ireland	62.9 (1.9)	67.9 (1.0)	60.6 (1.9)	69.0 (0.8)	23.3 (2.0)	56.4 (0.6)	53.7 (2.2)	55.3 (0.9)	38.1 (2.3)	48.1 (0.8)	47.7 (1.9)	72.3 (0.7)
Korea	67.2 (2.4)	79.2 (0.6)	74.5 (2.0)	80.0 (0.4)	67.7 (2.3)	72.3 (0.6)	72.9 (2.1)	71.2 (0.7)	58.6 (2.8)	74.7 (0.7)	51.7 (2.7)	73.9 (0.6)
Spain	81.7 (2.2)	68.6 (1.0)	83.5 (2.3)	70.6 (1.0)	67.1 (3.9)	62.7 (1.2)	80.7 (2.4)	59.4 (1.2)	63.8 (3.7)	56.5 (1.3)	68.6 (3.5)	72.3 (0.9)
United Kingdom	57.7 (2.7)	61.5 (0.9)	66.2 (2.1)	73.8 (0.7)	47.2 (2.7)	63.0 (0.8)	71.1 (2.1)	58.0 (0.8)	55.5 (2.6)	62.3 (0.8)	59.3 (2.8)	78.1 (0.6)
United States	69.0 (2.0)	61.4 (1.0)	62.0 (2.4)	59.9 (1.1)	36.1 (3.6)	49.1 (0.9)	59.4 (3.0)	43.9 (1.1)	65.6 (3.1)	54.7 (1.2)	42.4 (2.8)	63.0 (1.1)

NOTE: Jackknifed standard errors are presented in parentheses.

*** Standard errors are not computable because the OTL ratings and mean percents correct reported were computed by averaging the figures of four Canadian provinces in the original tables.

1/ Pearson's correlation coefficient of achievement and OTL for the six countries in the table.

SOURCE: A. E. Lapointe, N. A. Mead, and G. W. Phillips, *A World of Differences: An International Assessment of Mathematics and Science*, Report No. 19-CAEP-01 (Princeton: Educational Testing Service, 1989), 90-92.

Average instruction duration for 13-year-old students, by country, ranked by achievement in science: 1990-91

Country	Science average percent correct	Average minutes of science instruction each week	Mathematics average percent correct	Average minutes of mathematics instruction each week
South Korea	78 (0.5)	144 (2.8)	73 (0.6)	179 (2.0)
Taiwan	76 (0.4)	245 (***)	73 (0.7)	204 (2.1)
Switzerland /1	74 (0.9)	152 (***)	71 (1.3)	251 (3.9)
Hungary	73 (0.5)	207 (***)	68 (0.8)	186 (2.3)
Soviet Union	71 (1.0)	387 (6.0)	70 (1.0)	258 (1.9)
Slovenia	70 (0.5)	283 (7.0)	57 (0.8)	188 (4.3)
Israel	70 (0.7)	181 (***)	63 (0.8)	205 (3.6)
Canada	69 (0.4)	156 (1.9)	62 (0.6)	225 (1.9)
France	69 (0.6)	174 (8.1)	64 (0.8)	230 (1.8)
Scotland /1	68 (0.6)	179 (4.5)	61 (0.9)	210 (2.3)
Spain	68 (0.6)	189 (7.2)	55 (0.8)	235 (3.3)
United States /2	67 (1.0)	233 (7.9)	55 (1.0)	228 (5.6)
Ireland	63 (0.6)	159 (4.1)	61 (0.9)	189 (2.2)
Jordan	57 (0.7)	180 (0.7)	40 (1.0)	180 (0.6)

Continued

NOTES: Jackknifed standard errors are presented in parentheses. Four out of the 14 reporting nations had limited participation of schools and students in the sampling frame; these are Switzerland (14 out of 15 cantons, 76 percent of the age-eligible students participating), the Soviet Union (Russian-speaking schools in 14 out of 15 republics, 60 percent), Israel (Hebrew-speaking schools, 71 percent), and Spain (Spanish-speaking schools, except in Cataluna, 80 percent).

*** Jackknifed standard error is greater than 9.9.

1/ Results represent percent of classrooms in schools.

2/ Combined school and student participation rate is below 0.80 but at least 0.70; interpret results with caution because of possible nonresponse bias.

SOURCES: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 47, 49; A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 49.

Average instruction duration for 13-year-old students, by country, ranked by achievement in science: 1990-91, continued

Country	Total days of instruction per year	Total minutes of instruction each day	Average class size for modal grade
South Korea	222 (0.4)	264 (2.4)	49 (0.7)
Taiwan	222 (2.5)	318 (6.9)	44 (0.6)
Switzerland /1	207 (3.2)	305 (7.4)	18 (0.7)
Hungary	177 (1.5)	223 (1.3)	27 (0.8)
Soviet Union	198 (2.1)	243 (2.6)	22 (1.1)
Slovenia	190 (1.5)	248 (2.5)	25 (0.4)
Israel	215 (2.2)	278 (6.5)	32 (0.7)
Canada	188 (0.2)	304 (0.8)	25 (0.3)
France	174 (1.7)	370 (3.4)	25 (0.6)
Scotland /1	191 (0.9)	324 (2.3)	24 (0.7)
Spain	188 (2.3)	285 (3.2)	29 (0.7)
United States /2	178 (0.4)	338 (5.0)	23 (1.3)
Ireland	173 (0.9)	323 (4.4)	27 (0.7)
Jordan	191 (1.6)	260 (2.9)	27 (1.5)

NOTES: Jackknifed standard errors are presented in parentheses. Four out of the 14 reporting nations had limited participation of schools and students in the sampling frame: these are Switzerland (14 out of 15 cantons, 76 percent of the age-eligible students participating), the Soviet Union (Russian-speaking schools in 14 out of 15 republics, 60 percent), Israel (Hebrew-speaking schools, 71 percent), and Spain (Spanish-speaking schools, except in Cataluna, 80 percent).

1/ Results represent percent of classrooms in schools.

2/ Combined school and student participation rate is below 0.80 but at least 0.70; interpret results with caution because of possible nonresponse bias.

SOURCES: A. E. Lapointe, J. M. Askew, and N. A. Mead, *Learning Science*, IAEP Report No. 22-CAEP-02 (Princeton: Educational Testing Service, 1992), 47, 49; A. E. Lapointe, N. A. Mead, and J. M. Askew, *Learning Mathematics*, IAEP Report No. 22-CAEP-01 (Princeton: Educational Testing Service, 1992), 49.

Appendix Table 3-1

Number and percent of teachers who teach some mathematics or science, by age, sex, race and ethnicity, and teaching level: 1987-88

Teaching level	Total	Age			Sex		Race and ethnicity		
		20-29	30-49	50 and over	Male	Female	White	Black	Other
Total (weighted)	1,502,761 (10,079)	236,608 (3,887)	985,206 (7,707)	262,998 (4,344)	331,194 (4,999)	1,166,342 (9,329)	1,283,428 (9,875)	108,872 (3,909)	70,697 (2,055)
Sample size	26,437	4,359	17,284	4,468	6,622	19,722	22,654	1,544	1,484
Percent		17	66	17	25	75	88	6	6
Elementary (weighted)	1,025,316 (8,722)	163,801 (3,417)	664,589 (7,295)	184,521 (4,530)	100,710 (2,688)	920,888 (8,081)	869,880 (8,776)	77,338 (3,093)	50,927 (1,792)
Sample size	16,576	2,823	10,689	2,863	1,752	14,763	14,088	964	1,059
Percent		17	65	18	11	89	87	6	7
Secondary (weighted)	477,445 (5,729)	72,807 (1,632)	320,617 (4,513)	78,477 (2,153)	230,485 (4,090)	245,454 (4,453)	413,547 (5,304)	31,534 (1,775)	19,770 (1,233)
Sample size	9,861	1,536	6,595	1,605	4,870	4,959	8,566	580	425
Percent		16	68	16	50	50	90	6	4

NOTES: Standard errors are presented in parentheses. This table describes all teachers with responsibilities for teaching mathematics or science. This includes teachers with main or second assignments in mathematics or science and teachers who spend any portion of their day teaching mathematics or science. Details may not add to totals because of rounding or missing values in cells with too few cases.

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

...er of mathematics and science teachers who teach those subjects as a main or second assignment, by age, sex, race and ethnicity, and teaching level: 1987-88

Teaching level	Total	Age			Sex		Race and ethnicity		
		20-29	30-49	50 and over	Male	Female	White	Black	Other
Elementary	49,246 (2,421)	6,694 (1,172)	32,131 (1,792)	10,062 (742)	11,709 (1,151)	37,425 (1,859)	40,920 (2,043)	4,530 (737)	2,551 (539)
Sample size	733	95	475	156	178	552	615	58	41
Secondary	334,304 (4,826)	53,088 (1,588)	222,567 (3,764)	54,978 (1,534)	180,118 (3,517)	152,965 (3,572)	293,123 (4,214)	20,172 (1,323)	13,245 (942)
Sample size	6,794	1,096	4,517	1,102	3,760	3,011	5,987	353	277

NOTES. Standard errors are presented in parentheses. Details may not add to totals because of rounding or missing values in cells with too few cases.
SOURCE. National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-3

Number of mathematics and science teachers who teach only grades K-6, 7-8, or 9-12, by teaching field and assignment: 1987-88

Teaching assignments and grade range	Total	Mathematics	Science	Biology	Chemistry/ physics	Earth science	General/ other science
Main or second assignment							
K-6	47,560 (2,365)	30,742 (1,708)	16,818 (1,498)	--	--	--	--
Sample size	685	435	250	--	--	--	--
Weighted number (in thousands)	48	31	17	--	--	--	--
7-8	73,862 (2,644)	37,898 (1,733)	--	8,065 (779)	Low N	10,307 (701)	16,170 (1,050)
Sample size	1,307	677	--	142	28	179	281
Weighted number (in thousands)	74	38	--	8	1	10	16
9-12	175,869 (3,689)	92,514 (2,101)	--	37,212 (1,918)	24,667 (1,082)	5,979 (654)	15,496 (1,075)
Sample size	3,650	1,947	--	745	502	119	337
Weighted number (in thousands)	176	93	--	37	25	6	15
Not main or second assignment							
K-6	889,415 (8,900)	--	--	--	--	--	--
Sample size	14,136	--	--	--	--	--	--
Weighted number (in thousands)	889	--	--	--	--	--	--
7-8	22,960 (1,296)	--	--	--	--	--	--
Sample size	422	--	--	--	--	--	--
Weighted number (in thousands)	23	--	--	--	--	--	--
9-12	56,302 (1,425)	--	--	--	--	--	--
Sample size	1,253	--	--	--	--	--	--
Weighted number (in thousands)	56	--	--	--	--	--	--

NOTE: Standard errors are presented in parentheses.

-- Not applicable.

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Percent of secondary mathematics or science teachers who teach those subjects as a main or second assignment, by field of bachelor's degree and teaching field: 1987-88

Teaching assignment and field	Sample size	Bachelor's degree field										
		Mathematics	Biology	Chemistry	Earth science	Physics	Other physical science	Elementary education	Secondary education	Mathematics education	Science education	Other
Total	6,610	18.3 (0.5)	17.1 (0.6)	4.5 (0.3)	1.7 (0.2)	1.4 (0.2)	2.1 (0.2)	10.4 (0.5)	3.8 (0.3)	9.1 (0.4)	3.9 (0.3)	27.8 (0.6)
Secondary teachers' main assignment												
Mathematics	3,169	36.3 (1.1)	1.9 (0.3)	1.4 (0.2)	0.4 (0.1)	1.1 (0.3)	1.7 (0.3)	12.3 (0.8)	3.6 (0.4)	17.8 (0.8)	0.7 (0.1)	22.8 (0.9)
Biology	966	0.0 (0.0)	60.4 (2.3)	1.1 (0.4)	0.5 (0.3)	0.0 (0.0)	1.5 (0.5)	3.8 (0.8)	2.9 (0.5)	0.4 (0.2)	7.6 (0.9)	21.9 (2.0)
Chemistry/physics	535	2.6 (0.7)	23.1 (2.3)	31.4 (2.2)	0.8 (0.3)	7.4 (1.3)	5.3 (1.3)	0.5 (0.3)	5.1 (0.9)	0.8 (0.4)	9.0 (1.5)	13.9 (2.2)
Earth science	339	0.7 (0.4)	21.3 (2.3)	2.3 (0.9)	16.5 (2.8)	1.4 (0.7)	1.7 (0.9)	14.8 (2.8)	5.5 (1.3)	- -	5.8 (1.3)	29.8 (3.1)
General/other science	872	0.8 (0.4)	28.7 (2.0)	7.1 (1.0)	2.9 (0.6)	1.2 (0.5)	3.3 (0.8)	11.7 (1.3)	4.4 (0.7)	0.6 (0.3)	9.2 (1.3)	30.1 (2.1)
Secondary teachers' second assignment												
Mathematics	451	7.8 (1.8)	1.0 (0.6)	- -	- -	- -	- -	18.4 (2.5)	2.9 (0.9)	5.4 (1.2)	- -	63.4 (3.1)
Biology	68	0.0 (0.0)	5.5 (2.5)	0.0 (0.0)	- -	0.0 (0.0)	0.0 (0.0)	1.9 (1.3)	0.0 (0.0)	- -	0.0 (0.0)	89.1 (3.9)
Chemistry/physics	28	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Earth science	41	- -	- -	0.0 (0.0)	- -	0.0 (0.0)	- -	9.8 (5.2)	6.2 (4.0)	0.0 (0.0)	0.0 (0.0)	67.7 (9.3)
General/other science	141	- -	8.9 (3.7)	- -	0.0 (0.0)	0.0 (0.0)	- -	14.6 (4.1)	3.8 (1.7)	0.0 (0.0)	- -	67.5 (5.1)

NOTES: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.

- - Too few cases for a reliable estimate

SOURCE: National Center for Education Statistics, U S Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 3-5

Percent of mathematics or science teachers who teach those subjects as a main or second assignment, by age, sex, race and ethnicity, teaching level, and field: 1987-88

Teaching level and field	Sample size	Age: 20-29	Age: 30-49	Age: 50 and over	Sample size	Sex: Male	Sex: Female	Sample size	Race and ethnicity: White	Race and ethnicity: Black	Race and ethnicity: Other
Elementary teachers	726	13.7 (2.0)	65.7 (2.1)	20.6 (1.7)	730	23.8 (1.8)	76.2 (1.8)	714	85.2 (1.5)	9.4 (1.3)	5.3 (1.1)
Mathematics specialists	464	13.3 (2.7)	64.9 (2.4)	21.8 (2.4)	466	18.2 (1.9)	81.8 (1.9)	457	83.0 (2.0)	10.8 (1.8)	6.2 (1.6)
Science specialists	262	14.3 (2.2)	67.3 (3.5)	18.4 (2.5)	264	34.2 (3.7)	65.8 (3.7)	257	89.5 (2.1)	6.9 (1.8)	3.6 (1.4)
Secondary teachers	6,715	16.1 (0.4)	67.3 (0.4)	16.6 (0.4)	6,771	54.1 (0.8)	45.9 (0.8)	6,617	89.8 (0.4)	6.2 (0.4)	4.1 (0.3)
Mathematics	3,659	16.3 (0.6)	67.7 (0.8)	16.1 (0.6)	3,690	49.8 (1.1)	50.2 (1.1)	3,613	88.8 (0.7)	6.8 (0.6)	4.4 (0.4)
Biology	1,052	14.7 (1.4)	68.9 (1.9)	16.3 (1.3)	1,060	57.8 (1.7)	42.2 (1.7)	1,035	92.3 (1.0)	3.8 (0.7)	3.9 (0.7)
Chemistry/physics	577	12.5 (1.3)	64.9 (2.4)	22.6 (2.2)	582	68.3 (1.9)	31.7 (1.9)	564	93.1 (1.1)	2.7 (0.7)	4.2 (0.9)
Earth science	395	20.4 (2.3)	68.1 (2.2)	11.6 (2.1)	397	60.1 (2.9)	39.9 (2.9)	389	87.2 (2.1)	9.0 (2.0)	3.8 (1.1)
General/other science	1,032	16.9 (1.4)	65.5 (1.8)	17.7 (1.3)	1,042	54.8 (1.7)	45.2 (1.7)	1,016	89.9 (1.2)	6.9 (1.0)	3.2 (0.6)

NOTES: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.
SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 3-6

Mathematics and science teachers, by sex and grade range: 1977 and 1985-86

Subject and grade range	1977 Percent male	1977 Percent female	1977 Percent unknown	1977 Sample size	1985-86 Percent Male	1985-86 Percent female	1985-86 Percent unknown	1985-86 Sample size
Mathematics								
K-3	6	94	0	297	4	93	3	433
4-6	21	76	2	277	20	79	1	246
7-9	54	46	0	550	45	51	4	671
10-12	68	32	0	.548	53	46	1	565
Science								
K-3	2	98	0	287	3	94	3	431
4-6	33	67	0	271	23	76	1	273
7-9	62	38	0	535	56	41	3	658
10-12	74	24	2	586	68	31	1	1,050

SOURCE: I. R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume II* (Washington, DC: National Science Teachers Association, 1990), 7.

ercent of public high school mathematics and science teachers in each state, by age, grades 9-12: 1989

State	Mathematics: Total number of teachers	Mathematics: Under 30	Mathematics: 30-49	Mathematics: 50 and over	Biology: Total number of teachers	Biology: Under 30	Biology: 30-49	Biology: 50 and over
Alabama	1,597	13	69	13	809	12	72	12
Alaska	NA	NA	NA	NA	NA	NA	NA	NA
Arizona	NA	NA	NA	NA	NA	NA	NA	NA
Arkansas	(P) 650	14	71	15	518	12	74	14
California	9,684	13	61	26	3,733	14	65	21
Colorado /1	1,297	9	69	22	1,161	9	69	22
Connecticut	1,453	6	74	20	620	6	70	24
Delaware	(P) 240	9	63	28	(P) 55	4	73	23
District of Columbia	NA	NA	NA	NA	NA	NA	NA	NA
Florida	NA	NA	NA	NA	NA	NA	NA	NA
Georgia	NA	NA	NA	NA	NA	NA	NA	NA
Hawaii	831	14	63	17	153	14	62	15
Idaho	649	17	64	19	270	8	73	20
Illinois	3,745	11	66	23	1,312	9	63	28
Indiana	2,298	15	68	17	1,003	11	67	22
Iowa	1,487	15	67	18	700	16	65	19
Kansas	1,179	22	57	21	653	16	64	20
Kentucky	1,659	19	71	10	689	11	75	14
Louisiana	NA	NA	NA	NA	NA	NA	NA	NA
Maine	796	14	71	15	357	16	69	15
Maryland	NA	NA	NA	NA	NA	NA	NA	NA
Massachusetts	NA	NA	NA	NA	NA	NA	NA	NA
Michigan	3,339	8	68	24	839	8	66	26
Minnesota	1,811	10	61	29	715	9	61	30
Mississippi	719	14	68	17	398	11	71	18

Continued

NOTES: Total number of teachers includes teachers with primary or secondary assignment in subject. (P) denotes only teachers with primary assignment reported.
States without data did not participate in the survey.
1/ Total teachers reported under biology represent all science fields.
NA Not available.
SOURCES: State Departments of Education, Data on Public Schools (1989); North Carolina Department of Education, Data on Public Schools (1988);
R. K. Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education--1990* (Washington, DC: Council of Chief State School Officers, 1990), 62.

Percent of public high school mathematics and science teachers in each state, by age, grades 9-12: 1989, continued

State	Mathematics: Total number of teachers	Mathematics: Percent by age: Under 30	Mathematics: Percent by age: 30-49	Mathematics: Percent by age: 50 and over	Biology: Total number of teachers	Biology: Percent by age: Under 30	Biology: Percent by age: 30-49	Biology: Percent by age: 50 and over
Missouri	1,999	19	65	15	986	17	68	14
Montana	535	13	68	19	236	12	70	18
Nebraska	NA	NA	NA	NA	NA	NA	NA	NA
Nevada	673	11	68	22	213	10	71	19
New Hampshire	NA	NA	NA	NA	NA	NA	NA	NA
New Jersey	(P) 4,375	10	71	19	(P) 887	10	71	20
New Mexico	643	12	68	20	301	13	69	18
New York	7,853	9	71	20	5,180	11	68	21
North Carolina	(P) 2,656	20	70	10	(P) 1,036	21	66	13
North Dakota	471	22	65	13	262	19	65	16
Ohio	4,254	16	70	13	1,695	12	73	16
Oklahoma	1,674	17	72	11	901	19	72	9
Oregon	1,222	12	65	22	338	9	69	22
Pennsylvania	5,704	9	72	19	1,755	8	70	22
Rhode Island	(P) 418	3	82	15	(P) 155	6	77	17
South Carolina	1,853	18	70	13	615	15	72	13
South Dakota	707	18	60	22	230	23	64	13
Tennessee	1,872	15	63	14	709	12	66	13
Texas	NA	NA	NA	NA	NA	NA	NA	NA
Utah	1,114	16	62	22	505	12	68	20
Vermont	NA	NA	NA	NA	NA	NA	NA	NA
Virginia	3,114	12	69	19	994	12	66	22
Washington	NA	NA	NA	NA	NA	NA	NA	NA
West Virginia	NA	NA	NA	NA	NA	NA	NA	NA
Wisconsin	1,960	13	66	21	838	8	65	27
Wyoming	NA	NA	NA	NA	NA	NA	NA	NA
Total (36 States)	76,531	13	68	19	31,821	12	68	20

Continued

NOTES. Total number of teachers includes teachers with primary or secondary assignment in subject. (P) denotes only teachers with primary assignment reported. States without data did not participate in the survey.

NA Not available.

SOURCES: State Departments of Education, Data on Public Schools (1989); North Carolina Department of Education, Data on Public Schools (1988); R. K Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education--1990* (Washington, DC: Council of Chief State School Officers, 1990), 62

·ercent of public high school mathematics and science teachers in each state, by age, grades 9-12: 1989, continued

State	Chemistry: Total number of teachers	Chemistry: Percent by age, Under 30	Chemistry: 30-49	Chemistry: 50 and over	Physics: Total number of teachers	Physics: Percent by age, Under age 30	Physics: 30-49	Physics: 50 and over
Alabama	380	14	66	15	305	16	60	18
Alaska	NA	NA	NA	NA	NA	NA	NA	NA
Arizona	NA	NA	NA	NA	NA	NA	NA	NA
Arkansas	283	12	71	18	220	13	65	22
California	1,308	15	62	23	868	14	63	22
Colorado /1	NA	NA	NA	NA	NA	NA	NA	NA
Connecticut	373	6	67	27	243	7	64	29
Delaware	(P) 17	0	59	41	(P) 41	17	54	29
District of Columbia	NA	NA	NA	NA	NA	NA	NA	NA
Florida	NA	NA	NA	NA	NA	NA	NA	NA
Georgia	NA	NA	NA	NA	NA	NA	NA	NA
Hawaii	49	12	67	18	39	15	62	21
Idaho	129	11	62	27	104	13	56	31
Illinois	654	10	60	30	293	12	56	32
Indiana	491	13	66	21	368	13	62	25
Iowa	427	17	63	20	390	16	63	21
Kansas	370	20	63	17	262	14	63	23
Kentucky	345	14	73	13	220	16	71	12
Louisiana	NA	NA	NA	NA	NA	NA	NA	NA
Maine	203	14	68	18	173	13	83	21
Maryland	NA	NA	NA	NA	NA	NA	NA	NA
Massachusetts	NA	NA	NA	NA	NA	NA	NA	NA
Michigan	434	5	62	33	261	6	66	29
Minnesota	475	9	92	45	366	8	59	33
Mississippi	141	13	68	18	46	9	70	20

Continued

NOTES: Total number of teachers includes teachers with primary or secondary assignment in subject. (P) denotes only teachers with primary assignment reported.
States without data did not participate in the survey.
1/ Total teachers reported under biology represent all science fields.
NA Not available
SOURCES: State Departments of Education. Data on Public Schools (1989); North Carolina Department of Education, Data on Public Schools (1988);
R. K. Blank and M. Dalkilic. *State Indicators of Science and Mathematics Education--1990* (Washington, DC: Council of Chief State School Officers, 1990), 62.

Percent of public high school mathematics and science teachers in each state, by age, grades 9-12: 1989, continued

State	Chemistry: Total number of teachers	Chemistry: Percent by age: Under 30	Chemistry: Percent by age: 30-49	Chemistry: Percent by age: 50 and over	Physics: Total number of teachers	Physics: Percent by age: Under 30	Physics: Percent by age: 30-49	Physics: Percent by age: 50 and over
Missouri	574	19	63	18	361	14	65	21
Montana	154	18	65	17	132	16	67	17
Nebraska	NA	NA	NA	NA	NA	NA	NA	NA
Nevada	69	13	77	10	41	7	73	20
New Hampshire	NA	NA	NA	NA	NA	NA	NA	NA
New Jersey	(P) 337	12	66	22	(P) 82	7	65	28
New Mexico	121	7	75	18	78	10	73	17
New York	1,864	9	64	27	1,158	7	66	27
North Carolina	(P) 469	46	25	29	(P) 264	15	68	17
North Dakota	174	20	67	13	125	14	70	16
Ohio	985	14	71	15	751	13	73	14
Oklahoma	481	14	73	13	240	7	75	18
Oregon	NA	NA	NA	NA	NA	NA	NA	NA
Pennsylvania	1,016	10	66	24	670	10	64	26
Rhode Island	(P) 77	3	68	30	(P) 44	2	80	18
South Carolina	324	15	68	17	210	13	70	17
South Dakota	151	23	60	17	125	22	60	18
Tennessee	357	13	64	18	238	9	63	21
Texas	NA	NA	NA	NA	NA	NA	NA	NA
Utah	105	11	72	17	69	10	71	19
Vermont	NA	NA	NA	NA	NA	NA	NA	NA
Virginia	543	13	64	24	323	13	56	31
Washington	NA	NA	NA	NA	NA	NA	NA	NA
West Virginia	NA	NA	NA	NA	374	9	60	30
Wisconsin	522	10	62	28	NA	NA	NA	NA
Wyoming	NA	NA	NA	NA	NA	NA	NA	NA
Total (36 States)	14,402	13	65	22	9,484	11	65	23

NOTES: Total number of teachers includes teachers with primary or secondary assignment in subject. (P) denotes only teachers with primary assignment reported.
States without data did not participate in the survey.
NA Not available

SOURCES: State Departments of Education, Data on Public Schools (1989), North Carolina Department of Education, Data on Public Schools (1988).
R. K. Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education--1990* (Washington, DC: Council of Chief State School Officers, 1990), 62.

Appendix Table 3-8

Percent of all public school teachers, by age-group: 1961 to 1991

Age	1961	1966	1971	1976	1981	1986	1991
Total	NA	100.0	100.0	100.0	100.0	100.0	100.0
Less than 30 years	NA	33.9	37.1	37.1	18.7	11.0	11.1
30-49 years	NA	40.3	40.6	47.4	61.9	67.8	66.0
50 years and over	NA	25.8	22.3	15.5	19.4	21.2	22.9
Mean age	42	39	38	36	39	41	42

NA Subgroup data not available.
SOURCE: National Education Association, *Status of the American Public School Teacher. 1990-1991* (Washington, DC, 1992), 77.

Appendix Table 3-9

Percent of students, by mathematics teacher's race and ethnicity and student characteristics, grades 4 and 8: 1990

Grade and student characteristics	Mathematics teacher's race and ethnicity - - White	Black	Hispanic
	Percent of students	Percent of students	Percent of students
Grade 4	85 (2.0)	11 (1.6)	2 (0.6)
Sex			
Male	85 (2.1)	11 (1.7)	2 (0.7)
Female	85 (2.0)	11 (1.7)	2 (0.6)
Race and ethnicity			
White	93 (1.8)	5 (1.6)	1 (0.4)
Black	57 (4.3)	40 (4.3)	2 (0.7)
Hispanic	75 (4.0)	13 (2.5)	8 (2.9)
Grade 8	91 (1.7)	5 (1.3)	3 (0.9)
Sex			
Male	91 (1.9)	5 (1.3)	3 (1.1)
Female	91 (1.7)	6 (1.3)	2 (0.8)
Race and ethnicity			
White	95 (1.2)	3 (0.9)	2 (0.7)
Black	77 (5.2)	21 (5.0)	2 (0.8)
Hispanic	80 (5.1)	5 (1.7)	13 (4.8)

NOTE: Standard errors are presented in parentheses.

SOURCE: National Center for Education Statisitcs, *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States*, Report No. 21-ST-04 (Washington, DC: U.S. Department of Education, 1991), 215.

Appendix Table 3-10

Percent of mathematics or science teachers who teach those subjects as a main assignment, by years of teaching experience and teaching level: 1987-88

Teaching level	Sample size	Years of teaching experience: Percent of total	3 or less	4-19	20 or more	Sample size	Years of teaching experience in main field: Percent of total	3 or less	4-19	20 or more
Elementary	436	100.0	11.4	62.0	26.6	238	100.0	34.1	58.8	7.1
			(2.1)	(2.5)	(2.3)			(3.8)	(3.4)	(2.2)
Secondary	6,044	100.0	12.5	57.9	29.6	1,748	100.0	33.3	57.7	9.0
			(0.5)	(0.8)	(0.6)			(1.4)	(1.3)	(0.7)

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-11

Teaching experience for teachers of 4th- and 8th-grade students: 1990

Grade	Type of teaching experience	Percent ot total	Teaching experience: 5 years or less	6-14 years	15 years or more	Average years
Grade 4	All subjects	100.0	20.9	26.3	52.8	14.8
			(1.8)	(1.9)	(2.5)	(0.4)
	Mathematics only	100.0	25.1	27.7	47.2	13.6
			(2.1)	(1.9)	(2.5)	(0.4)
Grade 8	All subjects	100.0	17.0	27.9	55.1	16.0
			(1.7)	(2.1)	(2.5)	(0.5)
	Mathematics only	100.0	20.5	34.8	44.7	14.0
			(1.7)	(2.5)	(2.9)	(0.5)

NOTE: Standard errors are presented in parentheses.
SOURCE: Special tabulation created by the Educational Testing Service from the NAEP 1990 Mathematics Assessment: Teacher Questionnaire.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-12

Percent of mathematics or science teachers who teach those subjects as a main or second assignment, by highest degree earned and selected teacher characteristics: 1987-88

Teacher characteristic	Sample size	Highest degree earned: B.A./B.S.	M.A./M.S.	Education specialist	Professional or Ph.D.
Elementary specialists	728	55.7 (2.0)	36.1 (1.9)	6.5 (0.9)	1.7 (0.6)
Sex					
Male	178	49.6 (3.8)	43.1 (3.8)	3.6 (1.7)	3.7 (1.8)
Female	547	57.8 (2.4)	33.8 (2.4)	7.3 (1.0)	1.0 (0.6)
Years of teaching experience					
0 - 3	83	87.6 (4.7)	7.1 (3.1)	- -	1.9 (1.3)
4 - 19	457	56.8 (2.5)	36.9 (2.5)	4.8 (1.2)	1.5 (0.8)
20 or more	188	39.6 (3.8)	46.6 (3.8)	11.8 (2.5)	2.0 (1.4)
Secondary teachers	6,772	48.7 (0.6)	43.9 (0.6)	6.0 (0.3)	1.5 (0.2)
Sex					
Male	3,748	44.2 (0.7)	47.3 (0.8)	6.4 (0.5)	2.1 (0.3)
Female	3,001	54.0 (1.2)	39.7 (1.1)	5.6 (0.4)	0.7 (0.2)
Years of teaching experience					
0 - 3	875	85.6 (1.4)	11.8 (1.4)	1.6 (0.3)	1.1 (0.4)
4 - 19	3,954	49.6 (0.9)	44.0 (0.9)	5.2 (0.4)	1.2 (0.2)
20 or more	1,943	31.1 (1.3)	57.4 (1.4)	9.4 (0.7)	2.0 (0.4)

NOTE: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.

- - Too few cases for a reliable estimate.

SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 3-13

Percent of elementary teachers of mathematics or science, by field of bachelor's degree and teaching field:

Teaching field	Sample size	Bachelor's degree field: Mathematics	Science	Elementary education	Secondary education	Mathematics education
All elementary teachers	15,434	0.3 (0.1)	1.0 (0.1)	70.0 (0.4)	0.8 (0.1)	0.1 (0.0)
Elementary specialists						
Mathematics	453	2.6 (0.7)	2.0 (0.8)	62.6 (2.5)	1.8 (0.9)	1.5 (0.8)
Science	255	- -	10.5 (1.9)	55.6 (4.1)	0.8 (0.5)	- -

NOTE: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.
- - Too few cases for a reliable estimate.
SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 3-14

Percent of secondary school teachers of mathematics or science, by field of bachelor's degree, teaching assignment, and level: 1987-88

Teaching assignment and level	Sample size	Bachelor's degree field: Mathematics	Science	Elementary education	Secondary education	Mathematics education	Science education	Other
Total	9,442	13.5 (0.4)	20.0 (0.5)	13.8 (0.4)	3.4 (0.2)	6.7 (0.3)	2.9 (0.2)	39.7 (0.6)
Teach mathematics or science as main or second assignment								
Teach grades 7-8 only								
Mathematics	662	20.2 (2 2)	5.7 (1.0)	26.9 (2.1)	2.9 (0.8)	11.8 (1.4)	1.1 (0.5)	31.2 (2.3)
Science	607	0.9 (0.4)	34.4 (2.4)	19.6 (2.0)	4.3 (0.8)	- -	6.5 (1.1)	34.0 (2.2)
Teach grades 9-12 only								
Mathematics	1,902	43.4 (1.3)	7.1 (0.8)	3.0 (0.5)	4.0 (0.4)	19.1 (1.0)	0.4 (0.1)	23.0 (0.9)
Science	1,650	1.2 (0 2)	62 3 (1.5)	0.7 (0.2)	4.1 (0.4)	0.7 (0.2)	8.2 (0.9)	22.8 (1.3)
Teach mathematics or science, but not as main or second assignment								
Teach grades 7-8 only	404	2.1 (0.8)	2.3 (0.6)	30.5 (3.2)	4.7 (1.1)	- -	- -	60.0 (3.3)
Teach grades 9-12 only	1,137	2 6 (0.5)	3.8 (0.7)	8.4 (1.0)	2.8 (0.6)	1.1 (0.2)	0.9 (0.4)	80.4 (1.2)

NOTES Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.

- - Too few cases for a reliable estimate.

SOURCE. National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Mednch, Management Planning Research Associates, Inc 'ppendix Table 3-15

'ercent of secondary school mathematics or science teachers who teach those subjects as a main or second assignment, 'y field of bachelor's degree, teaching level, and field: 1987-88

'eaching level 'nd field	Sample size	Bachelor's degree field										
		Mathematics	Biology	Chemistry	Earth science	Physics	Other physical science	Elementary education	Secondary education	Mathematics education	Science education	Other
'otal	6,650	18.2 (0.5)	17.0 (0.6)	4.5 (0.3)	1.7 (0.2)	1.4 (0.2)	2.1 (0.2)	10.6 (0.5)	3.7 (0.3)	9.0 (0.4)	3.8 (0.3)	27.8 (0.6)
Teaching grades 7-8 only												
Mathematics	662	20.2 (2.2)	2.9 (0.8)	0.4 (0.2)	0.6 (0.2)	0.5 (0.2)	1.4 (0.6)	26.9 (2.1)	2.9 (0.8)	11.8 (1.4)	1.1 (0.5)	31.2 (2.3)
Biology	137	0.0 (0.0)	38.1 (4.9)	- -	- -	0.0 (0.0)	- -	18.4 (4.5)	- -	0.0 (0.0)	6.8 (2.7)	34.8 (5.2)
Earth science	174	- -	17.3 (3.3)	1.3 (0.8)	9.2 (3.3)	- -	0.0 (0.0)	25.2 (4.5)	4.3 (1.7)	- -	3.9 (1.5)	36.9 (4.7)
General/other science	296	1.6 (0.9)	26.0 (2.9)	4.1 (1.5)	2.7 (1.0)	- -	2.1 (0.9)	16.8 (2.6)	5.9 (1.3)	- -	7.8 (1.6)	31.9 (3.7)
Teaching grades 9-12 only												
Mathematics	1,902	43.4 (1.3)	1.5 (0.3)	1.7 (0.4)	0.4 (0.2)	1.6 (0.4)	1.9 (0.4)	3.0 (0.5)	4.0 (0.4)	19.1 (1.0)	0.4 (0.1)	23.0 (0.9)
Biology	726	0.0 (0.0)	62.7 (2.5)	1.2 (0.6)	0.6 (0.4)	0.0 (0.0)	1.5 (0.7)	0.5 (0.3)	2.8 (0.5)	0.7 (0.3)	7.4 (1.0)	22.6 (2.5)
Chemistry/physics	484	3.0 (0.7)	22.8 (2.5)	32.0 (2.5)	0.5 (0.3)	7.8 (1.4)	5.8 (1.4)	- -	5.0 (0.9)	1.0 (0.5)	8.3 (1.5)	13.6 (2.1)
Earth science	112	1.4 (1.0)	23.9 (5.3)	3.0 (1.8)	25.6 (5.0)	2.5 (1.5)	3.5 (2.7)	- -	8.3 (2.1)	0.0 (0.0)	8.4 (3.1)	22.4 (4.3)
General/other science	328	1.2 (0.8)	25.1 (2.7)	9.5 (1.4)	2.9 (1.2)	1.9 (1.0)	4.9 (1.7)	1.9 (0.7)	4.3 (1.1)	- -	9.8 (2.0)	38.1 (3.5)

NOTES: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding or missing values in cells with too few cases.
- - Too few cases for a reliable estimate.
SOURCE: National Center for Education Statistics, U S Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 3-16

Percent of public school 8th-grade students, by science teacher's baccalaureate major, and student and school characteristics: 1988

Student and school characteristic	Sample size	Science teacher's baccalaureate major: Major in science/science education	Minor in science/science education	Major in education only	Major in other subject
Total	8,517	48.6 (2.3)	23.5 (1.8)	15.6 (1.7)	12.3 (1.5)
Socioeconomic status					
Low	2,320	44.0 (2.9)	23.6 (2.3)	18.3 (2.3)	14.1 (2.0)
Middle	4,311	49.6 (2.5)	23.9 (2.0)	15.2 (1.7)	11.3 (1.5)
High	1,885	51.6 (2.6)	22.5 (2.2)	13.6 (1.9)	12.3 (2.2)
Race and ethnicity					
White	5,607	48.6 (2.6)	24.2 (2.1)	15.5 (1.9)	11.7 (1.7)
Black	1,042	48.9 (3.6)	19.6 (2.8)	18.5 (2.7)	13.0 (2.8)
Hispanic	1,123	46.6 (6.3)	20.5 (3.6)	16.1 (4.7)	16.8 (4.1)
Asian/Pacific Islander	496	53.3 (3.5)	22.6 (3.1)	11.4 (2.4)	12.6 (2.2)
Native American	146	39.9 (9.8)	47.7 (12.0)	7.1 (2.5)	5.3 (2.3)
School free lunch participation percentage					
5 or less	1,551	48.8 (5.0)	23.8 (4.0)	17.2 (3.9)	10.3 (3.0)
6-20	2,382	52.0 (4.1)	27.6 (3.5)	11.1 (2.6)	9.3 (2.0)
21-50	3,204	49.6 (3.7)	21.3 (3.3)	17.3 (3.1)	11.8 (2.1)
Over 50	1,264	38.9 (6.6)	19.5 (4.2)	16.5 (4.3)	25.1 (5.7)

NOTES: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding.

SOURCE: National Center for Education Statistics, U.S. Department of Education, National Education Longitudinal Study of 1988 (NELS:88), "Base Year Student and Teacher" surveys, as cited by L. Horn, A. Hafner, and J. Owings in *A Profile of American Eighth-Grade Mathematics and Science Instruction*, NCES 92-486 (Washington, DC: 1992), 27, 29, 88.

Appendix Table 3-17

Percent of public school 8th-grade students, by mathematics teacher's baccalaureate major, and student and school characteristics: 1988

Student and school characteristic	Sample size	Mathematics teacher's baccalaureate major: Major in mathematics/ mathematics education	Minor in mathematics/ mathematics education	Major in education only	Other subject
Total	9,075	43.3 (1.9)	27.1 (1.7)	18.2 (1.5)	11.4 (1.1)
Socioeconomic status					
Low	2,650	38.5 (2.4)	25.9 (2.3)	23.1 (2.2)	12.6 (1.5)
Middle	4,501	43.2 (2.0)	27.7 (1.8)	17.7 (1.5)	11.4 (1.3)
High	1,921	49.8 (2.3)	26.2 (2.1)	13.2 (1.7)	9.8 (1.3)
Race and ethnicity					
White	5,980	45.7 (2.1)	27.2 (2.0)	17.7 (1.7)	9.4 (1.2)
Black	1,218	40.0 (3.3)	26.6 (3.1)	21.5 (2.9)	12.9 (2.4)
Hispanic	1,201	33.3 (3.9)	28.5 (3.9)	17.5 (3.3)	20.8 (3.2)
Asian/Pacific Islander	515	44.1 (3.7)	23.5 (3.0)	15.0 (2.6)	17.5 (2.9)
Native American	81	30.5 (6.1)	23.5 (5.6)	23.4 (5.3)	22.6 (4.9)
School free lunch participation percentage					
5 or less	1,566	45.7 (4.3)	26.6 (3.7)	15.6 (3.1)	12.1 (2.7)
6-20	2,690	49.7 (3.4)	26.2 (2.8)	14.0 (2.3)	10.1 (2.1)
21-50	3,140	40.3 (3.2)	27.8 (3.1)	20.3 (2.8)	11.5 (1.6)
Over 50	1,568	31.8 (4.8)	26.1 (4.6)	24.1 (4.5)	18.2 (3.9)

NOTES: Standard errors are presented in parentheses. Percents may not add to 100 because of rounding.

SOURCE: National Center for Education Statistics, U.S. Department of Education, National Education Longitudinal Study of 1988 (NELS.88), "Base Year Student and Teacher" surveys, as cited by L. Horn, A. Hafner, and J. Owings in *A Profile of American Eighth-Grade Mathematics and Science Instruction*, NCES 92-486 (Washington, DC: 1992), 26, 28, 87.

Appendix Table 3-18

Average mathematics and science achievement test scores of public school 8th-grade students, by teacher's education and teaching experience: 1988

Teacher's education and experience	Mathematics score	Sample size	Science score	Sample size
Total	49.6 (0.2)	8,797	49.9 (0.3)	8,361
Highest degree earned				
Bachelor's	49.3 (0.3)	4,792	49.9 (0.4)	4,449
Post-graduate	49.9 (0.3)	3,948	50.0 (0.4)	3,813
No degree /1	- - (- -)	- -	- - (- -)	- -
Bachelor's subject				
Majored in subject taught	51.1 (0.3)	3,807	50.0 (0.3)	4,111
Minored in subject taught	49.9 (0.4)	2,352	50.2 (0.5)	1,964
Majored in education /2	47.1 (0.5)	1,557	49.0 (0.7)	1,232
Majored in other subject /2	47.4 (0.6)	1,081	49.9 (0.9)	1,054
Number of years teaching				
1-3	47.5 (0.5)	918	49.2 (0.6)	990
4-9	49.2 (0.5)	1,627	49.6 (0.4)	1,664
10 or more	50.0 (0.4)	5,476	50.2 (0.5)	5,639

NOTE: Standard errors are presented in parentheses.
- - Too few cases for a reliable estimate.
1/ Fewer than 50 students.
2/ Teachers fell into this category if mathematics teachers did not minor in mathematics and science teachers did not minor in science.
SOURCE: National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), "Base Year Student and Teacher" surveys (Washington, DC: U.S. Department of Education), 51, 102.

Appendix Table 3-19

Percent of elementary mathematics teachers, by college course taken and grades: 1985-86

College course taken	All teachers	Grades K-3	Grades 4-6
Methods of teaching elementary mathematics	90	90	90
Instructional uses of computers	32	30	34
Computer programming	20	17	24
Mathematics for elementary school teachers	90	89	90
Mathematics for secondary school teachers	16	11	21
Geometry for elementary or middle school teachers	19	17	21
College algebra, trigonometry, elementary functions	33	30	37
Calculus	9	8	12
Upper division geometry	6	5	7
Probability and statistics	23	21	27
Sample size	679	433	246

SOURCE: I. R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-36.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-20

Percent of mathematics teachers of grades 7-9, by college course taken: 1985-86

College course	Total	Taken	Not taken	Unknown
Calculus	101	69	29	3
College geometry	100	67	30	3
Abstract algebra	101	48	50	3
Applications of mathematics	101	35	63	3
Probability and statistics	100	59	38	3
Computer programming	101	46	52	3
Methods of teaching mathematics	100	83	14	3
Sample size	671			

NOTE: Percents may not add to 100 because of rounding.
SOURCE: I. R. Weiss, *Course Background Preparation of Science and Mathematics Teachers in the United States* (Chapel Hill, NC: Horizon Research, Inc., 1988), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-45.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-21

Percent of mathematics teachers of grades 10-12, by college course taken: 1985-86

College course	Total	Taken	Not taken	Unknown
Calculus	100	89	11	0
Three courses in calculus	100	67	29	4
Linear algebra	100	69	31	0
Abstract algebra	100	69	31	0
Geometry	100	80	20	0
Applications of mathematics	100	39	61	0
Probability and statistics	100	76	24	0
Other upper division mathematics	100	37	63	0
History of mathematics	99	37	62	0
Computer programming	100	64	36	0
Methods of teaching mathematics	100	85	11	4
Sample size	565			

NOTE: Percents may not add to 100 because of rounding.

SOURCE: I. R. Weiss, *Course Background Preparation of Science and Mathematics Teachers in the United States* (Chapel Hill, NC: Horizon Research, Inc., 1988), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-45.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-22

Percent of science teachers of grades 7-9, by number of college courses taken in teaching field: 1985-86

Number of college courses taken in teaching field	Teaching field		
	Life science/ biology	Earth science	Physical science
0	0	22	2
1	1	16	3
2	9	14	5
3	3	11	5
4	11	6	8
5	9	2	14
6	5	7	9
7	5	2	5
8 or more	56	19	47
Unknown	1	3	2
Total	100	102	100
Sample size	307	207	202

NOTE: Percents may not add to 100 because of rounding.

SOURCE: I. R. Weiss, *Course Background Preparation of Science and Mathematics Teachers in the United States* (Chapel Hill, NC: Horizon Research, Inc., 1988), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-31.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-23

Number of years since completing last college course for mathematics and science teachers, by grade range: 1985-86

Years since completing last college course	Percent of teachers: Teaching science in grades: K-6	7-9	10-12	Teaching mathematics in grades: K-6	7-9	10-12
Total	100	100	100	100	100	100
Within last 5 years	28	61	57	37	48	53
5 to 10 years ago	22	15	18	18	17	19
10 to 15 years ago	19	14	15	19	19	12
More than 15 years ago	31	10	10	26	16	16

SOURCE: I. R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-19.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-24

Percent of mathematics and science teachers, by time spent on in-service education in their teaching field in last 12 months: 1985-86

Subject and grade range	Sample size	Percent of total	Percent of teachers: None	Less than 6 hours	6-15 hours	16-35 hours	More than 35 hours	Unknown
Mathematics								
K-6	686	100	41	29	15	5	3	7
7-9	671	101	31	25	22	11	8	4
10-12	565	100	35	18	21	13	10	3
Science								
K-6	710	100	50	22	13	4	3	8
7-9	658	100	30	22	22	12	10	4
10-12	1,050	100	27	23	25	12	12	1

NOTE: Percents may not add to 100 because of rounding.
SOURCE: I. R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990), T-18.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-25

Percent of 8th-grade students, by mathematics and science teachers' perception of their preparedness to teach, and college course-taking: 1988

Teaching field and college course-taking	Teachers' perception of preparedness				
	Very well prepared	Well prepared	Adequately prepared	Somewhat prepared	Totally unprepared
Mathematics teachers					
Total	83	13	3	0	0
No courses in mathematics /1	60	31	9	1	0
Courses in mathematics education only /1	67	27	4	2	1
Courses in mathematics but not in mathematics education					
Calculus level or below	77	17	2	4	0
Some advanced courses	78	17	5	0	0
Courses in both mathematics and mathematics education					
Calculus level or below	76	18	5	0	0
Some advanced courses	91	7	1	0	0
Science teachers					
Total	52	30	14	4	0
No science courses, or science education only /1	49	16	0	35	0
Science courses only					
40 credits or less	37	34	22	6	1
More than 40 credits	67	17	12	4	0
Both science courses and science education					
40 credits or less	36	47	13	4	0
More than 40 credits	68	24	8	1	0

NOTE: Percents may not add to 100 because of rounding.

1/ Estimates in these categories are unstable because of the small number of teachers with no courses in mathematics or science.

SOURCE: NELS:88 Teacher Transcript Study as cited in B. Chaney, *Teacher's Academic Preparation and Its Connection to Teaching Methods and Student Outcomes in Science and Mathematics* (Washington, DC: National Science Foundation, 1991), 18.

Appendix Table 3-26

Percent of elementary teachers with different perceptions of their qualifications to teach various subjects: 1985-86

Subject	Total	Teachers' perception of qualification: Not well qualified	Adequately qualified	Very well qualified	Unknown
Mathematics	100	1	30	67	2
Life science	100	11	60	27	2
Physical science	100	23	59	15	3
Earth/space science	100	22	59	15	4
Social studies	100	4	47	47	2
Reading	100	1	15	82	2
Sample size	1.396				

SOURCE: I. R. Weiss. *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park. NC: Research Triangle Institute. 1987). as cited in *Science o ıd Mathematics Education Briefing Book. Volume I* (Washington. DC: National Science Teachers Association. 1990). T-8.

Indicators of Science and Mathematics Education 1992

...ent of U.S. college freshmen choosing selected careers, by sex: 1966 to 1990

Sex and planned career	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
All													
Education (elementary)	7.6	8.3	9.1	9.0	8.0	6.8	5.6	4.2	3.5	3.0	4.3	4.0	3.7
Education (secondary)	14.1	14.1	14.4	13.1	11.3	8.6	6.5	4.6	4.2	3.5	3.7	3.2	2.7
Engineer	8.9	8.4	8.3	8.3	7.5	5.3	5.3	5.3	4.7	5.9	7.8	8.3	9.1
Nurse	2.5	2.5	2.7	2.7	4.0	4.1	4.7	4.5	5.1	4.8	4.6	4.5	4.1
Research scientist	3.5	2.9	2.9	2.5	2.6	2.5	2.3	3.1	2.1	2.0	2.4	2.2	2.2
Men													
Education (elementary)	0.8	0.8	1.2	1.0	0.9	0.9	0.7	0.6	0.6	0.5	0.7	0.6	0.4
Education (secondary)	10.5	10.4	11.5	9.9	8.7	6.6	5.0	3.5	3.2	2.7	3.1	2.5	2.1
Engineer	16.3	15.0	14.6	14.5	13.3	9.7	9.6	9.4	8.5	10.2	13.7	15.1	16.5
Nurse	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2
Research scientist	4.9	3.9	3.8	3.3	3.5	3.3	3.1	3.7	2.7	2.5	3.0	2.8	2.7
Women													
Education (elementary)	15.7	17.6	19.4	19.3	16.6	13.8	11.1	8.2	6.7	5.8	8.1	7.5	6.8
Education (secondary)	18.4	18.8	18.1	17.2	14.4	11.0	8.4	5.9	5.2	4.5	4.4	3.9	3.3
Engineer	0.2	0.2	0.2	0.3	0.4	0.2	0.3	0.7	0.8	1.1	1.5	1.5	2.2
Nurse	5.3	5.4	6.1	6.0	8.7	8.6	9.8	9.2	10.2	9.9	9.1	8.8	7.7
Research scientist	1.9	1.6	1.7	1.4	1.6	1.5	1.5	2.4	1.4	1.5	1.7	1.6	1.7

Continued

NOTES: Figures for the years 1966 to 1976 are from annual Norms Reports. Figures from 1977 to 1990 are computed from disaggregated majors/careers
List of careers for 1973 to 1976 is not directly comparable to other years.
SOURCE: E. L. Dey, A. A. Astin, and W. S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966-1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), 54-55, 84-85, 114-15.

...ent of U.S. college freshmen choosing selected careers, by sex: 1966 to 1990, continued

Sex and planned career	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
All												
Education (elementary)	3.8	3.8	3.5	3.0	3.1	3.4	3.8	4.4	5.0	5.6	5.0	5.4
Education (secondary)	2.9	2.4	2.2	1.9	2.2	2.3	2.6	3.2	3.4	3.5	3.6	4.0
Engineer	9.3	10.7	10.9	12.0	10.8	10.4	10.0	9.7	8.5	8.6	9.0	8.1
Nurse	3.7	3.8	3.9	4.0	4.4	4.0	3.3	2.7	2.2	2.5	2.7	3.8
Research scientist	1.8	1.7	1.6	1.5	1.5	1.5	1.4	1.4	1.5	1.6	1.6	1.4
Men												
Education (elementary)	0.5	0.5	0.4	0.4	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.9
Education (secondary)	2.2	2.0	1.7	1.5	1.9	1.9	2.2	2.7	2.8	2.9	3.0	3.2
Engineer	16.8	19.1	19.5	20.6	18.8	18.5	17.7	17.4	15.2	15.7	16.5	14.9
Nurse	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.3	0.3	0.7
Research scientist	2.4	2.2	2.0	1.8	1.8	1.9	1.7	1.8	1.8	2.0	1.9	1.7
Women												
Education (elementary)	7.0	6.9	6.4	5.5	5.7	6.1	6.7	7.9	8.8	9.7	8.7	9.2
Education (secondary)	3.4	2.7	2.7	2.1	2.4	2.8	3.1	3.5	3.9	4.0	4.0	4.6
Engineer	2.3	2.9	2.9	3.6	3.3	2.9	2.9	2.8	2.6	2.5	2.6	2.4
Nurse	7.0	7.2	7.3	7.7	8.4	7.5	6.2	5.1	4.0	4.4	4.8	6.5
Research scientist	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.3	1.4	1.2

NOTES: Figures for the years 1966 to 1976 are from annual Norms Reports. Figures from 1977 to 1990 are computed from disaggregated majors/careers.
List of careers for 1973 to 1976 is not directly comparable to other years.

SOURCE: E. L. Dey, A. A. Astin, and W. S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966-1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), 54-55, 84-85, 114-15.

Percent of U.S. college freshmen choosing selected careers, by race and ethnicity: 1971 to 1990

Race and ethnicity and planned career	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
White										
Teacher (elementary)	7.3	6.7	NA	NA	NA	5.3	5.1	4.3	4.2	4.4
Teacher (secondary)	9.4	7.0	NA	NA	NA	4.5	3.7	3.5	3.2	2.4
Engineer	5.3	5.3	NA	NA	NA	7.7	8.3	8.9	9.2	10.2
Nurse	3.2	3.1	NA	NA	NA	4.0	3.1	4.1	3.1	3.3
Scientific researcher	3.4	3.2	NA	NA	NA	3.2	3.1	3.0	2.4	2.1
Black										
Teacher (elementary)	7.5	6.6	NA	NA	NA	4.6	4.0	3.3	3.1	2.7
Teacher (secondary)	8.5	7.1	NA	NA	NA	3.4	2.4	2.3	1.8	1.6
Engineer	4.2	4.5	NA	NA	NA	6.3	7.4	7.4	8.0	9.4
Nurse	4.2	6.1	NA	NA	NA	5.3	5.4	4.7	4.4	4.5
Scientific researcher	1 8	1.4	NA	NA	NA	1.2	1.0	0.8	0.8	0.9
Hispanic										
Teacher (elementary)	8.4	5.2	NA	NA	NA	3.3	5.1	3.1	4.0	2.5
Teacher (secondary)	7.5	6.1	NA	NA	NA	4.3	3.5	2.6	2.5	1.2
Engineer	3.9	6.5	NA	NA	NA	7.4	7.3	6.9	6.7	10.5
Nurse	1.7	6.5	NA	NA	NA	3.6	2.6	2.7	3.8	4.2
Scientific researcher	3.1	2.4	NA	NA	NA	2.0	0.9	1.3	1.2	1.8
Asian										
Teacher (elementary)	2.2	1.2	NA	NA	NA	1.0	1.8	0.8	1.4	0.7
Teacher (secondary)	4.1	4.4	NA	NA	NA	1.1	1.2	1.3	0.6	0.6
Engineer	14.1	12.1	NA	NA	NA	16.7	16.3	14.5	21.5	22.3
Nurse	1.3	1.8	NA	NA	NA	3.1	2.5	3.2	1.9	2.3
Scientific researcher	7.4	5.7	NA	NA	NA	4.6	4.3	3.7	3.3	2.3
Native American										
Teacher (elementary)	7.1	5.8	NA	NA	NA	5.3	3.9	1.6	3.5	2.8
Teacher (secondary)	10.2	6.7	NA	NA	NA	6.8	4.5	4.1	2.7	2.0
Engineer	3.7	5.4	NA	NA	NA	5.0	7.5	8.3	9.1	12.4
Nurse	2.0	2.7	NA	NA	NA	3.1	3.8	2.9	3.5	3.4
Scientific researcher	3.7	4.0	NA	NA	NA	2.6	3.4	3.2	2.9	2.7

Continued

NA Not available

SOURCE: E L Dey, A A Astin, and W S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966-1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), as cited in loose printouts that accompanied the source document.

Percent of U.S. college freshmen choosing selected careers, by race and ethnicity: 1971 to 1990, continued

Race and ethnicity and planned career	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
White										
Teacher (elementary)	4.3	3.4	4.2	3.5	4.2	4.8	5.5	5.5	5.8	6.2
Teacher (secondary)	2.4	2.4	2.3	2.8	3.2	3.6	3.5	3.8	3.9	4.3
Engineer	9.8	11.1	10.1	10.3	10.2	9.1	7.8	8.0	8.1	8.0
Nurse	3.3	3.6	3.9	3.4	2.5	2.0	1.6	1.8	1.6	2.0
Scientific researcher	2.2	1.7	2.1	1.8	1.8	1.6	1.7	1.9	1.9	2.0
Black										
Teacher (elementary)	2.1	1.6	1.8	2.1	2.4	2.6	2.9	2.8	2.5	4.4
Teacher (secondary)	1.3	0.9	1.5	1.0	1.7	1.7	1.9	1.7	2.2	2.3
Engineer	9.7	10.7	8.5	7.4	9.3	8.3	10.0	8.2	8.6	8.8
Nurse	4.1	5.1	5.2	5.2	5.2	4.1	3.2	3.2	3.1	3.3
Scientific researcher	0.8	0.6	1.0	0.7	0.6	0.7	0.8	0.8	0.9	0.8
Hispanic										
Teacher (elementary)	2.3	1.6	2.6	1.8	3.0	2.5	2.6	3.9	3.5	4.5
Teacher (secondary)	1.7	1.6	1.4	2.3	1.9	2.5	2.5	2.8	2.4	3.3
Engineer	12.9	10.1	10.1	8.8	11.6	10.2	10.2	8.6	9.6	10.0
Nurse	4.8	2.4	3.5	3.5	2.8	2.1	1.4	1.4	0.8	1.3
Scientific researcher	1.3	0.9	1.5	1.4	2.2	1.4	1.8	1.3	1.2	1.7
Asian										
Teacher (elementary)	0.6	0.6	0.6	0.9	0.5	0.8	0.6	1.0	1.0	1.2
Teacher (secondary)	0.9	0.6	0.7	0.6	0.8	1.0	1.0	0.8	1.2	1.2
Engineer	20.0	21.2	18.7	19.2	18.8	18.2	17.1	15.3	15.9	14.1
Nurse	2.7	3.0	2.7	2.5	1.5	1.1	1.1	0.7	1.2	2.1
Scientific researcher	2.6	3.2	3.1	2.8	2.6	2.4	2.3	2.6	2.2	2.4
Native American										
Teacher (elementary)	4.5	3.2	3.5	3.8	4.0	4.3	3.5	2.2	3.4	4.7
Teacher (secondary)	3.5	1.9	3.8	3.6	2.9	4.5	3.1	3.2	3.4	4.8
Engineer	9.2	8.5	7.4	6.5	5.1	9.1	8.5	6.8	9.4	6.3
Nurse	3.9	3.5	4.6	3.4	3.6	2.1	1.7	1.3	2.6	2.5
Scientific researcher	2.0	1.8	1.4	1.9	1.7	2.0	1.9	2.3	2.3	3.1

SOURCE: E. L. Dey, A. A. Astin, and W. S. Korn, *The American Freshman, Twenty-Five Year Trends, 1966-1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), as cited in loose printouts that accompanied the source document.

Average SAT scores for all college-bound seniors and for those designating education as their first-choice intended field of study: 1982 to 1991

Year	Average SAT scores: Education Verbal	Education Mathematics	All Verbal	All Mathematics
1982	394	419	426	467
1983	394	418	425	468
1984	398	425	426	471
1985	404	432	431	475
1986	---	---	431	475
1987	408	437	430	476
1988	407	442	428	476
1989	406	440	427	476
1990	406	442	424	476
1991	406	441	422	474

--- Data missing due to change in score reporting methodology in 1986.
SOURCE: College-Bound Seniors reports from the College Board.

Indicators of Science and Mathematics Education 1992

State certification for secondary science and mathematics teachers: 1989

State	Course credits by certification field: Mathematics	Science, broad field	Biology, chemistry, physics	Teaching methods requiring science/ mathematics	Supervisory teaching experience required
Alabama	27	52	27	Yes	9
Alaska	*	*	*	*	*
Arizona	30	30	30	Yes	8
Arkansas	21	- -	24	No	12 wks.
California	45	45 (bio./phys.)	- -	No	***
Colorado	*	*	*	Yes	400 hrs.
Connecticut	18	- -	18	No	6
Delaware	30	- -	39-45	Yes	6
District of Columbia	27	30	30	Yes	1 sem.
Florida	21	- -	30	Yes(S)	6
Georgia	60 qtr.	45 qtr.	40 qtr.	Yes(M)	15 qtr. hrs.
Hawaii	*	*	*	*	*
Idaho	20	45	20	No	6
Illinois	24	32	24	Yes	5
Indiana	36	36	36	Yes	9 wks.
Iowa	24	24	24	Yes	Yes
Kansas	*	*	*	*	*
Kentucky	30	48	30	No	9-12
Louisiana	20	- -	20	No	9
Maine	18	18	- -	Yes	6
Maryland	24	36	24	Yes	6
Massachusetts	36	36	36	Yes	300 hrs.
Michigan	30	30	30	No	6
Minnesota	**	**	**	**	**
Mississippi	24	- -	32	Yes(S)	6
Missouri	30	30	20	Yes	8
Montana	30	60	30	Yes	10 wks.
Nebraska	30	45	24	Yes	320 hrs.
Nevada	16	36	16	No	8
New Hampshire	*	*	*	*	*
New Jersey	30	30	30	No	*
New Mexico	24	24	24	Yes	6
New York	24	- -	36	No	*
North Carolina	**	**	**	**	**
North Dakota	16	21	12	No	6
Ohio	30	30	30	No	***
Oklahoma	40	- -	40	No	12 wks.
Oregon	21	45	45	Yes(M)	15 qtr. hrs.
Pennsylvania	*	*	*	*	*
Rhode Island	30	30	30	Yes	6
South Carolina	*	*	*	*	*
South Dakota	18	21	12	No	6
Tennessee	36 qtr.	48 qtr.	24 qtr.	Yes	4
Texas	24	48	24	No	6
Utah	**	**	**	**	**
Vermont	18	18	18	Yes	*
Virginia	27	- -	24	No	6
Washington	24	41	34	No	Yes
West Virginia	**	**	**	**	**
Wisconsin	34	54	34	Yes	5
Wyoming	24	30	12	No	1 course

- - No certification offered. Course credits = semester credit hours, unless otherwise specified (e.g., qtr. = quarter credit hours).

* Certification requirements determined by degree-granting institution or approved/competency-based program.

** Major or minor: Utah. Twenty to 40 percent of program: Minnesota, North Carolina. Courses matched with job requirements: West Virginia.

*** One semester full-time or two semesters half-time: California. Supervised teaching experience and 300 hours clinical/field-based experience: Ohio.

SOURCES: State Departments of Education. Data on Public Schools (1989); North Carolina Department of Education. Data on Public Schools (1988); R. K. Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education--1990* (Washington, DC: Council of Chief State School Officers, 1991), 67.

State requirements for entrance into teacher education and teacher certification: 1990

State	Entrance into teacher education		Completion of teacher education/certification					
	Test	Minimum GPA	Test of basic skills	Test of general knowledge	Test of professional knowledge	Test of specialty area	Minimum GPA	Entry year assistance program
Alabama	x	x					x	
Alaska								
Arizona	x	x	x		x			
Arkansas	x				x	x	x	
California	x/a	x/b	x	x/c		x/c		
Colorado	x	x/d						
Connecticut	x		x		x	x		x
Delaware			x					
Florida	x	x	x		x			x
Georgia	x	x				x		x
Hawaii			x	x	x	x	x	
Idaho			x	x	x		x	
Illinois								
Indiana			x	x	x	x		x
Iowa								
Kansas	x	x	x		x		x	
Kentucky	x	x	x	x	x	x	x	x
Louisiana	x	x	x	x	x	x	x	x/c
Maine			x	x	x			x
Maryland			x	x	x	x		
Massachusetts								
Michigan		x						
Minnesota			x					
Mississippi	x		x	x	x	x	x	x
Missouri	x	x				x		

Continued

NOTE Non reporting states show blank entries

a/ Used for diagnostic purposes. Institutional option for use in admission.

b/ Students must rank in top one-half of their class

c/ In lieu of completion of approved subject matter preparation program

d/ Requirement can be met by minimum GPA, class rank, or minimum college entrance test score

e/ Effective 1990-91

SOURCE: R. Coley and M. Goertz, *Educational Standards in 50 States: 1990* (Princeton: Educational Testing Service, 1990), 30-32.

State requirements for entrance into teacher education and teacher certification: 1990, continued

State	Entrance into teacher education		Completion of teacher education/certification					
	Test	Minimum GPA	Test of basic skills	Test of general knowledge	Test of professional knowledge	Test of specialty area	Minimum GPA	Entry year assistance program
Montana			x	x	x		x	
Nebraska			x			x/f		x
Nevada			x		x	x		
New Hampshire			x					
New Jersey	x	x		x/g		x		
New Mexico	x		x	x	x			
New York			x	x	x			
North Carolina	x				x	x		x
North Dakota							x	
Ohio								
Oklahoma		x				x	x	x
Oregon	x				x	x		
Pennsylvania			x	x	x	x		x
Rhode Island			x	x	x			
South Carolina	x				x	x		x
South Dakota		x						
Tennessee	x		x	x	x	x	x	x
Texas	x				x	x		
Utah								
Vermont								
Virginia			x	x	x	x		x
Washington	x				x/h			
West Virginia			x		x	x		
Wisconsin								
Wyoming	x	x						

NOTE: Non-reporting states show blank entries.
f/ To be implemented.
g/ For elementary education certification only
h/ Effective August 1993.
SOURCE: R. Coley and M. Goertz, *Educational Standards in 50 States 1990* (Princeton: Educational Testing Service, 1990), 30-32

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Appendix Table 3-32

Percent of science and mathematics teachers indicating that each factor is a serious problem in their school, by subject and grade range: 1985-86

Factor	Science teachers			Mathematics teachers		
	K-6	7-9	10-12	K-6	7-9	10-12
Belief that science/mathematics is less important than other subjects	8	5	5	2	2	2
Inadequate facilities	25	25	18	4	3	5
Insufficient funds for purchasing equipment and supplies	30	26	23	11	11	9
Lack of materials for individualizing instruction	30	27	20	14	15	10
Insufficient supply of textbooks	11	4	4	4	6	4
Lack of student interest in subject	3	14	16	5	22	22
Inadequate student reading abilities	13	19	23	9	18	23
Lack of teacher interest in subject	7	2	1	2	1	1
Teachers inadequately prepared to teach subject	9	5	2	2	3	3
Lack of teacher planning time	24	13	13	13	6	6
Not enough time to teach subject	21	9	10	4	6	4
Class sizes too large	15	19	18	15	15	12
Difficulty in maintaining discipline	4	9	6	4	6	7
Inadequate articulation of instruction across grade levels	7	3	7	4	7	6
Inadequate diversity of subject electives	5	4	4	3	6	5
Low enrollments in subject courses	2	2	4	1	1	3
Poor quality of textbooks	11	5	5	3	8	6
Inadequate access to computers	18	23	17	18	18	14
Student absences	3	11	17	3	13	24

SOURCE: I. R. Weiss. Report of the 1985-86 *National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987), as cited in *Science and Mathematics Education Briefing Book, Volume I* (Washington, DC: National Science Teachers Association, 1990). C-37.

Appendix Table 3-33

Percent of 8th-grade students, by teacher's perception of instructional freedom and resource availability, and average science proficiency scores: 1990

Teacher's perception	Agree/strongly agree		No opinion		Disagree/strongly disagree	
	Percent of students	Average score	Percent of students	Average score	Percent of students	Average score
I have a great deal of freedom in making decisions about the way I teach my science classes.	91 (1.9)	265 (1.4)	2 (0.6)	257 (8.1)	7 (1.4)	266 (3.2)
My facilities for teaching laboratory science are adequate.	56 (3.0)	267 (2.0)	6 (1.5)	267 (4.3)	39 (2.8)	263 (1.8)
I am well supplied with instructional materials and resources.	56 (3.1)	269 (1.6)	9 (1.8)	261 (5.0)	35 (3.0)	261 (2.0)
I have a great deal of freedom in making decisions about curriculum.	59 (3.3)	266 (1.7)	12 (1.9)	264 (3.2)	29 (2.7)	264 (2.1)
I rely primarily on textbooks to determine what I teach.	48 (3.0)	262 (1.9)	7 (1.3)	269 (3.1)	46 (3.0)	268 (2.1)

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics. *The 1990 Science Report Card: NAEP's Assessment of Fourth, Eighth, and Twelfth Graders* (Washington, DC: U.S. Department of Education, 1992), 95.

Indicators of Science and Mathematics Education 1992

Appendix Table 3-34

Percent of elementary and secondary teachers who left teaching: 1988-89

Teaching level	Percent who left teaching		Sample size	
	All teachers	Mathematics and science teachers /1	All teachers	Mathematics and science teachers /1
Total	6.4 (0.3)	6.1 (0.6)	6,763	1,058
Elementary	6.3 (0.4)	4.9 (1.7)	3,465	129
Secondary	6.5 (0.4)	6.4 (0.6)	3,294	929

NOTE: Standard errors are presented in parentheses.
1/ Mathematics and science teachers are those with mathematics or science as their main or second assignment.
SOURCE: National Center for Education Statistics, U.S. Department of Education, Schools and Staffing Survey, 1988-89, Teacher Follow-up Survey, special tabulations created by Elliott Mednich, Management Planning Research Associates, Inc.

Indicators of Science and Mathematics Education 1992

Average annual salary in teaching and in selected white-collar occupations (in 1991 constant dollars): 1962 to 1991

Year	Teacher	Assistant professor public comprehensive	Accountant III	Chemist IV	Engineer IV	Full professor public doctoral	Attorney III
1962	25,366	NA	34,109	45,699	47,134	NA	54,475
1964	26,866	34,507	35,439	47,647	49,368	56,018	57,434
1966	27,560	35,274	35,393	48,653	50,081	59,923	59,719
1968	29,236	37,417	36,893	50,221	51,576	63,412	60,194
1970	30,336	37,941	37,541	49,949	51,625	63,587	59,315
1971	31,533	38,782	38,725	51,152	52,850	65,318	59,565
1972	31,929	38,821	39,081	51,553	53,162	65,140	60,508
1973	30,797	37,830	37,746	48,847	51,540	62,042	59,212
1974	29,036	35,292	35,790	46,561	48,302	58,191	56,796
1975	29,451	35,018	36,424	48,381	48,983	57,188	56,830
1976	30,249	35,075	37,065	49,079	49,848	58,139	58,151
1977	30,063	35,349	37,252	48,800	49,696	56,739	57,324
1978	29,342	32,838	37,413	48,601	49,509	54,524	57,287
1979	27,290	30,261	35,489	46,411	47,377	51,407	54,040
1980	26,085	28,839	34,508	44,848	46,152	48,767	53,521
1981	25,828	28,708	35,022	45,815	46,635	48,937	54,103
1982	27,140	29,798	36,779	48,775	49,343	51,144	56,801
1983	28,388	30,396	37,782	48,964	50,742	52,778	58,403
1984	29,178	30,540	38,137	49,984	51,792	52,848	59,411
1985	30,154	31,213	38,425	50,425	52,437	54,496	61,074
1986 /1	31,963	32,899	39,407	52,573	53,989	57,700	63,418
1987 /1	32,247	33,344	38,862	52,681	53,747	59,054	63,196
1988 /1	32,572	32,930	38,324	53,097	53,004	59,270	64,291
1989	32,861	34,262	37,848	52,204	52,437	60,142	63,393
1990	32,728	34,203	37,086	51,273	51,586	60,108	61,746
1991	32,880	34,460	NA	NA	NA	60,450	NA

NA Not available.

1/ The Professional, Technical, Administrative and Clerical Survey is not exactly comparable in 1986, 1987, and 1988. Prior to 1986 the survey included firms with at least 100 employees. In 1986 the minimum fell to 50, in 1987 the minimum was 20, and in 1988 and subsequent years, the minimum size established was restored to 50 employees. Small firms tend to pay less.

SOURCE: F. H. Nelson, *Survey and Analysis of Salary Trends--1991* (Washington, DC: American Federation of Teachers, 1991), 35.

Appendix Table 3-36

Average annual base salary and percent receiving incentives to teach in a shortage field, for public and private school teachers whose main or second assignment is mathematics or science, by teaching level: 1987-88

Teaching level	Public school		Private school	
	Average base salary	Percent receiving incentive for shortage field	Average base salary	Percent receiving incentive for shortage field
Total	$ 26,604 (137)	2.3 (0.2)	$ 17,332 (273)	4.5 (1.0)
Sample size	5,813	5,724	857	864
Elementary	25,578 (357)	0.6 (0.3)	15,190 (566)	--
Sample size	468	479	158	162
Secondary	26,742 (138)	2.5 (0.3)	17,761 (277)	5.2 (1.2)
Sample size	5,345	5,245	699	702

NOTE: Standard errors are presented in parentheses.

-- Too few cases for a reliable estimate.

SOURCE: National Center for Education Statistics, U. S. Department of Education, Schools and Staffing Survey, 1987-88, Teacher Questionnaire, special tabulations created by Elliott Medrich, Management Planning Research Associates, Inc.

Appendix Table 4-1

Percent of public high school seniors who completed selected mathematics courses, by sex, parent's education, community type, and student educational expectation: 1980

Student characteristic	Algebra I	Geometry	Precalculus	Calculus	Sample size
Total	79 (0.4)	55 (0.5)	26 (0.4)	8 (0.3)	9,999
Sex					
Male	79 (0.6)	57 (0.7)	29 (0.7)	10 (0.4)	4,714
Female	80 (0.6)	54 '0.7)	22 (0.6)	7 (0.4)	5,285
Parent's education					
Less than high school	61 (1.2)	31 (1.1)	10 (0.7)	4 (0.5)	1,734
High school graduate	73 (0.8)	43 (0.9)	17 (C.7)	5 (0.4)	2,936
Some college	83 (0.7)	58 (0.9)	23 (0.8)	7 (0.5)	2,884
College degree	91 (0.9)	73 (1.3)	42 (1.5)	14 (1.0)	1,115
Advanced degree	92 (0.8)	78 (1.3)	48 (1.5)	19 (1.2)	1,095
Community type					
Central city	79 (0.8)	55 (0.9)	27 (0.8)	8 (0.5)	2,850
Suburb	81 (0.6)	60 (0.8)	28 (0.7)	9 (0.4)	4,212
Non-metropolitan	77 (0.8)	48 (0.9)	21 (0.8)	8 (0.5)	2,937
Student educational expectation					
High school only	53 (1.2)	21 (1.0)	5 (0.5)	2 (0.3)	1,752
Vocational training	72 (1.0)	38 (1.1)	9 (0.7)	2 (0.3)	1,930
Some college	85 (0.9)	52 (1.3)	15 (0.9)	2 (0.4)	1,573
Bachelor's degree	94 (0.5)	79 (0.8)	40 (1.0)	12 (0.7)	2,439
Advanced degree	95 (0.5)	83 (0.8)	57 (1.1)	25 (1.0)	2,029

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B).

Appendix Table 4-2

Percent of public high school seniors who completed selected mathematics courses, by sex, parent's education, community type, and student educational expectation: 1982

Student characteristic	Algebra I	Geometry	Precalculus	Calculus	Sample size
Total	77	51	23	8	8,683
	(0.5)	(0.5)	(0.5)	(0.3)	
Sex					
Male	75	50	26	10	4,291
	(0.7)	(0.8)	(0.7)	(0.5)	
Female	79	52	20	6	4,392
	(0.6)	(0.8)	(0.6)	(0.4)	
Parent's education					
Less than high school	61	28	7	3	1,050
	(1.5)	(1.4)	(0.8)	(0.5)	
High school graduate	70	40	15	5	2,570
	(0.9)	(1.0)	(0.7)	(0.4)	
Some college	81	54	23	7	2,602
	(0.8)	(1.0)	(0.8)	(0.5)	
College degree	90	72	38	14	1,035
	(0.9)	(1.4)	(1.5)	(1.1)	
Advanced degree	92	76	43	17	1,105
	(0.8)	(1.3)	(1.5)	(1.1)	
Community type					
Central city	77	50	22	6	2,066
	(0.9)	(1.1)	(0.9)	(0.5)	
Suburb	80	56	27	9	4,018
	(0.6)	(0.8)	(0.7)	(0.5)	
Non-metropolitan	73	44	18	7	2,599
	(0.9)	(1.0)	(0.8)	(0.5)	
Student educational expectation					
High school only	51	20	3	2	1,553
	(1.3)	(1.0)	(0.4)	(0.4)	
Vocational training	67	31	6	2	1,686
	(1.1)	(1.1)	(0.6)	(0.3)	
Some college	83	51	16	3	1,673
	(0.9)	(1.2)	(0.9)	(0.4)	
Bachelor's degree	94	76	41	13	2,007
	(0.5)	(1.0)	(1.1)	(0.8)	
Advanced degree	95	84	53	22	1,673
	(0.5)	(0.9)	(1.2)	(1.0)	

NOTE: Standard errors are presented in parentheses.

SOURCE. National Center for Education Statistics, U.S. Department of Education. High School and Beyond Study (HS&B).

Appendix Table 4-3

Percent of public high school seniors who completed selected mathematics courses, by sex, parent's education, community type, and student educational expectation: 1990

Student characteristic	Algebra I	Geometry	Precalculus	Calculus	Sample size
Total	86 (0.7)	70 (0.9)	26 (0.9)	8 (0.5)	2,536
Sex					
Male	84 (1.0)	68 (1.3)	28 (1.3)	10 (0.9)	1,233
Female	87 (0.9)	72 (1.2)	25 (1.2)	6 (0.7)	1,304
Parent's education					
Less than high school	59 (3.7)	42 (3.7)	7 (1.9)	2 (1.0)	180
High school graduate	84 (1.1)	65 (1.4)	18 (1.1)	5 (0.6)	1,167
Some college	86 (1.8)	68 (2.4)	23 (2.2)	6 (1.2)	372
College degree	94 (1.1)	83 (1.8)	37 (2.3)	13 (1.6)	442
Advanced degree	95 (1.2)	88 (1.7)	54 (2.7)	16 (2.0)	350
Community type					
Central city	83 (1.6)	63 (2.0)	22 (1.7)	8 (1.1)	574
Suburb	90 (0.9)	79 (1.2)	32 (1.4)	11 (0.9)	1,111
Non-metropolitan	82 (1.3)	62 (1.7)	21 (1.4)	4 (0.7)	855
Student educational expectation					
High school only	56 (4.0)	27 (3.6)	2 (1.1)	0 (0.0)	155
Vocational training	70 (2.6)	45 (2.8)	2 (0.8)	<1 (0.6)	307
Some college	82 (2.0)	55 (2.5)	7 (1.3)	<1 (0.5)	387
Bachelor's degree	94 (1.0)	83 (1.6)	25 (1.9)	6 (1.0)	545
Advanced degree	98 (0.5)	91 (1.0)	50 (1.7)	17 (1.3)	885

NOTE: Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of Amercian Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Appendix Table 4-4

Percent of public high school seniors who completed selected science courses, by sex, parent's education, community type, and student educational expectation: 1980

Student characteristic	No lab or some science	Chemistry (lab)	Physics (lab)	Sample size
Total	49 (0.5)	37 (0.5)	21 (0.4)	9,501
Sex				
Male	48 (0.7)	39 (0.7)	27 (0.7)	4,474
Female	50 (0.7)	36 (0.7)	15 (0.5)	5,027
Parent's education				
Less than high school	59 (0.9)	18 (0.7)	13 (0.6)	2,707
High school graduate	58 (1.2)	27 (1.1)	15 (0.9)	1,646
Some college	50 (0.9)	37 (0.9)	19 (0.7)	2,790
College degree	36 (0.9)	54 (1.0)	33 (0.9)	2,742
Advanced degree	32 (1.4)	60 (1.5)	35 (1.5)	1,063
Community type				
Central city	48 (1.0)	38 (0.9)	25 (0.8)	2,707
Suburb	47 (0.8)	40 (0.8)	21 (0.6)	3,991
Non-metropolitan	53 (0.9)	34 (0.9)	19 (0.7)	2,803
Student educational expectation				
High school only	67 (1.2)	11 (0.8)	9 (0.7)	1,671
Vocational training	64 (1.1)	20 (0.9)	10 (0.7)	1,822
Some college	58 (1.3)	28 (1.2)	12 (0.8)	1,465
Bachelor's degree	36 (1.0)	55 (1.0)	28 (0.9)	2,323
Advanced degree	24 (1.0)	70 (1.0)	46 (1.1)	1,964

NOTE: Standard errors are presented in parentheses.

SOURCE: National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B).

Appendix Table 4-5

Percent of public high school seniors who completed selected science courses, by sex, parent's education, community type, and student educational expectation: 1982

Student characteristic	No lab or some science	Biology (lab)	Chemistry (lab)	Physics (lab)	Sample size
Total	12 (0.4)	78 (0.4)	36 (0.5)	19 (0.4)	8,605
Sex					
Male	14 (0.5)	76 (0.7)	37 (0.7)	24 (0.7)	4,267
Female	11 (0.5)	80 (0.6)	34 (0.7)	15 (0.5)	4,338
Parent's education					
Less than high school	16 (1.1)	71 (1.4)	20 (1.2)	14 (1.1)	1,044
High school graduate	15 (0.7)	74 (0.9)	25 (0.9)	13 (0.7)	2,548
Some college	11 (0.6)	80 (0.8)	38 (1.0)	19 (0.8)	2,575
College degree	7 (0.8)	85 (1.1)	51 (1.6)	29 (1.4)	1,023
Advanced degree	7 (0.8)	87 (1.0)	58 (1.5)	32 (1.4)	1,100
Community type					
Central city	13 (0.7)	78 (0.9)	34 (1.0)	21 (0.9)	2,057
Suburb	12 (0.5)	77 (0.7)	37 (0.8)	21 (0.6)	3,976
Non-metropolitan	12 (0.6)	79 (0.8)	34 (0.9)	16 (0.7)	2,572
Student educational expectation					
High school only	23 (1.1)	62 (1.2)	12 (0.8)	10 (0.8)	1,518
Vocational training	16 (0.9)	72 (1.1)	19 (1.0)	9 (0.7)	1,671
Some college	11 (0.8)	80 (1.0)	30 (1.1)	14 (0.9)	1,660
Bachelor's degree	6 (0.5)	88 (0.7)	56 (1.1)	27 (0.6)	1,998
Advanced degree	3 (0.4)	91 (0.7)	67 (1.2)	40 (1.2)	1,667

NOTE: Standard errors are presented in parentheses.
SOURCE: National Center for Education Statistics, U.S. Department of Education, High School and Beyond Study (HS&B).

Appendix Table 4-6

Percent of public high school seniors who completed selected science courses, by sex, parent's education, community type, and student educational expectation: 1990

Student characteristic	Biology (lab)	Chemistry (lab)	Physics (lab)	Sample size
Total	76 (0.8)	42 (0.9)	18 (0.7)	2,826
Sex				
Male	75 (1.2)	41 (1.3)	22 (1.1)	1,392
Female	77 (1.1)	43 (1.3)	16 (1.0)	1,434
Parent's education				
Less than high school	62 (3.4)	17 (2.6)	4 (1.4)	209
High school graduate	75 (1.2)	36 (1.3)	14 (1.0)	1,283
Some college	71 (2.2)	40 (2.4)	16 (2.4)	434
College degree	84 (1.7)	54 (2.3)	25 (2.0)	478
Advanced degree	84 (1.9)	66 (2.4)	36 (2.4)	390
Community type				
Central city	76 (1.7)	42 (2.0)	22 (1.6)	637
Suburb	77 (1.2)	48 (1.4)	20 (1.1)	1,253
Non-metropolitan	75 (1.4)	35 (1.6)	14 (1.1)	939
Student educational expectation				
High school only	78 (3.3)	7 (2.0)	2 (1.1)	155
Vocational training	71 (2.6)	14 (2.0)	3 (1.0)	313
Some college	78 (2.1)	25 (2.2)	5 (1.1)	388
Bachelor's degree	93 (1.1)	58 (2.1)	20 (1.7)	545
Advanced degree	96 (0.7)	75 (1.5)	40 (1.6)	885

NOTE: Standard errors are presented in parentheses.

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Appendix Table 4-7

Mean student assessment of public high school mathematics courses: 1987 to 1991

Subject and grade	Like the subject	Teacher clarity	Textbook clarity	Challenge	Career utility	Sample size
Algebra 1						
Freshmen	2.7 (0.0)	3.1 (0.0)	2.8 (0.4)	3.3 (0.[illegible]	3.1 (0.0)	1,287
Sophomores	2.3 (0.6)	2.8 (0.1)	2.5 (0.1)	3.1 (0.1)	2.9 (0.1)	661
Juniors	2.2 (0.1)	2.8 (0.1)	2.7 (0.1)	3.2 (0.1)	2.9 (0.1)	133
Seniors	2.2 (0.2)	3.1 (0.2)	2.8 (0.2)	2.7 (0.2)	2.5 (0.2)	53
Geometry						
Freshmen	2.9 (0.1)	3.1 (0.1)	2.9 (0.1)	3.4 (0.1)	3.0 (0.1)	298
Sophomores	2.4 (0.0)	2.9 (0.0)	2.6 (0.0)	3.2 (0.0)	2.7 (0.1)	887
Juniors	2.1 (0.1)	2.8 (0.1)	2.6 (0.1)	3.3 (0.1)	2.3 (0.1)	339
Seniors	2.3 (0.2)	2.8 (0.2)	2.6 (0.2)	3.2 (0.1)	2.1 (0.2)	87
Algebra 2						
Freshmen	2.9 (0.2)	3.1 (0.2)	2.7 (0.2)	3.5 (0.1)	3.3 (0.2)	63
Sophomores	2.9 (0.1)	3.0 (0.1)	2.7 (0.1)	3.4 (0.1)	3.0 (0.1)	374
Juniors	2.5 (0.1)	2.9 (0.1)	2.6 (0.1)	3.4 (0.0)	2.6 (0.1)	627
Seniors	2.5 (0.1)	3.1 (0.1)	2.6 (0.1)	3.4 (0.1)	2.7 (0.1)	219
Precalculus						
Juniors	2.8 (0.1)	3.1 (0.1)	2.5 (0.1)	3.5 (0.1)	2.8 (0.1)	267
Seniors	2.6 (0.1)	2.8 (0.1)	2.5 (0.1)	3.4 (0.1)	2.7 (0.1)	308
Calculus						
Seniors	3.1 (0.1)	3.2 (0.1)	2.6 (0.1)	3.8 (0.0)	3.0 (0.1)	181

NOTES: Students were asked to grade each course in which they were enrolled each semester, using a letter grade from A to F, on each of the following dimensions:

Subject matter: How much do you like the subject matter of each course? The letter A means you really like the subject; F means you hate it.

Teacher clarity: How clear is the teacher in explaining the material? The letter A means very clear; F means not clear at all.

Textbook clarity: How clear is the textbook for each course? The letter A means very clear; F means hard to understand.

Challenge: How much does each course challenge you to use your mind? The letter A means it challenges you a lot; F means that it never challenges you.

Usefulness: How useful do you think that each course will be to you in your career? The letter A means that it will be very useful; F means that it will be of no use.

The letter grades were converted to a 4.0 scale, with A = 4.0. Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Mean student assessment of public high school science courses: 1987 to 1991

Subject and grade	Like the subject	Teacher clarity	Textbook clarity	Challenge	Career utility	Sample size
Biology (no lab)						
Freshmen	3.0 (0.2)	2.9 (0.3)	3.1 (0.2)	2.7 (0.2)	2.3 (0.3)	33
Sophomores	2.7 (0.2)	3.0 (0.2)	3.2 (0.1)	2.9 (0.2)	2.4 (0.2)	82
Juniors	2.6 (0.3)	3.1 (0.3)	3.1 (0.3)	2.5 (0.2)	1.6 (0.3)	28
Seniors	2.7 (0.3)	3.5 (0.2)	3.1 (0.3)	3.1 (0.3)	2.3 (0.3)	20
Biology (with lab)						
Freshmen	2.9 (0.1)	3.1 (0.1)	3.0 (0.1)	3.2 (0.0)	2.6 (0.1)	569
Sophomores	2.6 (0.0)	2.9 (0.0)	2.9 (0.0)	3.0 (0.0)	2.2 (0.0)	1,414
Juniors	2.6 (0.1)	2.9 (0.1)	2.9 (0.1)	3.2 (0.1)	2.2 (0.1)	242
Seniors	3.0 (0.1)	3.1 (0.1)	2.9 (0.1)	3.0 (0.1)	2.6 (0.1)	183
Chemistry (with lab)						
Sophomores	2.7 (0.1)	2.8 (0.1)	2.7 (0.1)	3.4 (0.1)	2.6 (0.1)	325
Juniors	2.5 (0.1)	2.7 (0.1)	2.5 (0.1)	3.3 (0.0)	2.1 (0.1)	618
Seniors	2.3 (0.1)	2.6 (0.1)	2.4 (0.1)	3.3 (0.1)	2.3 (0.1)	149
Physics (with lab)						
Juniors	2.9 (0.1)	2.8 (0.1)	2.6 (0.1)	3.6 (0.1)	2.7 (0.1)	158
Seniors	3.0 (0.1)	3.1 (0.1)	2.7 (0.1)	3.5 (0.1)	2.9 (0.1)	288

NOTES: Students were asked to grade each course in which they were enrolled each semester, using a letter grade from A to F, on each of the following dimensions:

Subject matter: How much do you like the subject matter of each course? The letter A means you really like the subject; F means you hate it.

Teacher clarity: How clear is the teacher in explaining the material? The letter A means very clear; F means not clear at all.

Textbook clarity: How clear is the textbook for each course? The letter A means very clear; F means hard to understand.

Challenge: How much does each course challenge you to use your mind? The letter A means it challenges you a lot; F means that it never challenges you.

Usefulness: How useful do you think that each course will be to you in your career? The letter A means that it will be very useful; F means that it will be of no use.

The letter grades were converted to a 4.0 scale, with A = 4.0. Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Appendix Table 4-9

Mean student assessment of public high school English and social studies courses: 1987 to 1991

Subject and grade	Like the subject	Teacher clarity	Textbook clarity	Challenge	Career utility	Sample size
English						
Freshmen	2.8 (0.03)	3.1 (0.03)	3.1 (0.03)	2.8 (0.03)	3.1 (0.03)	2,134
Sophomores	2.8 (0.03)	3.1 (0.03)	3.1 (0.03)	2.7 (0.03)	3.1 (0.03)	1,982
Juniors	2.7 (0.03)	3.1 (0.03)	3.1 (0.03)	2.8 (0.03)	2.9 (0.03)	1,921
Seniors	2.9 (0.03)	3.3 (0.03)	3.1 (0.03)	2.9 (0.03)	2.8 (0.03)	1,482
Social studies						
Freshmen	2.7 (0.03)	3.1 (0.03)	3.1 (0.02)	2.6 (0.03)	2.1 (0.04)	1,617
Sophomores	2.7 (0.03)	3.1 (0.03)	3.1 (0.03)	2.6 (0.04)	1.9 (0.04)	1,329
Juniors	2.7 (0.03)	3.2 (0.02)	3.1 (0.03)	2.7 (0.03)	1.9 (0.03)	1,861
Seniors	2.9 (0.03)	3.2 (0.03)	3.1 (0.03)	2.7 (0.03)	2.4 (0.04)	1,245

NOTES: Students were asked to grade each course in which they were enrolled each semester, using a letter grade from A to F, on each of the following dimensions:

Subject matter: How much do you like the subject matter of each course? The letter A means you really like the subject; F means you hate it.

Teacher clarity: How clear is the teacher in explaining the material? The letter A means very clear; F means not clear at all.

Textbook clarity: How clear is the textbook for each course? The letter A means very clear; F means hard to understand.

Challenge: How much does each course challenge you to use your mind? The letter A means it challenges you a lot; F means that it never challenges you.

Usefulness: How useful do you think that each course will be to you in your career? The letter A means that it will be very useful; F means that it will be of no use.

The letter grades were converted to a 4.0 scale, with A = 4.0. Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Indicators of Science and Mathematics Education 1992

Percent of public high school seniors citing selected reasons for not taking a mathematics course in their senior year, by sex, parent's education, community type, and student educational expectation: 1989-90

Student characteristic	Took all	Will not need	Do not like	Not do well	Advised not to	Wanted other	Avoid work	Sample size
All seniors	5	28	34	31	31	37	27	687
	(0.8)	(1.7)	(1.8)	(1.8)	(1.8)	(1.8)	(1.7)	
Sex								
Male	7	31	27	28	26	33	27	297
	(1.5)	(2.7)	(2.6)	(2.6)	(2.5)	(2.7)	(2.6)	
Female	3	25	40	33	34	40	27	390
	(0.9)	(2.2)	(2.5)	(2.4)	(2.4)	(2.5)	(2.2)	
Parent's education								
Less than high school	9	30	27	26	42	29	19	45
	(4.3)	(6.8)	(6.6)	(6.5)	(7.4)	(6.8)	(5.8)	
High school graduate	5	28	34	31	31	37	25	368
	(1.1)	(2.3)	(2.5)	(2.4)	(2.4)	(2.5)	(2.3)	
Associate degree	4	18	33	24	30	38	29	101
	(1.9)	(3.8)	(4.7)	(4.2)	(4.6)	(4.8)	(4.5)	
Bachelor's degree	4	31	34	35	32	37	35	112
	(1.9)	(4.4)	(4.5)	(4.5)	(4.4)	(4.6)	(4.5)	
Graduate degree	5	33	49	37	19	37	25	57
	(2.9)	(6.2)	(6.6)	(6.4)	(5.2)	(6.4)	(5.7)	
Community type								
Central city	3	27	35	28	36	36	21	128
	(1.5)	(3.9)	(4.2)	(4.0)	(4.2)	(4.2)	(3.6)	
Suburb	5	29	32	30	31	38	27	314
	(1.2)	(2.6)	(2.6)	(2.6)	(2.6)	(2.7)	(2.5)	
Non-metropolitan	6	27	37	34	27	35	31	247
	(1.5)	(2.8)	(3.1)	(3.0)	(2.8)	(3.0)	(2.9)	
Student educational expectation								
High school only	7	27	18	12	28	24	24	52
	(3.5)	(6.2)	(5.3)	(4.5)	(6.2)	(5.9)	(5.9)	
Vocational training	7	27	31	17	39	35	24	117
	(2.4)	(4.1)	(4.3)	(3.5)	(4.5)	(4.4)	(3.9)	
Some college	5	28	39	40	28	34	25	154
	(1.8)	(3.6)	(3.9)	(3.9)	(3.6)	(3.8)	(3.5)	
Bachelor's degree	2	25	35	33	31	36	28	195
	(1.0)	(3.1)	(3.4)	(3.4)	(3.3)	(3.4)	(3.2)	
Master's degree	4	38	37	38	33	54	32	110
	(1.9)	(4.6)	(4.6)	(4.6)	(4.5)	(4.8)	(4.4)	
Doctoral/professional degree	10	22	37	33	15	28	28	61
	(3.8)	(5.3)	(6.2)	(6.0)	(4.6)	(5.7)	(5.7)	

NOTES: The students were asked the following question: If you are not taking any mathematics classes this semester, which of the following best indicates your reason for this decision? (Mark all that apply.)

--- I have taken the highest level math course available here.
--- I will not need advanced math for what I plan to do in the future.
--- I do not like math.
--- I did not think that I would do well in more advanced math classes.
--- I was advised that I did not need to take more math.
--- There were other courses that I wanted to take.
--- I did not want to work that hard during my senior year.

Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of American Youth Codebook* (Dekalb, IL: Social Science Research Institute, Northern Illinios University, 1992) and unpublished tabulations.

Percent of public high school seniors citing selected reasons for not taking a science course in their senior year, by sex, parent's education, community type, and student educational expectation: 1989-90

Student characteristic	Took all	Will not need	Do not like	Not do well	Advised not to	Wanted other	Avoid work	Sample size
All seniors	8	39	29	24	30	37	24	918
	(0.9)	(1.6)	(1.5)	(1.4)	(1.5)	(1.6)	(1.4)	
Sex								
Male	9	42	22	24	26	31	21	412
	(1.4)	(2.4)	(2.0)	(2.1)	(2.2)	(2.3)	(2.0)	
Female	7	38	35	24	32	41	26	506
	(1.1)	(2.2)	(2.1)	(1.9)	(2.1)	(2.2)	(1.9)	
Parent's education								
Less than high school	18	31	23	24	44	35	20	55
	(5.2)	(6.2)	(5.7)	(5.8)	(6.7)	(6.4)	(5.4)	
High school graduate	6	38	27	22	32	34	22	486
	(1.1)	(2.2)	(2.0)	(1.9)	(2.1)	(2.1)	(1.9)	
Associate degree	9	39	34	24	26	38	27	136
	(2.5)	(4.2)	(4.1)	(3.7)	(3.8)	(4.2)	(3.8)	
Bachelor's degree	9	41	31	26	23	36	28	152
	(2.3)	(4.0)	(3.8)	(3.6)	(3.4)	(3.9)	(3.6)	
Graduate degree	8	54	33	25	30	39	26	86
	(2.9)	(5.4)	(5.1)	(4.7)	(4.9)	(5.3)	(4.7)	
Community type								
Central city	11	42	29	25	29	31	21	172
	(2.4)	(3.8)	(3.5)	(3.3)	(3.5)	(3.5)	(3.1)	
Suburb	6	40	26	24	30	37	23	452
	(1.1)	(2.3)	(2.1)	(2.0)	(2.2)	(2.3)	(2.0)	
Non-metropolitan	8	38	33	25	30	39	26	295
	(1.6)	(2.8)	(2.7)	(2.5)	(2.7)	(2.8)	(2.6)	
Student educational expectation								
High school only	2	46	16	12	24	21	20	61
	(1.8)	(6.4)	(4.7)	(4.2)	(5.5)	(5.2)	(5.1)	
Vocational training	6	38	32	21	38	32	23	153
	(1.9)	(3.9)	(3.8)	(3.3)	(3.9)	(3.8)	(3.4)	
Some college	7	39	31	30	34	31	20	197
	(1.8)	(3.5)	(3.3)	(3.3)	(3.4)	(3.3)	(2.8)	
Bachelor's degree	7	40	29	25	29	37	25	275
	(1.5)	(3.0)	(2.7)	(2.6)	(2.7)	(2.9)	(2.6)	
Master's degree	10	42	30	26	21	45	27	165
	(2.3)	(3.8)	(3.6)	(3.4)	(3.2)	(3.9)	(3.5)	
Doctoral/professional degree	16	28	22	17	27	58	25	67
	(4.5)	(5.5)	(5.1)	(4.6)	(5.4)	(6.0)	(5.3)	

NOTES: The students were asked the following question:

If you are not taking any science classes this semester, which of the following best indicates your reasons for this decision? (Mark all that apply.)

--- I have taken the highest level science course available here.
--- I will not need advanced science for what I plan to do in the future.
--- I do not like science.
--- I did not think that I would do well in more advanced science classes.
--- I was advised that I did not need to take more science.
--- There were other courses that I wanted to take.
--- I did not want to work that hard during my senior year.

Standard errors are presented in parentheses.

SOURCE: J. D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Percent of public middle school and high school students with a correct understanding of the level of mathematics courses needed for selected occupations: 1987 to 1991

Occupation and grade	Algebra	Geometry	Trigonometry	Calculus	Sample size
Scientist					
Cohort 2 /1					
7th-grade students	31	31	34	42	59
	(6.0)	(6.0)	(6.2)	(6.4)	
8th-grade students	49	42	45	44	41
	(7.8)	(7.7)	(7.8)	(7.8)	
9th-grade students	56	51	57	55	47
	(7.2)	(7.3)	(7.2)	(7.3)	
10th-grade students	46	42	39	55	54
	(6.8)	(6.7)	(6.6)	(6.8)	
Cohort 1 /2					
10th-grade students	52	40	50	57	32
	(8.8)	(8.7)	(8.8)	(8.8)	
11th-grade students	58	57	59	47	20
	(11.0)	(11.1)	(11.0)	(11.2)	
12th-grade students	57	49	66	52	26
	(9.7)	(9.8)	(9.3)	(9.8)	
Engineer					
Cohort 2 /1					
7th-grade students	47	49	42	49	135
	(4.3)	(4.3)	(4.2)	(4.3)	
8th-grade students	47	48	42	45	164
	(3.9)	(3.9)	(3.9)	(3.9)	
9th-grade students	50	51	50	57	133
	(4.3)	(4.3)	(4.3)	(4.3)	
10th-grade students	56	57	54	62	135
	(4.3)	(4.3)	(4.3)	(4.2)	
Cohort 1 /2					
10th-grade students	58	60	57	61	131
	(4.3)	(4.3)	(4.3)	(4.3)	
11th-grade students	70	73	74	68	121
	(4.2)	(4.0)	(4.0)	(4.2)	
12th-grade students	72	71	74	78	88
	(4.8)	(4.8)	(4.7)	(4.4)	

NOTES: The students were asked the following question:

Which of the following high school math courses will you need to take to qualify for your first choice of job? (Mark all that apply.)

--- None. I don't need any for this job.
--- Geometry
--- Algebra
--- Trigonometry
--- Calculus
--- I am not sure.

Standard errors are presented in parentheses.

1/ Cohort 2 refers to a national sample of approximately 3,000 7th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.

2/ Cohort 1 refers to a national sample of approximately 3,000 10th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Percent of public middle school and high school students with a correct understanding of the level of science courses needed for selected occupations: 1987 to 1991

Occupation and grade	Biology	Chemistry	Physics	Sample size
Scientist				
Cohort 2 /1				
7th-grade students	60	47	56	59
	(6.4)	(6.5)	(6.5)	
8th-grade students	73	66	72	41
	(6.9)	(7.4)	(7.0)	
9th-grade students	73	61	72	47
	(6.5)	(7.1)	(6.5)	
10th-grade students	80	63	71	54
	(5.4)	(6.6)	(6.2)	
Cohort 1 /2				
10th-grade students	72	68	49	32
	(7.9)	(8.2)	(8.8)	
11th-grade students	80	72	71	20
	(8.9)	(10.0)	(10.1)	
12th-grade students	59	57	63	26
	(9.6)	(9.7)	(9.5)	
Engineer				
Cohort 2 /1				
7th-grade students	13	23	37	135
	(2.9)	(3.6)	(4.2)	
8th-grade students	12	25	38	164
	(2.5)	(3.4)	(3.8)	
9th-grade students	18	32	51	133
	(3.3)	(4.0)	(4.3)	
10th-grade students	23	31	57	135
	(3.6)	(4.0)	(4.3)	
Cohort 1 /2				
10th-grade students	24	38	66	131
	(3.7)	(4.2)	(4.1)	
11th-grade students	26	47	66	121
	(4.0)	(4.5)	(4.3)	
12th-grade students	26	58	81	88
	(4.7)	(5.3)	(4.2)	

NOTES: The students were asked the following question:
Which of the following high school science courses will you need to take to qualify for your first choice of job? (Mark all that apply.)
--- None. I don't need any for this job.
--- Biology
--- Chemistry
--- Physics
--- I am not sure.
Standard errors are presented in parentheses.
1/ Cohort 2 refers to a national sample of approximately 3,000 7th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.
2/ Cohort 1 refers to a national sample of approximately 3,000 10th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.
SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Percent of public high school seniors expecting a career in science, mathematics, or engineering, by sex: 1972 to 1990

Expected career	1972	1980	1990
All science, mathematics, or engineering careers	5.0 (0.2)	6.3 (0.5)	6.3 (0.5)
Sample size	13,172	2,474	2,433
Male	9.3 (0.4)	9.9 (0.9)	10.0 (0.9)
Sample size	6,355	1,169	1,192
Female	1.1 (0.1)	2.7 (0.4)	2.8 (0.5)
Sample size	6,817	1,305	1,241
Science and mathematics	1.7 (0.1)	1.1 (0.2)	1.3 (0.2)
Male	2.5 (0.2)	1.4 (0.3)	1.4 (0.3)
Female	1.0 (0.1)	0.8 (0.3)	1.1 (0.3)
Engineering	3.4 (0.2)	5.2 (0.5)	5.0 (0.4)
Male	6.8 (0.3)	8.5 (0.8)	8.6 (0.8)
Female	0.1 (0.0)	1.9 (0.4)	1.7 (0.4)

NOTE: Standard errors are presented in parentheses.

SOURCES: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992); National Center for Education Statistics, U.S Department of Education, National Longitudinal Study of the High School Class of 1972 (NLS-72) and High School and Beyond Study (HS&B).

Indicators of Science and Mathematics Education 1992

Appendix Table 4-15

Percent of public middle school and high school students expecting a career in science, mathematics, or engineering, by certainty level: 1987 to 1990

Grade	Certainty level: High	Moderate	Low
Cohort 2 /1			
7th-grade students	3.7	4.4	0.7
8th-grade students	4.0	4.7	0.9
9th-grade students	3.6	5.0	1.9
10th-grade students	3.5	4.8	1.1
Cohort 1 /2			
10th-grade students	2.6	5.4	0.4
11th-grade students	2.8	4.0	0.9
12th-grade students	3.2	4.0	0.3

1/ Cohort 2 refers to a national sample of approximately 3,000 7th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.

2/ Cohort 1 refers to a national sample of approximately 3,000 10th-grade students selected by the Longitudinal Study of American Youth in the fall semester, 1987.

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Percent of public high school seniors expecting a career in science, mathematics, or engineering, by sex, parent's education, community type, and student educational expectation: 1990

Student characteristic	Expected career: Science or mathematics	Expected career: Engineering	Sample size
Total	1.3 (0.2)	5.0 (1.0)	2,433
Sex			
Male	1.4 (0.3)	8.6 (0.8)	1,175
Female	1.1 (0.3)	1.7 (0.4)	1,255
Parent's education			
Less than high school	0	5.6 (1.8)	160
High school	0.9 (0.3)	4.2 (0.6)	1,232
Associate degree	1.4 (0.8)	4.1 (1.3)	229
Bachelor's degree	1.8 (0.6)	5.7 (1.1)	449
Master's degree	2.4 (1.0)	6.7 (1.6)	239
Doctoral degree	3.1 (1.8)	7.9 (2.7)	98
Community type			
Urban	1.2 (0.5)	4.6 (0.9)	547
Suburban	1.8 (0.4)	5.7 (0.7)	1,079
Non-metropolitan	0.6 (0.3)	4.4 (0.7)	807
Student educational expectation			
Bachelor's degree	NA	7.4 (1.1)	562
Master's degree	2.9 (0.7)	9.4 (1.1)	662
Doctoral/professional degree	4.2 (1.2)	6.8 (1.6)	262

NOTES: In the LSAY, each student is asked each semester to write the name of the job or occupation that he or she expects to be doing at 40 years of age. The open-ended responses are coded into a three-digit Census Bureau occupational code, which is subsequently grouped into major occupational classifications. For these tabulations, the scientist category includes graduate-level jobs in research or teaching. The engineer category includes all engineering occupations at the baccalaureate level or higher. The number of students who indicate an expectation to become a mathematician was insufficient to include that category in these tabulations.

Standard errors are presented in parentheses.

NA Not available.

SOURCE: J.D. Miller et al., *Longitudinal Study of American Youth Codebook* (DeKalb, IL: Social Science Research Institute, Northern Illinois University, 1992) and unpublished tabulations.

Percent of U.S. college freshmen choosing selected careers, by sex: 1966 to 1990

Career and sex	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
All													
Artist (including performer)	6.6	5.8	5.8	5.7	6.2	6.0	6.5	3.6	5.7	5.2	6.8	6.8	6.3
Business	11.6	11.2	11.3	11.1	11.4	10.7	10.5	---	13.2	13.8	16.4	18.1	19.3
College teacher	1.8	1.2	1.1	1.1	1.0	0.7	0.6	1.0	0.7	0.6	0.4	0.3	0.3
Engineer	8.9	8.4	8.3	8.3	7.5	5.3	5.3	5.3	4.7	5.9	7.8	8.3	9.1
Lawyer (or judge)	3.9	3.5	3.4	3.5	3.8	4.3	4.7	4.7	3.9	4.0	4.3	4.4	4.3
Research scientist	3.5	2.9	2.9	2.5	2.6	2.5	2.3	3.1	2.1	2.0	2.4	2.2	2.2
Undecided	---	10.1	11.1	11.3	11.6	13.2	13.9	11.2	12.4	13.7	10.3	9.7	10.6
Male													
Artist (including performer)	4.6	4.1	4.2	4.3	5.1	4.9	5.2	2.7	4.5	4.1	5.5	5.5	4.9
Business	18.5	17.5	17.5	16.9	17.4	16.1	15.4	---	17.6	17.2	20.9	22.4	23.0
College teacher	2.1	1.4	1.3	1.3	1.2	0.8	0.7	0.9	0.7	0.6	0.4	0.3	0.3
Engineer	16.3	15.0	14.6	14.5	13.3	9.7	9.6	9.4	8.5	10.2	13.7	15.1	16.5
Lawyer (or judge)	6.7	5.8	5.5	5.6	6.2	6.8	7.1	6.7	5.3	5.4	5.5	5.5	5.3
Research scientist	4.9	3.9	3.8	3.3	3.5	3.3	3.1	3.7	2.7	2.5	3.0	2.8	2.7
Undecided	---	10.2	11.3	11.6	11.5	12.9	13.4	10.8	12.3	13.5	9.7	8.8	9.6
Female													
Artist (including performer)	8.9	8.1	7.8	7.6	7.6	7.2	8.0	4.5	7.1	6.5	8.2	8.1	7.7
Business	3.3	3.3	3.3	3.6	4.2	4.4	4.8	---	8.5	10.0	11.6	13.8	15.8
College teacher	1.5	0.9	0.9	0.8	0.9	0.5	0.6	1.0	0.8	0.6	0.3	0.3	0.3
Engineer	0.2	0.2	0.2	0.3	0.4	0.2	0.3	0.7	0.8	1.1	1.5	1.5	2.2
Lawyer (or judge)	0.7	0.6	0.6	0.8	1.0	1.4	2.0	2.5	2.3	2.5	3.0	3.4	3.4
Research scientist	1.9	1.6	1.7	1.4	1.6	1.5	1.5	2.4	1.4	1.5	1.7	1.6	1.7
Undecided	---	9.9	10.8	11.0	11.8	13.5	14.4	11.6	12.6	13.8	10.9	10.7	11.6

Career and sex	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
All												
Artist (including performer)	6.8	6.5	6.6	6.3	6.0	5.7	6.4	6.6	7.4	6.8	6.4	6.0
Business	19.7	19.7	19.6	20.2	20.4	22.2	23.9	24.1	24.6	23.6	21.8	18.4
College teacher	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Engineer	9.3	10.7	10.9	12.0	10.8	10.4	10.0	9.7	8.5	8.6	9.0	8.1
Lawyer (or judge)	4.2	4.1	3.9	4.3	3.9	4.1	3.9	4.0	4.5	5.4	5.4	5.2
Research scientist	1.8	1.7	1.6	1.5	1.5	1.5	1.4	1.4	1.5	1.6	1.6	1.4
Undecided	10.4	10.1	10.1	9.5	10.1	10.9	10.7	11.6	11.4	11.5	11.6	11.1
Male												
Artist (including performer)	5.6	5.5	5.3	5.1	5.1	4.9	5.5	5.5	6.5	6.1	5.5	5.2
Business	23.0	21.7	21.3	20.9	21.4	23.5	25.2	25.8	27.6	26.5	24.4	20.5
College teacher	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Engineer	16.8	19.1	19.5	20.6	18.8	18.5	17.7	17.4	15.2	15.7	16.5	14.9
Lawyer (or judge)	5.0	4.8	4.5	4.7	4.2	4.4	4.1	4.1	4.5	5.5	5.3	4.9
Research scientist	2.4	2.2	2.0	1.8	1.8	1.9	1.7	1.8	1.8	2.0	1.9	1.7
Undecided	9.4	8.9	8.8	8.1	8.8	9.2	9.2	9.9	9.9	9.8	10.0	10.3
Female												
Artist (including performer)	8.1	7.8	7.8	7.6	7.0	6.4	7.3	7.6	8.1	7.5	7.2	6.6
Business	16.7	17.9	18.2	19.3	19.5	21.2	22.7	22.6	22.0	21.1	19.6	16.6
College teacher	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3
Engineer	2.3	2.9	2.9	3.6	3.3	2.9	2.9	2.8	2.6	2.5	2.6	2.4
Lawyer (or judge)	3.4	3.5	3.4	3.9	3.6	3.7	3.7	4.0	4.5	5.3	5.4	5.5
Research scientist	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.3	1.4	1.2
Undecided	11.4	11.3	11.3	10.8	11.3	12.3	12.1	13.2	12.6	12.9	13.0	11.8

NOTES: Where blank for 1966 and 1973, results were not comparable to those of other years due to changes in question text or order.

Figures for the years 1966 to 1976 are from annual Norms Reports. Figures for years 1977 to 1990 are computed from disaggregated majors/careers.

List of careers for years 1973 to 1976 is not directly comparable to other years. The other career choices on the survey were clergy or other religious worker; doctor (M.D. or D.D.S.); education (elementary); education (secondary); farmer, rancher, or forester; health professional (non-M.D.); nurse; and other.

SOURCE: E. L. Dey, A. W. Astin, and W. S. Korn, *The American Freshman: Twenty-Five Year Trends, 1966-1990* (Los Angeles: Higher Education Research Institute, UCLA, 1991), 54, 84, 114.

Course-taking behavior of 1985-86 bachelor's degree recipients, by major field of study and selected program area: 1987

Program area and selected course-taking characteristics	Major field of study				
	Business and management	Engineering	Natural sciences	Social and behavioral sciences	Humanities
Number of majors /1	237,462	87,736	127,259	118,261	87,543
All courses					
Average number of courses taken	50.2	58.5	52.1	48.6	51.7
Business and management					
Percent who took 1 or more courses /2	99.0	39.9	47.2	53.0	38.3
Average number of courses taken	18.9	2.9	5.6	4.3	3.0
Computer science					
Percent who took 1 or more courses	60.8	57.8	72.6	40.6	28.2
Average number of courses taken	2.2	2.2	6.1	1.6	1.6
Education					
Percent who took 1 or more courses	31.2	22.2	33.6	41.5	40.6
Average number of courses taken	2.1	1.9	2.8	2.7	3.7
Engineering					
Percent who took 1 or more courses	12.0	98.6	24.0	7.2	8.0
Average number of courses taken /3	3.0	24.3	3.9	2.6	1.8
Fine and applied arts					
Percent who took 1 or more courses	65.3	43.8	69.6	77.7	90.3
Average number of courses taken	2.4	2.4	3.1	3.5	13.7
Foreign language					
Percent who took 1 or more courses	33.6	20.6	48.3	63.9	61.7
Average number of courses taken	2.5	2.2	3.1	3.6	5.9
History					
Percent who took 1 or more courses	74.3	58.0	71.4	84.4	78.4
Average number of courses taken	2.1	2.0	2.2	4.4	2.6
Letters/literature					
Percent who took 1 or more courses	96.0	93.8	94.3	94.8	95.4
Average number of courses taken	4.3	3.3	4.0	4.7	9.0

Continued

1/ These are estimates of the number of majors based on the sample weights on the file. These estimates differ from the counts provided by the Integrated Postsecondary Education Data System due to sampling and errors.

2/ For each of the program areas the average shown is for students who took one or more courses.

3/ Social and behavioral sciences category does not include psychology because there were too few cases for reliable estimates. The number of unweighted cases upon which an estimate would be based is less than 30, the number required to meet NCES statistical standards.

SOURCE: National Center for Education Statistics, U.S. Department of Education, unpublished tabulations from the 1987 Recent College Graduates Transcript Study: Estimates of 1985-86 Bachelor's Degree Recipients Course-taking Behavior.

Course-taking behavior of 1985-86 bachelor's degree recipients, by major field of study and selected program area: 1987, continued

Program area and selected course-taking characteristics	Major field of study				
	Business and management	Engineering	Natural sciences	Social and behavioral sciences	Humanities
Life science /4					
Percent who took 1 or more courses	54.2	26.1	67.7	66.3	65.2
Average number of courses taken	2.0	2.1	6.6	2.5	2.3
Mathematics					
Percent who took 1 or more courses	95.0	97.8	97.4	85.1	69.5
Average number of courses taken	3.9	6.8	6.8	3.1	2.5
Physical science /5					
Percent who took 1 or more courses	66.6	97.1	88.7	77.5	63.3
Average number of courses taken	2.4	8.7	10.1	3.1	2.7
Psychology					
Percent who took 1 or more courses	77.7	57.2	72.1	80.3	74.6
Average number of courses taken	1.9	1.7	2.0	6.4	2.3
Social science					
Percent who took 1 or more courses	98.1	92.3	92.2	99.0	92.6
Average number of courses taken	6.4	3.2	3.8	11.1	4.1
Vocational/technical					
Percent who took 1 or more courses	39.7	56.3	48.9	21.8	25.6
Average number of courses taken	2.4	3.2	2.1	1.9	2.3

4/ Life science includes general biology, biochemistry and biophysics, botany, cell and molecular biology, microbiology/bacteriology, zoology, and miscellaneous biological specializations (e.g., anatomy, ecology).

5/ Physical science includes geological sciences, chemistry, physics, and other physical sciences such as astronomy, atmoshpenc sciences, metallurgy, and oceanography.

SOURCE: National Center for Education Statistics, U.S. Department of Education, unpublished tabulations from the 1987 Recent College Graduates Transcript Study: Estimates of 1985-86 Bachelor's Degree Recipients Course-taking Behavior.

Percent of students rating college experiences as satisfactory or very satisfactory, by sex: 1988 follow-up of fall 1984 college freshmen

Sex and course /1	Total of all four-year colleges and universities	Universities		Four-year colleges		Two-year colleges		
		Public	Private	Public	Private	All	Public	Private
Male								
Science and mathematics courses	67.0	68.3	74.1	62.5	69.0	79.3	79.3	79.0
Humanities courses	71.4	73.2	77.1	67.0	72.9	72.2	70.6	86.0
Social science courses	66.3	67.5	70.2	62.8	68.1	71.2	70.4	78.9
Overall quality of instruction	69.4	67.6	81.7	63.4	74.6	79.1	79.0	80.2
Female								
Science and mathematics courses	61.8	56.2	66.4	63.5	64.1	72.2	73.7	63.1
Humanities courses	78.5	78.1	85.9	73.2	83.3	71.0	71.0	71.0
Social science courses	73.3	73.6	80.9	70.3	74.7	71.2	72.2	65.4
Overall quality of instruction	73.6	69.2	87.5	70.1	78.4	72.9	72.7	73.9

1/ Students responding "Don't know, can't rate" were not included in tabulations.

SOURCE: A. W. Astin, W. S. Korn, E. L. Dey, and S. Hurtado, *The American College Student, 1988: National Norms for 1984 and 1986 College Freshmen* (Los Angeles: Higher Education Research Institute, UCLA, 1990), 142, 165.

Indicators of Science and Mathematics Education 1992

Appendix Table 5-4

Percent of full-time faculty in four-year institutions who are somewhat or very satisfied with the quality of their students, by department program area: Fall 1987

Department program	Quality of graduate students whom I have taught here: Number	Percent /1	Quality of undergraduate students whom I have taught here: Number	Percent /1
Total	264,166	78 (1.3)	339,307	67 (0.9)
Natural sciences	41,065	75 (3.1)	58,781	62 (2.3)
Engineering	15,031	72 (3.3)	18,682	73 (5.0)
Social and behavioral sciences	28,839	70 (3.0)	38,673	58 (3.6)
Business	17,006	71 (4.3)	23,540	67 (3.0)
Humanities	25,696	73 (1.5)	47,048	60 (1.7)

NOTES: Standard errors are presented in parentheses. Total includes agriculture and home economics, communications, education, fine arts, health sciences, library sciences, law, theology, and interdisciplinary studies.

1/ Percent who said "somewhat satisfied" or "very satisfied"; responses were based on a four-point scale of "very dissatisfied," "somewhat dissatisfied," "somewhat satisfied," and "very satisfied."

SOURCE: National Center for Education Statistics, U.S. Department of Education, "1988 National Survey of Postsecondary Faculty," as cited in *Faculty in Higher Education Institutions, 1988* (Data series DR-NSOPF-87/88-1.27), 62, 64, 142, 144.

Indicators of Science and Mathematics Education 1992

Appendix Table 5-5

Percent of instructional faculty by their opinion as to the quality of undergraduate students, by department program area: Fall 1987

Department program area	Improved	Stayed the same	Worsened	Have no idea	Sample size
Natural sciences	13.7	25.9	51.9	8.5	1,049
Engineering	16.3	34.1	40.9	8.6	307
Social and behavioral sciences	15.2	35.7	43.2	5.9	591
Business	19.9	25.0	45.6	9.5	523
Humanities	15.7	33.4	44.6	6.4	2,653

SOURCE: Unpublished tabulations from the 1988 National Survey of Postsecondary Faculty, NCES.

Indicators of Science and Mathematics Education 1992

GRE test score means and standard deviations for the general test and selected subject tests: 1978-79 to 1990-91

Test		1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91 /1
General test														
Total volume for year		282,482	272,281	262,855	256,381	263,674	265,221	271,972	279,428	293,560	303,703	326,096	344,572	379,882
Verbal ability	M	476	474	473	469	473	475	474	475	477	483	484	486	485
	SD	130	131	128	130	131	130	126	126	126	123	125	123	122
Quantitative ability	M	517	522	523	533	541	541	545	552	550	557	560	562	562
	SD	135	136	136	137	138	139	140	140	140	140	142	143	141
Analytical ability /2	M	---	---	---	498	504	512	516	520	521	528	530	534	536
	SD	---	---	---	126	128	129	129	129	128	128	129	128	129
Subject test														
Natural sciences														
Biology	M	621	619	617	616	623	622	619	612	616	615	612	612	609
	SD	117	115	115	114	115	115	114	114	116	114	114	114	113
	Sample size	18,795	16,693	15,002	14,185	12,883	12,429	12,647	13,231	13,012	12,744	12,661	12,333	10,906
Chemistry	M	623	618	615	616	620	619	621	628	629	631	642	662	660
	SD	104	105	103	105	105	102	101	106	104	108	117	123	123
	Sample size	5,725	5,422	4,926	4,940	4,964	4,969	4,806	4,934	4,825	4,665	4,854	5,164	4,723
Computer science	M	605	605	602	604	606	607	604	607	614	622	620	628	631
	SD	104	101	101	95	98	97	97	98	101	98	98	97	97
	Sample size	2,040	2,421	2,521	3,150	3,813	4,495	5,464	6,541	6,778	6,279	6,414	6,044	6,001
Geology	M	574	576	574	570	573	574	578	576	574	582	580	577	569
	SD	91	90	91	86	87	91	88	92	90	88	84	91	87
	Sample size	2,991	3,077	3,047	3,359	4,114	3,650	2,978	2,485	1,851	1,473	1,182	1,039	1,077

Continued

NOTE: Results based on annual summary data for the total group of examinees.
1/ The 1990-91 norms are provisional, pending computational changes that are scheduled to be made
2/ Analytical ability scores earned between 1977-78 and 1980-81 cannot be compared to scores later because the analytical scale was changed in 1981-82
Therefore, analytical ability scores earned between 1977-78 and 1980 81 are not presented in this table.
SOURCE: D.M. Wah and D. S. Robinson, *Examinee and Score Trends for the GRE General Test 1977-78, 1982-83, 1986-87, 1987-88* (Princeton: Educational Testing Service, 1990).

GRE test score means and standard deviations for the general test and selected subject tests: 1978-79 to 1990-91, continued

Test		1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91 /1
Subject test														
Natural sciences, cont.														
Mathematics	M	679	696	695	696	700	711	717	714	710	720	720	728	730
	SD	155	160	163	159	153	157	158	159	161	161	161	164	164
	Sample size	3,342	3,424	3,109	3,287	3,533	3,715	4,096	4,151	4,122	3,938	3,997	3,842	4,087
Physics	M	648	650	648	647	641	637	640	645	641	645	661	685	665
	SD	145	146	147	145	139	142	142	145	143	147	146	156	153
	Sample size	3,302	3,255	3,227	3,322	3,623	3,680	3,863	4,164	4,485	4,613	4,962	5,279	4,997
Engineering	M	592	590	590	593	599	604	615	616	619	622	626	617	611
	SD	115	116	116	115	114	114	120	119	119	120	116	111	111
	Sample size	8,036	7,747	7,469	7,482	8,212	8,218	8,620	9,005	8,952	8,116	7,031	6,092	5,963
Social and behavioral sciences														
Economics	M	601	603	613	614	613	617	623	609	612	625	630	639	640
	SD	110	106	108	108	107	105	102	106	108	105	106	113	109
	Sample size	3,684	3,600	3,436	3,461	3,384	3,206	3,150	3,318	3,291	2,838	2,716	2,514	2,571
Psychology	M	530	534	532	532	542	543	541	542	536	537	538	537	535
	SD	97	98	97	97	95	96	95	97	95	94	95	95	95
	Sample size	16,515	15,656	14,802	15,237	14,387	14,315	14,040	14,300	15,178	14,943	16,095	16,312	17,695
Sociology	M	436	438	427	433	434	434	442	430	427	434	425	422	427
	SD	117	109	109	106	106	105	104	99	101	100	97	96	89
	Sample size	2,617	2,268	1,967	1,588	1,328	1,236	1,154	1,502	1,716	1,680	2,086	2,214	2,152

NOTE: Results based on annual summary data for the total group of examinees.
1/ The 1990-91 norms are provisional, pending computational changes that are scheduled to be made
SOURCE: D. M. Wah and D. S. Robinson, *Examinee and Score Trends for the GRE General Test: 1977-78, 1982-83, 1986-87, and 1987-88* (Princeton: Educational Testing Service, 1990).

Employment status of 1988 and 1989 bachelor's and master's degree recipients in science and engineering, by major field of study: 1990

		Graduates employed				
Degree and field	Number of graduates	Full-time graduate students (Percent)	In science and engineering occupations (Percent)	In occupations other than science and engineering (Percent)	Not employed (Percent)	Median salary
Bachelor's degree						
Total science and engineering	643,200	20	44	32	5	$26,000
Natural sciences	252,400	24	49	22	5	24,417
Physical science	29,400	39	38	18	5	25,100
Mathematics/statistics	35,200	18	50	26	6	23,600
Computer science	69,300	6	77	13	4	30,100
Environmental science	7,300	30	49	15	5	23,700
Life science	111,200	32	34	28	6	21,000
Social and behavioral sciences	242,100	20	19	55	5	20,732
Psychology	85,700	21	20	54	5	18,600
Social science	156,400	20	19	55	5	21,900
Engineering	148,700	11	73	12	3	33,000
Master's degree						
Total science and engineering	136,600	23	61	13	4	37,000
Natural sciences	66,500	23	63	11	3	34,561
Physical science	9,200	41	49	8	2	34,900
Mathematics/statistics	10,600	18	67	13	2	32,800
Computer science	22,200	9	78	10	3	42,100
Environmental science	5,200	21	71	6	2	33,800
Life science	19,300	35	47	15	4	26,900
Social and behavioral sciences	27,200	28	37	29	6	31,268
Psychology	7,300	34	36	26	4	32,000
Social science	19,900	26	37	30	7	31,000
Engineering	42,900	17	73	6	3	41,400

NOTE: Percents may not add to 100 because of rounding.
SOURCE: Division of Science Resources Studies, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990*, as cited in the NSF article "Activities of Recent S&E Graduates Vary Significantly by Field of Degree" (NSF 91-121).

Appendix Table 5-8

Associate degrees, by selected fields of study: 1984-85 to 1989-90

Field of study /1	1984-85	1985-86	1986-87	1987-88	1988-89 /2	1989-90 /3
Total	454,712	446,047	437,137	435,085	436,764	454,679
Agriculture and natural resources	6,554	5,741	5,428	5,029	4,725	4,832
Architecture and environmental design	1,490	1,432	1,662	1,809	1,815	2,011
Area and ethnic studies	32	33	19	18	16	68
Business and management	120,731	117,358	115,197	110,971	107,629	106,980
Communications	1,846	2,055	1,590	1,919	1,777	1,658
Communications technologies	2,270	1,929	1,947	1,476	1,966	2,014
Education	7,580	7,391	7,309	7,219	7,391	8,018
Engineering	**3,881**	**5,256**	**4,518**	**3,850**	**2,676**	**2,380**
Engineering technologies	59,951	58,083	58,191	58,377	53,692	51,751
Health sciences	68,453	66,559	62,545	59,711	59,566	64,128
Home economics	9,611	9,469	9,311	9,739	10,505	10,230
Law	2,060	2,259	2,501	3,139	3,742	4,547
Letters	617	548	508	484	522	567
Liberal/general studies	106,396	107,672	108,207	113,048	118,411	128,721
Natural sciences	**15,642**	**13,357**	**11,797**	**11,313**	**10,597**	**10,645**
Computer and information sciences	12,677	10,704	9,098	8,628	7,900	7,604
Life sciences	1,121	998	907	854	982	1,034
Mathematics	789	602	667	684	654	760
Physical sciences	1,055	1,053	1,125	1,147	1,061	1,247
Science technology	1,138	1,054	934	743	900	888
Social and behavioral sciences	**3,570**	**3,479**	**3,631**	**3,709**	**3,831**	**3,980**
Psychology	983	939	1,011	1,000	1,090	1,110
Social sciences	2,587	2,540	2,620	2,709	2,741	2,870
Other	42,890	42,372	41,842	42,531	47,003	51,261

1/ The course definitions for associate degrees are not identical to those for bachelor's, master's, and doctoral degrees in later tables.
2/ Revised from previously published data.
3/ Preliminary data.
SOURCE: National Center for Education Statistics, "Degrees and Other Formal Awards Conferred" surveys, and Integrated Postsecondary Education Data System (IPEDS) Completion survey, as cited in NCES *Digest of Education Statistics: 1991*, No. NCES 91-697, 236, and unpublished tabulations.

Recipients of first university degrees as a percent of all persons 22 years old, by major field of study and country: 1975 to 1990

Country	Year	Degree field: Natural sciences	Engineering	All fields	Population age 22 /1
Canada					
	1975	1.2	1.1	NA	416,200
	1976	2.1	1.1	23.3	439,557
	1977	2.1	1.1	23.1	464,230
	1978	2.0	1.2	23.4	490,290
	1979	1.8	1.3	22.0	517,817
	1980	2.0	1.6	22.9	461,000
	1981	1.9	1.6	22.6	462,119
	1982	2.0	1.6	23.1	463,240
	1983	2.2	1.7	23.1	464,364
	1984	2.4	1.8	23.3	465,491
	1985	2.8	1.8	24.0	466,620
	1986	3.2	1.9	25.2	450,569
	1987	3.2	2.0	25.4	435,070
	1988	3.4	1.9	26.0	420,105
	1989	3.4	1.9	26.4	405,654
	1990	3.4	2.0	27.5	391,700
France					
	1975	0.8	1.2	4.2	849,380
	1976	0.8	1.2	4.5	848,623
	1977	0.8	1.2	4.9	847,866
	1978	0.9	1.2	5.2	847,110
	1979	0.9	1.3	5.6	846,355
	1980	1.0	1.4	6.1	845,600
	1981	1.1	1.4	6.5	848,315
	1982	1.0	1.4	7.0	851,038
	1983	1.0	1.5	7.5	853,770
	1984	1.1	1.5	7.7	856,510
	1985	1.2	1.6	8.3	859,260
	1986	1.3	1.6	8.5	857,295
	1987	1.4	1.7	8.8	855,335
	1988	1.5	1.8	9.0	853,379
	1989	1.6	1.8	NA	851,427
	1990	1.7	1.9	9.2	849,480
Germany					
	1975	0.8	0.5	4.0	848,000
	1976	0.8	0.5	4.2	864,283
	1977	0.8	0.5	4.3	880,878
	1978	0.9	0.6	4.4	897,792
	1979	0.8	0.6	4.7	915,030
	1980	0.9	0.6	5.0	932,600
	1981	0.9	0.6	4.9	952,442
	1982	1.0	0.6	5.2	972,705
	1983	1.0	0.7	5.5	993,400
	1984	1.1	0.7	5.6	1,014,535
	1985	1.1	0.7	5.9	1,036,120
	1986	1.2	0.7	6.2	1,032,207
	1987	1.3	0.7	6.8	1,028,308
	1988	1.4	0.7	7.3	1,024,424
	1989	1.6	0.9	7.8	1,020,555
	1990	1.8	1.0	8.0	1,016,700

Continued

NA Not available.

1/ Estimated by the number of 20- to 24-year-olds at the end of the academic year divided by 5. When population data for the end of the academic year were not available, the year before or after was used.

SOURCE: National Science Foundation, Division of Science Resources Studies' international database on human resources.

Recipients of first university degrees as a percent of all persons 22 years old, by major field of study and country: 1975 to 1990, continued

		Degree field			
Country	Year	Natural sciences	Engineering	All fields	Population age 22 /1
Japan					
	1975	1.0	3.6	17.0	1,837,830
	1976	1.1	3.8	18.3	1,783,292
	1977	1.2	4.1	19.6	1,730,372
	1978	1.3	4.3	21.3	1,679,022
	1979	1.5	4.6	23.0	1,629,197
	1980	1.4	4.7	24.0	1,580,850
	1981	1.5	4.8	24.3	1,591,885
	1982	1.4	4.7	23.9	1,602,997
	1983	1.4	4.4	22.9	1,614,186
	1984	1.4	4.4	22.9	1,625,454
	1985	1.4	4.4	22.8	1,636,800
	1986	1.4	4.5	22.6	1,665,869
	1987	1.5	4.6	22.6	1,695,454
	1988	1.4	4.5	22.2	1,725,565
	1989	1.3	4.4	21.5	1,756,210
	1990	1.4	4.6	22.4	1,787,400
United Kingdom					
	1975	2.2	1.3	NA	778,200
	1976	2.2	1.3	NA	787,343
	1977	2.3	1.4	11.4	796,593
	1978	2.3	1.5	10.6	805,951
	1979	2.3	1.5	NA	815,420
	1980	2.3	1.6	11.1	825,000
	1981	2.5	1.5	12.4	848,499
	1982	2.5	1.3	NA	872,667
	1983	2.1	1.2	14.4	897,523
	1984	2.0	1.2	NA	923,087
	1985	1.9	1.1	14.7	949,380
	1986	1.9	1.1	NA	938,995
	1987	1.8	1.0	15.4	928,724
	1988	2.0	1.1	16.0	918,565
	1989				908,518
	1990				898,580
United States					
	1975	3.0	1.0	23.9	3,905,380
	1976	2.9	0.9	22.6	4,140,104
	1977	2.8	0.9	21.2	4,385,316
	1978	2.6	1.0	20.0	4,641,987
	1979	2.4	1.1	19.0	4,911,086
	1980	2.7	1.4	21.8	4,316,800
	1981	2.8	1.5	22.0	4,301,654
	1982	2.8	1.6	22.5	4,286,561
	1983	2.9	1.7	23.0	4,271,522
	1984	3.0	1.8	23.2	4,256,534
	1985	3.2	1.8	23.4	4,241,600
	1986	3.3	1.9	24.2	4,140,066
	1987	3.3	1.8	24.8	4,040,962
	1988	3.1	1.8	25.5	3,944,231
	1989	3.0	1.7	26.8	3,849,816
	1990	2.8	1.7	28.3	3,757,560

NA Not available.

1/ Estimated by the number of 20- to 24-year-olds at the end of the academic year divided by 5. When population data for the end of the academic year were not available, the year before or after was used.

SOURCE: National Science Foundation, Division of Science Resources Studies' international database on human resources.

:e and engineering bachelor's degrees, by degree field and sex: 1970-71 to 1989-90

/ear	All degrees	Total Science and engineering			Natural sciences /1			Engineering			Social and behavioral sciences /2		
	Total	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
:970-71	846,110	294,357	209,318	85,039	94,544	70,696	23,848	45,248	44,887	361	154,565	93,735	60,830
1971-72	894,110	306,459	216,422	90,037	96,410	71,701	24,709	45,711	45,219	492	164,338	99,502	64,836
1972-73	930,272	321,085	225,090	95,995	103,004	76,119	26,885	46,779	46,203	576	171,302	102,768	68,534
1973-74	954,376	326,230	223,652	102,578	109,752	79,766	29,986	43,248	42,550	698	173,230	101,336	71,894
1974-75	931,663	313,555	210,741	102,814	110,584	78,706	31,878	39,824	38,979	845	163,147	93,056	70,091
1975-76	934,443	309,491	205,570	103,921	113,296	79,643	33,653	38,790	37,473	1,317	157,405	88,454	68,951
1976-77	928,228	303,798	198,805	104,993	113,908	78,619	35,289	41,357	39,313	2,044	148,533	80,873	67,660
1977-78	930,201	303,555	195,888	107,667	112,286	75,829	36,457	47,251	43,769	3,482	144,018	76,290	67,728
1978-79	931,340	303,162	193,247	109,915	110,790	73,296	37,494	53,469	48,588	4,881	138,903	71,363	67,540
1979-80	940,251	304,695	191,215	113,480	110,253	71,348	38,905	58,810	52,858	5,952	135,632	67,009	68,623
1980-81	946,877	306,792	190,977	115,815	110,468	70,102	40,366	63,717	56,654	7,063	132,607	64,221	68,386
1981-82	964,043	315,023	193,624	121,399	113,998	71,179	42,819	67,460	59,185	8,275	133,565	63,260	70,305
1982-83	980,679	317,875	194,538	123,337	116,554	71,128	45,426	72,670	63,018	9,652	128,651	60,392	68,259
1983-84	986,345	324,483	199,262	125,221	122,252	74,279	47,973	76,153	65,424	10,729	126,078	59,559	66,519
1984-85	990,877	332,422	203,464	128,958	129,817	78,368	51,449	77,572	66,326	11,246	125,033	58,770	66,263
1985-86	1,000,204	335,460	204,771	130,689	131,082	79,246	51,836	76,820	65,682	11,138	127,558	59,843	67,715
1986-87	1,003,532	331,526	199,981	131,545	125,166	75,460	49,706	74,425	63,021	11,404	131,935	61,500	70,435
1987-88	1,006,033	322,482	191,549	130,933	115,611	69,042	46,569	70,154	59,375	10,779	136,717	63,132	73,585
1988-89	1,030,171	322,821	189,338	133,483	109,137	65,691	43,446	66,947	56,759	10,188	146,737	66,888	79,849
1989-90	1,062,151	329,094	189,082	140,012	105,021	62,341	42,680	64,705	54,732	9,973	159,368	72,009	87,359

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.
2/ Includes degrees in social science and psychology.
SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992)

Appendix Table 5-11

Bachelor's degrees in natural sciences, by sex: 1970-71 to 1989-90

Year	Computer and information sciences			Biological/agricultural sciences			Mathematics			Physical sciences		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
1970-71	2,388	2,064	324	45,728	34,712	11,016	24,918	15,424	9,494	21,510	18,496	3,014
1971-72	3,402	2,941	461	48,291	36,514	11,777	23,848	14,525	9,323	20,869	17,721	3,148
1972-73	4,305	3,665	640	54,687	40,908	13,779	23,223	13,878	9,345	20,789	17,668	3,121
1973-74	4,757	3,977	780	61,906	45,174	16,732	21,813	12,874	8,939	21,276	17,741	3,535
1974-75	5,039	4,083	956	66,321	46,937	19,384	18,346	10,646	7,700	20,878	17,040	3,838
1975-76	5,664	4,540	1,124	70,004	48,168	21,836	16,085	9,531	6,554	21,543	17,404	4,139
1976-77	6,426	4,887	1,539	70,589	47,339	23,250	14,303	8,354	5,949	22,590	18,039	4,551
1977-78	7,224	5,360	1,864	69,215	44,852	24,363	12,701	7,455	5,246	23,146	18,162	4,984
1978-79	8,769	6,306	2,463	66,781	41,994	24,787	11,901	6,943	4,958	23,339	18,053	5,286
1979-80	11,213	7,814	3,399	63,942	38,931	25,011	11,473	6,625	4,848	23,625	17,978	5,647
1980-81	15,233	10,280	4,953	59,922	35,265	24,657	11,173	6,392	4,781	24,140	18,165	5,975
1981-82	20,431	13,316	7,115	57,535	33,222	24,313	11,708	6,650	5,058	24,324	17,991	6,333
1982-83	24,682	15,690	8,992	55,820	31,343	24,477	12,557	7,059	5,498	23,495	17,036	6,459
1983-84	32,435	20,369	12,066	52,719	29,316	23,403	13,342	7,428	5,914	23,756	17,166	6,590
1984-85	39,121	24,690	14,431	51,583	28,298	23,285	15,267	8,231	7,036	23,846	17,149	6,697
1985-86	42,195	27,069	15,126	50,639	27,595	23,044	16,388	8,772	7,616	21,860	15,810	6,050
1986-87	39,927	26,038	13,889	48,571	26,168	22,403	16,515	8,833	7,682	20,153	14,421	5,732
1987-88	34,896	23,543	11,353	46,925	24,550	22,375	15,981	8,569	7,412	17,809	12,380	5,429
1988-89	30,963	21,418	9,545	45,531	23,852	21,679	15,314	8,264	7,050	17,329	12,157	5,172
1989-90	27,695	19,321	8,374	46,451	24,050	22,401	14,674	7,863	6,811	16,201	11,107	5,094

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Appendix Table 5-12

Bachelor's degrees in social and behavioral sciences, by sex: 1970-71 to 1989-90

Year	Psychology			Social sciences /1		
	Total	Men	Women	Total	Men	Women
1970-71	38,154	21,117	17,037	116,411	72,618	43,793
1971-72	43,421	23,267	20,154	120,917	76,235	44,682
1972-73	48,096	25,110	22,986	123,206	77,658	45,548
1973-74	52,256	25,849	26,407	120,974	75,487	45,487
1974-75	51,436	24,333	27,103	111,711	68,723	42,988
1975-76	50,363	22,987	27,376	107,042	65,467	41,575
1976-77	47,794	20,692	27,102	100,739	60,181	40,558
1977-78	45,057	18,517	26,540	98,961	57,773	41,188
1978-79	43,012	16,649	26,363	95,891	54,714	41,177
1979-80	42,513	15,590	26,923	93,119	51,419	41,700
1980-81	41,364	14,447	26,917	91,243	49,774	41,469
1981-82	41,539	13,756	27,783	92,026	49,504	42,522
1982-83	40,825	13,228	27,597	87,826	47,164	40,662
1983-84	40,375	12,949	27,426	85,703	46,610	39,093
1984-85	40,237	12,815	27,422	84,796	45,955	38,841
1985-86	40,937	12,691	28,246	86,621	47,152	39,469
1986-87	43,195	13,399	29,796	88,740	48,101	40,639
1987-88	45,378	13,584	31,794	91,339	49,548	41,791
1988-89	48,954	14,291	34,663	97,783	52,597	45,186
1989-90	54,018	15,399	38,619	105,350	56,610	48,740

1/ Includes degrees in general social sciences, anthropology, archaeology, economics, geography, political science and government, sociology, criminology, international relations, urban studies, demography, and other social sciences.

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*. NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Appendix Table 5-13

Science and engineering master's degrees, by degree field and sex: 1970-71 to 1989-90

Year	All degrees	Total Science and engineering			Natural sciences /1			Engineering			Social and behavioral sciences /2		
	Total	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
1970-71	231,486	56,454	46,116	10,338	20,735	16,137	4,598	16,367	16,181	186	19,352	13,798	5,554
1971-72	252,774	60,049	48,721	11,328	21,658	16,807	4,851	16,764	16,493	271	21,627	15,421	6,206
1972-73	264,525	62,046	50,233	11,813	21,899	17,216	4,683	16,545	16,267	278	23,602	16,750	6,852
1973-74	278,259	62,239	49,528	12,711	22,040	17,127	4,913	15,205	14,858	347	24,994	17,543	7,451
1974-75	293,651	63,198	49,410	13,788	21,468	16,580	4,888	15,167	14,795	372	26,563	18,035	8,528
1975-76	313,001	65,007	49,992	15,015	21,150	16,164	4,986	16,045	15,477	568	27,812	18,351	9,461
1976-77	318,241	67,397	50,899	16,498	21,856	16,363	5,493	16,012	15,314	698	29,529	19,222	10,307
1977-78	312,816	67,264	50,034	17,230	21,967	16,287	5,680	16,080	15,237	843	29,217	18,510	10,707
1978-79	302,075	64,226	46,614	17,612	21,544	15,692	5,852	15,279	14,342	937	27,403	16,580	10,823
1979-80	299,095	64,089	46,004	18,085	21,347	15,444	5,903	15,943	14,820	1,123	26,799	15,740	11,059
1980-81	296,798	64,366	45,505	18,861	21,136	15,161	5,975	16,451	15,122	1,329	26,779	15,222	11,557
1981-82	296,580	66,568	46,557	20,011	22,368	15,646	6,722	17,557	15,982	1,575	26,643	14,929	11,714
1982-83	290,931	67,716	46,718	20,998	22,540	15,486	7,054	18,886	17,131	1,755	26,290	14,101	12,189
1983-84	285,462	68,564	47,033	21,531	23,170	15,687	7,483	20,145	18,045	2,100	25,249	13,301	11,948
1984-85	287,213	70,562	48,232	22,330	23,961	16,231	7,730	20,972	18,728	2,244	25,629	13,273	12,356
1985-86	289,829	71,831	48,611	23,220	25,151	16,846	8,305	21,096	18,696	2,400	25,584	13,069	12,515
1986-87	290,532	72,603	48,759	23,844	25,208	16,663	8,545	22,070	19,300	2,770	25,325	12,796	12,529
1987-88	300,091	73,655	49,820	23,835	25,784	17,321	8,463	22,726	19,918	2,808	25,145	12,581	12,564
1988-89	311,050	76,425	50,845	25,580	26,047	17,216	8,831	23,743	20,661	3,082	26,635	12,968	13,667
1989-90	324,947	77,788	51,230	26,558	26,255	17,228	9,027	23,995	20,726	3,269	27,538	13,276	14,262

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.
2/ Includes degrees in social science and psychology.
SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992)

Appendix Table 5-14

Master's degrees in natural sciences, by sex: 1970-71 to 1989-90

Year	Computer and information sciences			Biological/agricultural sciences			Mathematics			Physical sciences		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
1970-71	1,588	1,424	164	7,604	5,546	2,058	5,201	3,677	1,524	6,342	5,490	852
1971-72	1,977	1,752	225	8,200	6,014	2,186	5,209	3,657	1,552	6,272	5,384	888
1972-73	2,113	1,888	225	8,514	6,406	2,108	5,033	3,528	1,505	6,239	5,394	845
1973-74	2,276	1,983	293	8,866	6,633	2,233	4,840	3,340	1,500	6,058	5,171	887
1974-75	2,299	1,961	338	9,030	6,755	2,275	4,338	2,910	1,428	5,801	4,954	847
1975-76	2,603	2,226	377	9,223	6,752	2,471	3,863	2,550	1,313	5,461	4,636	825
1976-77	2,798	2,332	466	10,060	7,219	2,841	3,698	2,398	1,300	5,300	4,414	886
1977-78	3,038	2,471	567	10,001	6,981	3,020	3,383	2,233	1,150	5,545	4,602	943
1978-79	3,055	2,480	575	10,016	6,785	3,231	3,046	1,989	1,057	5,427	4,438	989
1979-80	3,647	2,883	764	9,631	6,502	3,129	2,868	1,832	1,036	5,201	4,227	974
1980-81	4,218	3,247	971	9,107	6,061	3,046	2,569	1,692	877	5,242	4,161	1,081
1981-82	4,935	3,625	1,310	9,199	5,896	3,303	2,731	1,821	910	5,503	4,304	1,199
1982-83	5,321	3,813	1,508	9,136	5,699	3,437	2,839	1,859	980	5,244	4,115	1,129
1983-84	6,190	4,379	1,811	8,705	5,298	3,407	2,749	1,795	954	5,526	4,215	1,311
1984-85	7,101	5,064	2,037	8,207	4,876	3,331	2,888	1,877	1,011	5,765	4,414	1,351
1985-86	8,070	5,658	2,412	8,027	4,680	3,347	3,171	2,055	1,116	5,883	4,453	1,430
1986-87	8,481	5,985	2,496	7,775	4,437	3,338	3,327	2,026	1,301	5,625	4,215	1,410
1987-88	9,166	6,702	2,464	7,556	4,312	3,244	3,434	2,057	1,377	5,628	4,250	1,378
1988-89	9,399	6,773	2,626	7,523	4,210	3,313	3,430	2,060	1,370	5,695	4,173	1,522
1989-90	9,643	6,968	2,675	7,527	4,080	3,447	3,684	2,208	1,476	5,401	3,972	1,429

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Appendix Table 5-15

Master's degrees in social and behavioral sciences, by sex: 1970-71 to 1989-90

Year	Psychology			Social sciences /1		
	Total	Men	Women	Total	Men	Women
1970-71	4,438	2,787	1,651	14,914	11,011	3,903
1971-72	5,293	3,260	2,033	16,334	12,161	4,173
1972-73	5,882	3,515	2,367	17,720	13,235	4,485
1973-74	6,616	3,986	2,630	18,378	13,557	4,821
1974-75	7,104	4,059	3,045	19,459	13,976	5,483
1975-76	7,859	4,188	3,671	19,953	14,163	5,790
1976-77	8,320	4,316	4,004	21,209	14,906	6,303
1977-78	8,194	3,931	4,263	21,023	14,579	6,444
1978-79	8,031	3,688	4,343	19,372	12,892	6,480
1979-80	7,861	3,397	4,464	18,938	12,343	6,595
1980-81	8,039	3,371	4,668	18,740	11,851	6,889
1981-82	7,849	3,228	4,621	18,794	11,701	7,093
1982-83	8,439	3,254	5,185	17,851	10,847	7,004
1983-84	8,073	2,980	5,093	17,176	10,321	6,855
1984-85	8,481	3,064	5,417	17,148	10,209	6,939
1985-86	8,363	2,937	5,426	17,221	10,132	7,089
1986-87	8,165	2,838	5,327	17,160	9,958	7,202
1987-88	7,925	2,599	5,326	17,220	9,982	7,238
1988-89	8,652	2,814	5,838	17,983	10,154	7,829
1989-90	9,308	3,025	6,283	18,230	10,251	7,979

1/ Includes degrees in general social sciences, anthropology, archaeology, economics, geography, political science and government, sociology, criminology, international relations, urban studies, demography, and other social sciences.

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Full-time science and engineering graduate students, by field and source of financial support: 1980 to 1990

Field and source of support	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total science and engineering	215,354	219,088	222,770	230,570	232,182	235,593	244,424	248,652	252,643	259,411	267,621
Federal	44,590	43,098	41,139	42,138	42,018	42,945	45,387	47,202	49,279	51,203	52,875
National Science Foundation	9,278	9,149	9,253	9,494	9,812	10,142	10,793	11,200	11,587	11,861	11,961
National Institutes of Health	10,614	10,132	9,583	9,673	9,972	10,083	10,770	11,491	12,377	12,993	13,416
Other Health and Human Services	2,148	1,802	1,412	1,114	947	1,164	1,106	1,157	999	1,179	1,250
Department of Defense	5,086	5,485	5,749	6,751	6,873	7,052	7,713	8,563	9,276	8,760	8,357
Other Federal	17,464	16,530	15,142	15,106	14,414	14,504	15,005	14,791	15,040	16,410	17,891
Non-federal	104,440	109,282	113,486	116,847	120,409	123,923	129,066	130,819	133,663	137,465	141,158
Self-support	66,324	66,708	68,145	71,585	69,755	68,725	69,971	70,631	69,701	70,743	73,588
Natural sciences											
Total	98,284	99,603	102,350	105,853	107,807	110,501	114,202	115,350	116,747	118,954	121,256
Federal	25,713	25,259	24,401	24,804	25,409	26,678	28,314	29,417	30,409	31,844	32,595
Non-federal	53,112	54,337	56,788	58,649	60,375	61,722	63,335	63,745	65,132	66,307	67,353
Self-support	19,459	20,007	21,161	22,400	22,023	22,101	22,533	22,188	21,206	20,803	21,308
Physical sciences	22,918	23,308	24,040	25,205	25,852	26,669	27,764	28,414	28,574	29,193	29,573
Federal	7,707	7,956	7,713	8,126	8,640	8,821	9,523	9,717	9,857	10,247	10,333
Non-federal	13,688	13,803	14,786	15,306	15,531	16,053	16,348	16,694	16,840	17,157	17,248
Self-support	1,523	1,549	1,541	1,773	1,681	1,795	1,893	2,003	1,877	1,789	1,992
Mathematics	9,902	10,154	10,823	10,964	11,319	11,833	12,398	13,049	13,523	13,705	13,870
Federal	868	796	818	760	762	935	999	1,090	1,190	1,211	1,346
Non-federal	7,137	7,262	7,703	8,004	8,399	8,660	9,083	9,384	9,753	9,994	10,042
Self-support	1,897	2,096	2,302	2,200	2,158	2,238	2,316	2,575	2,580	2,500	2,482
Computer sciences	6,587	7,445	9,171	10,687	11,587	14,101	15,310	15,572	15,596	16,008	16,872
Federal	953	1,008	1,075	1,130	1,269	1,638	1,892	2,084	2,226	2,361	2,444
Non-federal	2,696	3,050	3,523	4,050	4,509	5,686	6,127	6,283	6,462	6,602	6,893
Self-support	2,938	3,387	4,573	5,507	5,809	6,777	7,291	7,205	6,908	7,045	7,535
Environmental sciences	10,969	11,038	11,436	12,049	11,819	11,439	11,323	10,543	10,296	10,138	10,295
Federal	3,442	3,010	2,854	2,874	2,848	2,960	3,033	2,868	2,799	2,863	2,939
Non-federal	4,912	5,231	5,474	5,554	5,640	5,561	5,566	5,232	5,379	5,357	5,251
Self-support	2,615	2,797	3,108	3,621	3,331	2,918	2,724	2,443	2,118	1,918	2,105

Continued

SOURCES: Division of Science Resources Studies, *Selected Data on Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: National Science Foundation, 1991); unpublished tabulations and annual series, as cited in *Science and Engineering Indicators 1991*, NSF-NSB 91-1, 252-53, table 2-20.

Full-time science and engineering graduate students, by field and source of financial support: 1980 to 1990, continued

Field and source of support	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Natural sciences, continued											
Life sciences	47,908	47,658	46,880	46,948	47,230	46,459	47,407	47,772	48,758	49,910	50,646
Federal	12,743	12,489	11,941	11,914	11,890	12,324	12,867	13,658	14,337	15,162	15,533
Non-federal	24,679	24,991	25,302	25,735	26,296	25,762	26,211	26,152	26,698	27,197	27,919
Self-support	10,486	10,178	9,637	9,299	9,044	8,373	8,329	7,962	7,723	7,551	7,194
Social and behavioral sciences											
Total	73,963	73,228	70,187	70,396	68,847	68,809	69,514	71,135	72,496	75,741	79,818
Psychology	26,692	26,725	25,812	26,701	26,108	25,769	26,521	27,497	28,480	30,172	30,992
Federal	3,390	3,055	2,414	2,141	2,062	2,057	2,035	2,052	2,173	2,215	2,401
Non-federal	10,088	10,960	10,746	11,178	11,630	11,893	12,361	12,190	12,385	12,945	13,341
Self-support	13,214	12,710	12,652	13,382	12,416	11,819	12,125	13,255	13,922	15,012	15,250
Social sciences	47,271	46,503	44,375	43,695	42,739	43,040	42,993	43,638	44,016	45,569	48,826
Federal	4,296	3,810	3,229	3,208	2,957	2,943	2,659	2,613	2,677	2,799	2,972
Non-federal	22,078	22,467	22,532	22,354	22,145	22,102	22,725	23,679	24,434	25,348	26,722
Self-support	20,897	20,226	18,614	18,133	17,637	17,995	17,609	17,346	16,905	17,422	19,132
Engineering											
Total	43,107	46,257	50,233	54,321	55,528	56,283	60,708	62,167	63,400	64,716	66,547
Federal	11,191	10,974	11,095	11,985	11,590	11,267	12,379	13,120	14,020	14,345	14,907
Non-federal	19,162	21,518	23,420	24,666	26,259	28,206	30,645	31,205	31,712	32,865	33,742
Self-support	12,754	13,765	15,718	17,670	17,679	16,810	17,684	17,842	17,668	17,506	17,898

SOURCES Division of Science Resources Studies, *Selected Data on Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: National Science Foundation, 1991); unpublished tabulations and annual series, as cited in *Science and Engineering Indicators 1991*, NSF-NSB 91-1, 252-53, table 2-20.

Appendix Table 5-17

Full-time science and engineering graduate students in all institutions, by major type of financial support: 1980 to 1990

Year	Total	Fellowships	Traineeships	Research assistantships	Teaching assistantships	Other
1980	239,647	20,675	17,677	51,711	53,927	95,657
1981	243,471	20,252	16,875	52,876	55,798	97,670
1982	246,046	21,018	14,740	52,681	58,386	99,221
1983	253,578	21,512	13,600	55,051	60,168	103,247
1984	255,430	21,774	13,537	57,845	61,378	100,896
1985	259,320	22,771	13,758	61,137	61,990	99,664
1986	268,185	23,160	13,613	66,193	62,706	102,513
1987	273,090	22,271	14,114	70,303	62,989	103,413
1988	277,859	22,756	14,410	74,645	63,338	102,710
1989	285,989	23,847	14,615	79,216	64,550	103,761
1990	295,836	25,642	15,204	81,038	65,058	108,894

NOTE: For 1984 through 1987, the table includes estimated data for institutions granting master's degrees, which were surveyed on a sample basis during those years.

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Graduate Students and Postdoctorates in Science and Engineering.

Appendix Table 5-18

Science and engineering doctoral degrees, by degree field and sex: 1970-71 to 1990-91

	All degrees	Total Science and engineering			Natural sciences /1			Engineering			Social and behavioral sciences /2		
Year	Total	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
1970-71	31,867	19,381	17,385	1,996	10,280	9,280	1,000	3,514	3,498	16	5,587	4,607	980
1971-72	33,041	19,342	17,191	2,151	9,986	8,946	1,040	3,509	3,487	22	5,847	4,758	1,089
1972-73	33,755	19,373	16,853	2,520	9,804	8,633	1,171	3,374	3,328	46	6,195	4,892	1,303
1973-74	33,047	18,714	16,043	2,671	9,266	8,103	1,163	3,161	3,127	34	6,287	4,813	1,474
1974-75	32,952	18,799	15,870	2,929	9,250	7,998	1,252	3,011	2,959	52	6,538	4,913	1,625
1975-76	32,946	18,472	15,375	3,097	8,866	7,594	1,272	2,838	2,783	55	6,768	4,998	1,770
1976-77	31,716	18,008	14,775	3,233	8,640	7,367	1,273	2,648	2,574	74	6,720	4,834	1,886
1977-78	30,875	17,653	14,199	3,454	8,560	7,163	1,397	2,425	2,372	53	6,668	4,664	2,004
1978-79	31,239	17,872	14,128	3,744	8,796	7,269	1,527	2,494	2,432	62	6,582	4,427	2,155
1979-80	31,020	17,775	13,814	3,961	8,826	7,174	1,652	2,479	2,389	90	6,470	4,251	2,219
1980-81	31,357	18,258	14,057	4,201	8,956	7,232	1,724	2,528	2,429	99	6,774	4,396	2,378
1981-82	31,111	18,275	13,925	4,350	9,135	7,267	1,868	2,646	2,522	124	6,494	4,136	2,358
1982-83	31,282	18,635	13,920	4,715	9,182	7,199	1,983	2,781	2,657	124	6,672	4,064	2,608
1983-84	31,337	18,748	13,956	4,792	9,329	7,324	2,005	2,913	2,762	151	6,506	3,870	2,636
1984-85	31,297	18,935	14,044	4,891	9,435	7,312	2,123	3,166	2,968	198	6,334	3,764	2,570
1985-86	31,895	19,435	14,269	5,166	9,612	7,386	2,226	3,376	3,151	225	6,447	3,732	2,715
1986-87	32,364	19,890	14,581	5,309	9,845	7,484	2,361	3,712	3,470	242	6,333	3,627	2,706
1987-88	33,491	20,925	15,268	5,657	10,437	7,867	2,570	4,188	3,902	286	6,300	3,499	2,801
1988-89	34,319	21,727	15,621	6,106	10,656	7,857	2,799	4,544	4,169	375	6,527	3,595	2,932
1989-90	36,027	22,857	16,492	6,365	11,363	8,431	2,932	4,893	4,478	415	6,601	3,583	3,018
1990-91		23,979	16,742	6,865	11,989	8,727	3,122	5,212	4,590	452	6,778	3,425	3,291

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.
2/ Includes degrees in social science and psychology.
SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Indicators of Science and Mathematics Education 1992

...oral degrees in natural sciences, by sex: 1970-71 to 1990-91

Year	Computer and information sciences			Biological/agricultural sciences			Mathematics			Physical sciences		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
1970-71	0	0	0	4,557	3,897	660	1,238	1,142	96	4,485	4,241	244
1971-72	0	0	0	4,454	3,781	673	1,281	1,185	96	4,251	3,980	271
1972-73	1	0	1	4,503	3,714	789	1,232	1,113	119	4,068	3,806	262
1973-74	0	0	0	4,304	3,524	780	1,211	1,096	115	3,751	3,483	268
1974-75	0	0	0	4,402	3,553	849	1,147	1,038	109	3,701	3,407	294
1975-76	0	0	0	4,361	3,508	853	1,003	890	113	3,502	3,196	306
1976-77	31	26	5	4,266	3,423	843	933	811	122	3,410	3,107	303
1977-78	121	110	11	4,369	3,411	958	838	718	120	3,232	2,924	308
1978-79	210	183	27	4,501	3,470	1,031	769	650	119	3,316	2,966	350
1979-80	218	197	21	4,715	3,565	1,150	744	649	95	3,149	2,763	386
1980-81	232	206	26	4,786	3,565	1,221	728	616	112	3,210	2,845	365
1981-82	220	200	20	4,844	3,552	1,292	720	624	96	3,351	2,891	460
1982-83	286	250	36	4,756	3,390	1,366	701	588	113	3,439	2,971	468
1983-84	295	258	37	4,877	3,529	1,348	698	583	115	3,459	2,954	505
1984-85	310	277	33	4,904	3,495	1,409	688	582	106	3,533	2,958	575
1985-86	399	351	48	4,805	3,353	1,452	729	608	121	3,679	3,074	605
1986-87	450	385	65	4,815	3,284	1,531	740	615	125	3,840	3,200	640
1987-88	515	459	56	5,127	3,436	1,691	749	628	121	4,046	3,344	702
1988-89	612	504	108	5,201	3,432	1,769	859	704	155	3,984	3,217	767
1989-90	705	595	110	5,505	3,643	1,862	892	734	158	4,261	3,459	802
1990-91	797	674	116	5,713	3,699	1,968	1,040	820	194	4,439	3,534	844

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Appendix Table 5-20

Doctoral degrees in social and behavioral sciences, by sex: 1970-71 to 1990-91

	Psychology			Social sciences /1		
Year	Total	Men	Women	Total	Men	Women
1970-71	2,145	1,615	530	3,442	2,992	450
1971-72	2,279	1,670	609	3,568	3,088	480
1972-73	2,458	1,741	717	3,737	3,151	586
1973-74	2,598	1,797	801	3,689	3,016	673
1974-75	2,751	1,878	873	3,787	3,035	752
1975-76	2,883	1,937	946	3,885	3,061	824
1976-77	2,990	1,902	1,088	3,730	2,932	798
1977-78	3,055	1,928	1,127	3,613	2,736	877
1978-79	3,091	1,831	1,260	3,491	2,596	895
1979-80	3,098	1,787	1,311	3,372	2,464	908
1980-81	3,358	1,885	1,473	3,416	2,511	905
1981-82	3,159	1,721	1,438	3,335	2,415	920
1982-83	3,347	1,750	1,597	3,325	2,314	1,011
1983-84	3,257	1,626	1,631	3,249	2,244	1,005
1984-85	3,117	1,576	1,541	3,217	2,188	1,029
1985-86	3,124	1,526	1,598	3,323	2,206	1,117
1986-87	3,169	1,474	1,695	3,164	2,153	1,011
1987-88	3,064	1,388	1,676	3,236	2,111	1,125
1988-89	3,203	1,406	1,797	3,324	2,189	1,135
1989-90	3,269	1,362	1,907	3,332	2,221	1,111
1990-91	3,240	1,241	1,984	3,538	2,184	1,307

1/ Includes degrees in general social sciences, anthropology, archeology, economics, geography, political science and government, sociology, criminology, international relations, urban studies, demography, and other social sciences.

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Indicators of Science and Mathematics Education 1992

Appendix Table 5-21

Foreign student and total enrollment for higher education in leading host countries: 1987

Host country /1	Foreign student enrollment	Total enrollment	Foreign student enrollment as percent of total enrollment
United States /2	356,187	12,808,487	2.8
France	123,928	1,327,771	9.3
U.S.S.R.	105,800	5,122,000	2.1
Germany, F.R.	85,749	1,626,334	5.3
United Kingdom	59,220	1,086,092	5.5
Canada	27,119	1,277,624	2.1
Italy	22,781	1,227,809	1.9
Belgium	22,555	254,329	8.9
Saudi Arabia (1986)	17,971	130,924	13.7
Japan	17,641	2,510,169	0.7
Australia (1985)	16,075	393,734	4.1
Switzerland	13,925	121,693	11.4
Syria (1986)	12,309	182,933	6.7
Egypt	10,729	875,033	1.2
Sweden (1985)	10,401	184,324	5.6
Germany, D.R.	10,351	437,919	2.4
Vatican City	9,882	9,882	100.0
Netherlands	8,351	413,488	2.0
Turkey	8,233	534,459	1.5
Yugoslavia	6,787	348,068	1.9
Kuwait	5,152	25,521	20.2
Czechoslovakia	4,803	170,550	2.8
Philippines	4,680	1,627,000	0.3
Denmark	4,534	122,256	3.7
China	4,408	2,064,910	0.2
Cuba	4,143	265,225	1.6

1/ When year on which percentages are based is different from 1987, it is shown in parentheses.

2/ Source: *Open Doors, 1987-88.*

SOURCE: UNESCO Statistical Yearbook 1990, "Education at the Third Level: Number of Foriegn Students Enrolled," 376-79, table 3.14, and "Education at the Third Level: Teachers and Students by Type of Institution," 246-82, table 3.11, as cited in Institute of International Education, *Open Doors, 1990-1991, Report on International Educational Exchange* (New York: 1991), 8.

Foreign students studying in the United States, by world region of origin: 1954-55 to 1990-91

Year	Africa		Asia		Europe		Latin America		Middle East		North America		Oceania/1		Year total /2
	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	
1954-55	1,234	3.6	10,175	29.7	5,205	15.2	8,446	24.7	4,079	11.9	4,714	13.8	337	1.0	34,232
1955-56	1,231	3.4	11,625	31.9	5,504	15.1	8,474	23.2	4,239	11.6	5,042	13.8	353	0.9	36,494
1956-57	1,424	3.5	13,429	33.0	6,005	14.8	9,110	22.4	4,763	11.9	5,444	13.4	424	1.0	40,666
1957-58	1,515	3.5	14,786	34.1	6,837	15.8	9,212	21.2	5,115	11.8	5,354	12.3	495	1.1	43,391
1958-59	1,735	3.7	16,486	34.9	6,606	14.0	10,249	21.7	5,956	12.6	5,512	11.6	612	1.3	47,245
1959-60	1,959	4.0	17,808	36.7	6,392	13.2	9,428	19.4	6,477	13.4	5,761	11.9	568	1.2	48,486
1960-61	2,831	5.3	19,988	37.6	6,702	12.6	9,626	18.1	7,096	13.4	6,128	11.6	658	1.2	53,107
1961-62	3,930	6.8	22,451	38.7	6,833	11.8	9,915	17.1	7,394	12.7	6,639	11.4	796	1.4	58,086
1962-63	4,996	7.7	24,728	38.2	7,923	12.2	11,021	17.0	7,887	12.2	7,089	11.0	948	1.5	64,705
1963-64	6,144	8.2	27,682	37.0	9,348	12.5	12,882	17.2	8,980	12.0	8,548	11.4	1,080	1.5	74,814
1964-65	6,855	8.4	30,640	37.4	10,108	12.3	13,657	16.6	9,977	12.1	9,338	11.4	1,265	1.5	82,045
1965-66	6,896	8.3	30,371	36.7	10,226	12.4	13,998	16.9	9,895	12.0	9,851	11.9	1,325	1.6	82,709
1966-67	7,170	7.2	34,999	34.9	14,207	14.2	18,182	18.1	11,401	11.4	12,230	12.2	1,635	1.6	100,262
1967-68	6,901	6.3	38,672	35.1	15,556	14.1	21,908	19.9	11,903	10.7	12,236	11.1	1,683	1.5	110,315
1968-69	6,979	5.8	44,212	36.4	16,453	13.6	23,438	19.3	12,338	10.2	12,948	10.7	1,869	1.5	121,362
1969-70	7,607	5.6	51,033	37.8	18,524	13.7	24,991	18.5	13,278	9.9	13,415	9.9	2,077	1.5	134,959
1970-71	8,734	6.0	56,459	39.0	18,306	12.7	29,300	20.2	14,840	10.3	12,732	8.8	1,995	1.4	144,708
1971-72	9,592	6.8	54,276	38.7	16,219	11.6	28,832	20.6	14,651	10.5	10,541	7.5	2,131	1.5	140,126
1972-73	11,465	7.8	56,486	38.7	16,296	11.2	28,383	19.4	16,278	11.1	9,805	6.7	2,107	1.4	146,097
1973-74	12,937	8.6	57,072	37.8	15,539	10.3	30,276	20.0	18,381	12.2	8,883	5.9	2,375	1.6	151,066

Continued

1/ Oceania includes Australia, New Zealand, and 18 Pacific Ocean island areas.
2/ Includes students classified as stateless or of unknown origin.
SOURCE: Institute of International Education, *Open Doors, 1990-1991, Report on International Educational Exchange* (New York: 1991), 16.

Foreign students studying in the United States, by world region of origin: 1954-55 to 1990-91, continued

Year	Africa		Asia		Europe		Latin America		Middle East		North America		Oceania/1		Year
	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	Foreign students	Percent of total	total /2
1974-75	18,400	11.9	58,460	37.8	13,740	8.9	26,270	17.0	23,910	15.5	8,630	5.6	2,650	1.7	154,580
1975-76	25,290	14.1	64,540	36.0	14,400	8.1	29,820	16.6	32,590	18.2	9,720	5.4	2,740	1.5	179,340
1976-77	25,860	12.7	70,020	34.5	16,700	8.2	37,240	18.4	38,490	18.9	11,420	5.6	3,150	1.6	203,070
1977-78	29,560	12.6	73,760	31.3	19,310	8.2	38,840	16.5	57,210	24.3	12,920	5.5	3,810	1.6	235,510
1978-79	33,990	12.9	76,850	29.1	21,690	8.2	41,120	15.6	70,430	26.6	15,520	5.9	4,150	1.6	263,940
1979-80	36,180	12.6	81,730	28.6	22,570	7.9	42,280	14.8	83,700	29.2	15,570	5.4	4,140	1.4	286,340
1980-81	38,180	12.2	94,640	30.4	25,330	8.1	49,810	16.0	84,710	27.2	14,790	4.7	4,180	1.3	311,880
1981-82	41,660	12.8	106,160	32.5	28,990	8.9	55,360	17.0	74,390	22.8	15,460	4.7	4,000	1.2	326,300
1982-83	42,690	12.7	119,650	35.5	31,570	9.4	56,810	16.9	67,280	19.9	14,570	4.3	4,040	1.2	336,990
1983-84	41,690	12.3	132,270	39.0	31,860	9.4	52,350	15.5	60,660	17.9	15,670	4.6	4,090	1.2	338,890
1984-85	39,520	11.6	143,680	42.0	33,350	9.7	48,560	14.2	56,580	16.5	15,960	4.7	4,190	1.2	342,110
1985-86	39,190	9.9	156,830	45.6	34,310	10.0	45,480	13.2	52,720	15.3	16,030	4.7	4,030	1.2	343,780
1986-87	31,580	9.1	170,700	48.8	36,140	10.3	43,480	12.4	47,000	13.4	16,300	4.7	4,230	1.2	349,610
1987-88	28,450	8.0	180,540	50.7	38,820	10.9	44,550	12.5	43,630	12.2	16,360	4.6	3,620	1.0	356,190
1988-89	26,430	7.2	191,430	52.2	42,770	11.7	45,030	12.3	40,200	11.0	16,730	4.6	3,610	1.0	366,350
1989-90	24,570	6.4	208,110	53.8	46,040	11.9	48,090	12.4	37,330	9.7	18,590	4.8	4,010	1.0	386,850
1990-91	23,800	5.9	229,830	56.4	49,640	12.2	47,580	11.8	33,420	8.1	18,950	4.6	4,230	1.0	407,530

1/ Oceania includes Australia, New Zealand, and 18 Pacific Ocean island areas.
2/ Includes students classified as stateless or of unknown origin.
SOURCE: Institute of International Education, *Open Doors, 1990-1991. Report on International Educational Exchange* (New York: 1991), 16.

Appendix Table 5-23

Science and engineering doctorates awarded to U.S. citizens and non-U.S. citizens: 1970 to 1991

Field	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Total	18,044	19,363	19,324	19,352	18,694	18,710	18,268	17,723	17,383	17,589	17,523
U.S. citizens											
Science and engineering	14,567	15,465	15,144	14,971	13,750	14,288	14,082	13,636	13,331	13,524	13,410
Natural sciences	7,984	8,320	7,915	7,654	6,880	7,129	6,927	6,739	6,722	6,960	6,921
Engineering	2,518	2,426	2,334	2,145	1,754	1,717	1,558	1,473	1,261	1,294	1,255
Social and behavioral sciences	4,065	4,719	4,895	5,172	5,116	5,442	5,597	5,424	5,348	5,270	5,234
Non-U.S. citizens											
Science and engineering	3,295	3,618	3,860	4,044	4,092	4,056	3,839	3,651	3,557	3,602	3,662
Natural sciences	1,693	1,794	1,907	1,976	2,008	1,935	1,767	1,706	1,645	1,649	1,718
Engineering	908	1,056	1,143	1,186	1,231	1,241	1,206	1,101	1,095	1,140	1,150
Social and behavioral sciences	694	768	810	882	853	880	866	844	817	813	794
Unknown											
Science and engineering	182	280	320	337	852	366	347	436	495	463	451

Field	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Total	17,996	18,017	18,393	18,514	18,712	19,251	19,707	20,741	21,530	22,677	23,748
U.S. citizens											
Science and engineering	13,544	13,292	13,403	13,250	12,947	12,869	12,820	13,217	13,311	14,010	13,923
Natural sciences	6,969	7,084	6,997	7,040	6,881	6,707	6,658	6,907	6,957	7,229	7,249
Engineering	1,170	1,169	1,163	1,239	1,279	1,383	1,558	1,781	1,864	1,953	1,977
Social and behavioral sciences	5,405	5,039	5,243	4,971	4,787	4,779	4,603	4,529	4,491	4,828	4,697
Non-U.S. citizens											
Science and engineering	3,855	3,981	4,298	4,527	4,957	5,128	5,536	6,049	6,499	7,721	8,504
Natural sciences	1,751	1,782	1,928	2,012	2,229	2,375	2,612	2,901	2,996	3,766	4,246
Engineering	1,243	1,326	1,489	1,543	1,734	1,715	1,887	2,087	2,306	2,660	2,854
Social and behavioral sciences	861	873	881	972	994	1,038	1,037	1,059	1,197	1,295	1,404
Unknown											
Science and engineering	597	744	692	737	808	1,254	1,351	1,475	1,720	946	1,321

NOTE: Non-U.S. citizens includes permanent and temporary residents.

SOURCES: Division of Science Resources Studies, *Science and Engineering Doctorates: 1960-90*, NSF 91-310 (Washington, DC: National Science Foundation, 1991) 42-60; Division of Science Resources Studies, *Selected Data on Science and Engineering Doctorates, 1991*, NSF 92-309 (Washington, DC: National Science Foundation, 1992), 37.

Appendix Table 5-24

Non-citizen doctorate recipients with definite post-graduation plans in the United States, by type of plan: 1970 to 1990

Field of study	Total doctorates to non-citizens	Those with plans: Total	Employment	Study
1970				
Natural sciences	1,693	667	270	395
Engineering	908	335	273	60
Social and behavioral sciences	694	244	215	27
1980				
Natural sciences	1,718	635	233	398
Engineering	1,150	545	417	126
Social and behavioral sciences	794	186	154	31
1990				
Natural sciences	3,766	1,347	375	968
Engineering	2,660	805	582	221
Social and behavioral sciences	1,295	330	263	66

NOTE: Non-citizens includes permanent and temporary residents.

SOURCE: Division of Science Resources Studies, *Science and Engineering Doctorates, 1960-90*, NSF 91-310 (Washington, DC: National Science Foundation, 1991), 202-04.

Appendix Table 5-25

Science and engineering bachelor's degrees awarded to women: 1970-71 to 1989-90

Year	Total Science and engineering: Total	Total Science and engineering: Women	Natural sciences /1: Total	Natural sciences /1: Women	Engineering: Total	Engineering: Women	Social and behavioral sciences /2: Total	Social and behavioral sciences /2: Women
1970-71	294,357	85,039	94,544	23,848	45,248	361	154,565	60,830
1971-72	306,459	90,037	96,410	24,709	45,711	492	164,338	64,836
1972-73	321,085	95,995	103,004	26,885	46,779	576	171,302	68,534
1973-74	326,230	102,578	109,752	29,986	43,248	698	173,230	71,894
1974-75	313,555	102,814	110,584	31,878	39,824	845	163,147	70,091
1975-76	309,491	103,921	113,296	33,653	38,790	1,317	157,405	68,951
1976-77	303,798	104,993	113,908	35,289	41,357	2,044	148,533	67,660
1977-78	303,555	107,667	112,286	36,457	47,251	3,482	144,018	67,728
1978-79	303,162	109,915	110,790	37,494	53,469	4,881	138,903	67,540
1979-80	304,695	113,480	110,253	38,905	58,810	5,952	135,632	68,623
1980-81	306,792	115,815	110,468	40,366	63,717	7,063	132,607	68,386
1981-82	315,023	121,399	113,998	42,819	67,460	8,275	133,565	70,305
1982-83	317,875	123,337	116,554	45,426	72,670	9,652	128,651	68,259
1983-84	324,483	125,221	122,252	47,973	76,153	10,729	126,078	66,519
1984-85	332,422	128,958	129,817	51,449	77,572	11,246	125,033	66,263
1985-86	335,460	130,689	131,082	51,836	76,820	11,138	127,558	67,715
1986-87	331,526	131,545	125,166	49,706	74,425	11,404	131,935	70,435
1987-88	322,482	130,933	115,611	46,569	70,154	10,779	136,717	73,585
1988-89	322,821	133,483	109,137	43,446	66,947	10,188	146,737	79,849
1989-90	329,094	140,012	105,021	42,680	64,705	9,973	159,368	87,359

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.

2/ Includes degrees in social science and psychology.

SOURCE: Division of Science Resources Studies. *Science and Engineering Degrees: 1966-90*. NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Science and engineering master's degrees awarded to women: 1970-71 to 1989-90

Year	Total Science and engineering		Natural sciences /1		Engineering		Social and behavioral sciences /2	
	Total	Women	Total	Women	Total	Women	Total	Women
1970-71	56,454	10,338	20,735	4,598	16,367	186	19,352	5,554
1971-72	60,049	11,328	21,658	4,851	16,764	271	21,627	6,206
1972-73	62,046	11,813	21,899	4,683	16,545	278	23,602	6,852
1973-74	62,239	12,711	22,040	4,913	15,205	347	24,994	7,451
1974-75	63,198	13,788	21,468	4,888	15,167	372	26,563	8,528
1975-76	65,007	15,015	21,150	4,986	16,045	568	27,812	9,461
1976-77	67,397	16,498	21,856	5,493	16,012	698	29,529	10,307
1977-78	67,264	17,230	21,967	5,680	16,080	843	29,217	10,707
1978-79	64,226	17,612	21,544	5,852	15,279	937	27,403	10,823
1979-80	64,089	18,085	21,347	5,903	15,943	1,123	26,799	11,059
1980-81	64,366	18,861	21,136	5,975	16,451	1,329	26,779	11,557
1981-82	66,568	20,011	22,368	6,722	17,557	1,575	26,643	11,714
1982-83	67,716	20,998	22,540	7,054	18,886	1,755	26,290	12,189
1983-84	68,564	21,531	23,170	7,483	20,145	2,100	25,249	11,948
1984-85	70,562	22,330	23,961	7,730	20,972	2,244	25,629	12,356
1985-86	71,831	23,220	25,151	8,305	21,096	2,400	25,584	12,515
1986-87	72,603	23,844	25,208	8,545	22,070	2,770	25,325	12,529
1987-88	73,655	23,835	25,784	8,463	22,726	2,808	25,145	12,564
1988-89	76,425	25,580	26,047	8,831	23,743	3,082	26,635	13,667
1989-90	77,788	26,558	26,255	9,027	23,995	3,269	27,538	14,262

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.
2/ Includes degrees in social science and psychology.
SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees: 1966-90*, NSF 92-326 (Washington, DC: National Science Foundation, 1992).

Appendix Table 5-27

Science and engineering doctoral degrees awarded to women: 1970-71 to 1990-91

Year	Total Science and engineering		Natural sciences /1		Engineering		Social and behavioral sciences /2	
	Total	Women	Total	Women	Total	Women	Total	Women
1970-71	19,381	1,996	10,280	1,000	3,514	16	5,587	980
1971-72	19,342	2,151	9,986	1,040	3,509	22	5,847	1,089
1972-73	19,373	2,520	9,804	1,171	3,374	46	6,195	1,303
1973-74	18,714	2,671	9,266	1,163	3,161	34	6,287	1,474
1974-75	18,799	2,929	9,250	1,252	3,011	52	6,538	1,625
1975-76	18,472	3,097	8,866	1,272	2,838	55	6,768	1,770
1976-77	18,008	3,233	8,640	1,273	2,648	74	6,720	1,886
1977-78	17,653	3,454	8,560	1,397	2,425	53	6,668	2,004
1978-79	17,872	3,744	8,796	1,527	2,494	62	6,582	2,155
1979-80	17,775	3,961	8,826	1,652	2,479	90	6,470	2,219
1980-81	18,258	4,201	8,956	1,724	2,528	99	6,774	2,378
1981-82	18,275	4,350	9,135	1,868	2,646	124	6,494	2,358
1982-83	18,635	4,715	9,182	1,983	2,781	124	6,672	2,608
1983-84	18,748	4,792	9,329	2,005	2,913	151	6,506	2,636
1984-85	18,935	4,891	9,435	2,123	3,166	198	6,334	2,570
1985-86	19,435	5,166	9,612	2,226	3,376	225	6,447	2,715
1986-87	19,890	5,309	9,845	2,361	3,712	242	6,333	2,706
1987-88	20,925	5,657	10,437	2,570	4,188	286	6,300	2,801
1988-89	21,727	6,106	10,656	2,799	4,544	375	6,527	2,932
1989-90	22,857	6,365	11,363	2,932	4,893	415	6,601	3,018
1990-91	23,979	6,865	11,989	3,122	5,212	452	6,778	3,291

1/ Includes degrees in computer and information sciences, biological sciences, mathematics, and physical sciences.
2/ Includes degrees in social science and psychology.
SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Full-time regular instructional faculty in institutions of higher education, by faculty characteristics and teaching field: 1987-88

Faculty characteristics	Number in thousands	Teaching field: All fields	Natural sciences	Engineering	Social and behavioral sciences	Business	Humanities
Total (in thousands)	489	--	84	25	53	37	62
Percent	--	100	17	5	11	7	13
			Percent distribution				
Total	489	100	100	100	100	100	100
Sex							
Male	356	73	83	98	78	72	67
Female	133	27	17	2	22	28	33
Race and ethnicity							
White, non-Hispanic	438	90	91	87	90	88	90
Asian	21	4	6	11	2	6	2
Black, non-Hispanic	16	3	2	---	5	4	3
Hispanic	11	2	1	2	3	1	5
Native American	4	1	---	---	1	1	1
Age							
34 or younger	48	10	9	10	7	10	5
35-39	72	15	15	13	15	16	13
40-44	82	17	17	13	21	18	14
45-49	92	19	22	18	20	17	20
50-54	74	15	17	14	14	17	16
55-59	59	12	11	17	10	12	15
60 and older	62	13	9	14	13	9	16
Degree							
Less than bachelor's	4	1	1	---	---	---	---
Bachelor's	11	2	1	4	---	4	---
Graduate work, no degree	7	2	2	2	1	1	1
Master's	134	28	24	29	18	39	26
Professional	48	10	1	1	2	6	1
Doctoral	276	57	71	64	79	50	71
Rank							
Professor	162	33	38	41	36	21	38
Associate professor	116	24	23	24	26	21	25
Assistant professor	111	23	18	23	22	27	19
Instructor	56	12	9	7	6	19	8
Lecturer	8	2	2	1	1	3	3
Other	3	1	---	1	1	---	---
No rank	34	7	9	3	8	8	8

NOTE: Because of rounding and survey item nonresponse, details may not add to totals.
-- Not applicable.
--- Less than 0.5 percent.
SOURCE: U.S. Department of Education, National Survey of Postsecondary Faculty (NSOPF), 1987-88, as cited in NCES *Digest of Education Statistics, 1991*, NCES 91-697, 221.

Science and engineering bachelor's degrees awarded to African Americans and Hispanics: 1976-77 to 1989-90

Field	1976-77	1978-79	1980-81	1984-85	1986-87	1988-89	1989-90
Total							
All fields	928,228	931,340	946,877	990,877	1,003,532	1,030,171	1,062,151
Science and engineering	374,579	373,431	374,693	375,786	376,450	371,248	379,392
Natural sciences	119,071	116,856	116,660	130,058	125,371	109,350	105,234
Engineering /1	49,677	62,800	75,395	98,104	95,000	87,045	83,853
Social and behavioral sciences	205,831	193,775	182,6[illegible]	147,624	156,079	174,853	190,305
Percent							
All fields	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Science and engineering	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Natural sciences	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Engineering /1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Social and behavioral sciences	100.0	100.0	100.0	100.0	100.0	100.0	100.0
African Americans							
All fields	58,700	60,301	60,729	57,563	55,103	56,837	59,301
Science and engineering	23,134	23,324	23,767	20,223	20,224	20,481	21,274
Natural sciences	4,489	4,700	4,932	6,009	6,524	6,005	5,782
Engineering /1	1,385	1,775	2,449	3,316	3,584	3,275	3,272
Social and behavioral sciences	17,260	16,849	16,386	10,898	10,116	11,201	12,220
Percent							
All fields	6.3	6.5	6.4	5.8	5.5	5.5	5.6
Science and engineering	6.2	6.2	6.3	5.4	5.4	5.5	5.6
Natural sciences	3.8	4.0	4.2	4.6	5.2	5.5	5.5
Engineering /1	2.8	2.8	3.2	3.4	3.8	3.8	3.9
Social and behavioral sciences	8.4	8.7	9.0	7.4	6.5	6.4	6.4
Hispanics							
All fields	27,043	29,719	33,167	36,391	38,196	41,361	43,864
Science and engineering	11,002	12,163	13,107	13,373	13,846	14,811	15,680
Natural sciences	2,706	3,129	3,646	4,359	4,660	4,417	4,357
Engineering /1	1,290	1,555	1,820	2,712	3,218	3,195	3,295
Social and behavioral sciences	7,006	7,479	7,641	6,302	5,968	7,199	8,028
Percent							
All fields	2.9	3.2	3.5	3.7	3.8	4.0	4.1
Science and engineering	2.9	3.3	3.5	3.6	3.7	4.0	4.1
Natural sciences	2.3	2.7	3.1	3.4	3.7	4.0	4.1
Engineering /1	2.6	2.5	2.4	2.8	3.4	3.7	3.9
Social and behavioral sciences	3.4	3.9	4.2	4.3	3.8	4.1	4.2

NOTE: Data from institutions in Puerto Rico and other territories are included in these tabulations.

1/ Engineering includes engineering technologies.

SOURCE: Division of Science Resources Studies. *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977-90.* NSF 92-327 (Washington, DC: National Science Foundation, 1992).

Appendix Table 5-30

Science and engineering master's degrees awarded to African Americans and Hispanics: 1976-77 to 1989-90

Field	1976-77	1978-79	1980-81	1984-85	1986-87	1988-89	1989-90
Total							
All fields	318,241	302,075	296,798	287,213	290,532	311,050	324,947
Science and engineering	83,475	79,785	79,869	81,446	84,398	88,918	91,020
Natural sciences	22,730	22,451	22,119	24,034	25,269	26,089	26,293
Engineering /1	16,251	15,510	16,716	21,751	22,940	24,870	25,179
Social and behavioral sciences	44,494	41,824	41,034	35,661	36,189	37,959	39,548
Percent							
All fields	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Science and engineering	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Natural sciences	100.0	100.0	100.0	100.C	100.0	100.0	100.0
Engineering /1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Social and behavioral sciences	100.0	100.0	100.0	100.0	100.0	100.0	100.0
African Americans							
All fields	21,041	19,422	17,152	13,960	13,173	13,455	14,473
Science and engineering	4,197	4,042	3,695	3,189	3,265	3,206	3,603
Natural sciences	551	518	488	523	581	495	527
Engineering /1	240	246	260	367	445	410	431
Social and behavioral sciences	3,406	3,278	2,947	2,299	2,239	2,301	2,645
Percent							
All fields	6.6	6.4	5.8	4.9	4.5	4.3	4.5
Science and engineering	5.0	5.1	4.6	3.9	3.9	3.6	4.0
Natural sciences	2.4	2.3	2.2	2.2	2.3	1.9	2.0
Engineering /1	1.5	1.6	1.6	1.7	1.9	1.6	1.7
Social and behavioral sciences	7.7	7.8	7.2	6.4	6.2	6.1	6.7
Hispanics							
All fields	7,071	6,470	7,439	7,730	7,781	8,133	8,495
Science and engineering	2,078	1,702	2,052	2,237	2,308	2,349	2,330
Natural sciences	336	288	353	481	493	444	431
Engineering /1	251	215	285	352	529	478	455
Social and behavioral sciences	1,491	1,199	1,414	1,404	1,286	1,427	1,444
Percent							
All fields	2.2	2.1	2.5	2.7	2.7	2.6	2.6
Science and engineering	2.5	2.1	2.6	2.7	2.7	2.6	2.6
Natural sciences	1.5	1.3	1.6	2.0	2.0	1.7	1.6
Engineering /1	1.5	1.4	1.7	1.6	2.3	1.9	1.8
Social and behavioral sciences	3.4	2.9	3.4	3.9	3.6	3.8	3.7

NOTE: Data from institutions in Puerto Rico and other territories are included in these tabulations.

1/ Engineering includes engineering technologies.

SOURCE: Division of Science Resources Studies, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977-90*, NSF 92-327 (Washington, DC: National Science Foundation, 1992).

Science and engineering doctoral degrees awarded to African Americans and Hispanics: 1979-80 to 1990-91

Field	1979-80	1980-81	1981-82	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Total											
All fields	31,020	31,357	31,111	31,337	31,297	31,895	32,363	33,490	34,318	36,057	37,451
Science and engineering	17,775	18,258	18,275	18,748	18,935	19,435	19,890	20,925	21,727	22,857	23,979
Natural sciences	8,826	8,956	9,135	9,329	9,435	9,612	9,845	10,437	10,656	11,363	11,989
Engineering	2,479	2,528	2,646	2,913	3,166	3,376	3,712	4,188	4,544	4,893	5,212
Social and behavioral sciences	6,470	6,774	6,494	6,506	6,334	6,447	6,333	6,300	6,527	6,601	6,778
Percent											
All fields	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Science and engineering	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Natural sciences	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Engineering	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Social and behavioral sciences	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
African Americans											
All fields	1,444	1,491	1,526	1,494	1,440	1,270	1,218	1,263	1,246	1,348	1,355
Science and engineering	527	569	567	624	598	532	503	552	547	573	607
Natural sciences	177	213	189	222	208	194	180	202	196	190	220
Engineering	57	59	55	68	72	49	56	67	58	75	77
Social and behavioral sciences	293	297	323	334	318	289	267	283	293	308	310
Percent											
All fields	4.7	4.8	4.9	4.8	4.6	4.0	3.8	3.8	3.6	3.7	3.6
Science and engineering	3.0	3.1	3.1	3.3	3.2	2.7	2.5	2.6	2.5	2.5	2.5
Natural sciences	2.0	2.4	2.1	2.4	2.2	2.0	1.8	1.9	1.8	1.7	1.8
Engineering	2.3	2.3	2.1	2.3	2.3	1.5	1.5	1.6	1.3	1.5	1.5
Social and behavioral sciences	4.5	4.4	5.0	5.1	5.0	4.5	4.2	4.5	4.5	4.7	4.6

Continued

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Science and engineering doctoral degrees awarded to African Americans and Hispanics: 1979-80 to 1990-91, continued

Field	1979-80	1980-81	1981-82	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Hispanics											
All fields	821	931	920	918	1,000	1,055	1,055	1,051	1,064	1,226	1,280
Science and engineering	481	570	509	555	581	637	652	695	698	768	834
Natural sciences	231	276	230	260	300	309	339	361	353	387	420
Engineering	77	96	91	81	86	95	98	125	118	128	127
Social and behavioral sciences	173	198	188	214	195	233	215	209	227	253	287
Percent											
All fields	2.6	3.0	3.0	2.9	3.2	3.3	3.3	3.1	3.1	3.4	3.4
Science and engineering	2.7	3.1	2.8	3.0	3.1	3.3	3.3	3.3	3.2	3.4	3.5
Natural sciences	2.6	3.1	2.5	2.8	3.2	3.2	3.4	3.5	3.3	3.4	3.5
Engineering	3.1	3.8	3.4	2.8	2.7	2.8	2.6	3.0	2.6	2.6	2.4
Social and behavioral sciences	2.7	2.9	2.9	3.3	3.1	3.6	3.4	3.3	3.5	3.8	4.2

SOURCE: Division of Science Resources Studies, National Science Foundation, Survey of Earned Doctorates.

Indicators of Science and Mathematics Education 1992

Appendix B: Technical Notes

Studies of Elementary and Secondary Education

National Studies, K-12

International Studies, K-12

Studies of Higher Education

National Studies, K–12

High School and Beyond Study (HS&B), 1980 to 1992

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Overview

The High School and Beyond Study (HS&B) is a national longitudinal survey conducted by the National Center for Education Statistics to capture changes in educational conditions. Federal and state programs. students' school experiences. and future educational and occupational goals and plans. The study began in 1980 with a total of 58.270 students in grades 10 and 12, and four follow-up studies (1982. 1984. 1986. and 1992) were subsequently completed. In the follow-ups. data collection efforts included changes in the educational experiences of the cohorts. including high school completion. dropout. and return to school.

The basic tenets of the longitudinal study were similar to those of the National Longitudinal Study of the High School Class of 1972. but HS&B conducted a more extensive and expanded study including a considerably larger sample size and broader data coverage. Survey instruments included the student questionnaires with cognitive tests. the school administrator and parent questionnaires. and the teacher comment checklist.

Population Coverage

The target population was defined as all 10th- and 12th-grade students in public and private schools in the Nation. Detailed information on the criteria used for population inclusion and exclusion is not available in the published documents.

Sampling

A two-stage stratified probability sampling was used. In the first stage, schools were stratified by region. racial minority. enrollment. and urbanicity and were selected with probability proportional to the size of enrollment in grades 10 and 12. To produce stable estimates of subpopulations. schools with a high percentage of minority students. alternative public schools. and private schools with high achieving students were oversampled. In the second stage, a random sample of 36 students on average was selected from each school for each grade cohort. yielding a sample size of over 30,000 seniors and 28,000 sophomores.

The senior follow-up sample total of 11,995 consisted of a subsample of 11,500 students selected from the senior cohort base year participants and 495 selected from 6,741 base year nonparticipants. Among sophomores, all students selected for the base year, whether or not they actually participated, had a chance of being included in the first follow-up sample; approximately 30,000 sophomores participated. Beginning with the second follow-up, only the 1980 senior cohort was surveyed.

Sample Size and Response Rate

Sample	Original Selection	Cooperating	Substitution	Finally Achieved Sample
School (base year)	1,122 (100%)	811 (72%)	204	1,015

Sample	Original Selection	Completed Questionnaire	Completed Test
Student	70,704	58,270 (82%)	52,638 (74%)
Sophomores	35,723	30,030 (84%)	27,569 (77%)
Seniors	34,981	28,240 (81%)	25,069 (72%)
First Follow-up Senior Cohort	11,995	11,227 (94%)	—
Second Follow-up Senior Cohort	11,995	10,925 (91%)	—
Third Follow-up Senior Cohort	11,995	10,536 (88%)	—

— Not applicable.

Data Collection Method

Student questionnaires with cognitive tests were administered to the participating students in groups. The school questionnaire was filled out by an official in each school, and the teacher comment list was completed by a teacher of the participating student. Parent questionnaires were mailed to and filled out by a sample of parents of both cohorts.

In the first follow-up study, data on the sophomore cohort were collected by the same method used in the base year. For the senior cohort, questionnaires were mailed to and returned by participants. Approximately 75% of the targeted senior cohort members completed and returned first follow-up questionnaires by mail. An additional 19% completed the questionnaires by personal or telephone interview. In the subsequent follow-ups, the mail-back method was used for both the cohorts, supplemented by personal or telephone interviews for nonresponding members.

457

Sample Weighting

Weighting was carried out to compensate for the unequal probabilities of selection, retention (for the follow-up surveys), and nonresponse. The weights of the base year were based on the inverse of the selection probabilities in two stages of sample selection and nonresponse adjustment factors. The follow-up weight was calculated based on the inverse of the product of selection probability for the base year sample and the probability of retention in the follow-up sample and then adjusted for noncompletion. The two strata of the senior follow-up sample (base year participants and base year nonparticipants) were separately weighted with the inverse probability weights.

Estimation of Sampling Error

Sampling errors for the base year and follow-ups were estimated using special calculating methods such as Taylor series approximation or balanced repeated replication. The design effect was also calculated for each estimate for all survey waves. The estimates of standard errors and design effects can be found in the technical documents associated with each follow-up study.

Technical Document Reference

Calvin Jones, *High School and Beyond 1980 Senior Cohort First Follow-up (1982) Data File User's Manual*, The National Center for Education Statistics, U.S. Department of Education, 1983; Bruce Spencer et al., *High School and Beyond Third Follow-up (1986) Sample Design Report*, Contractor Report, The National Center for Education Statistics, U.S. Department of Education, 1987; and Martin R. Frankel et al., *Sample Design Report*, The National Center for Education Statistics, U.S. Department of Education, 1981.

High School Graduate Transcript Study, 1987

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Overview

As an attempt to examine course-taking patterns of and curriculum implementation for students completing high school and to measure curricular changes over time, the High School Graduate Transcript Study analyzed transcript records of approximately 22,700 high school graduates that were obtained as part of the 1987 High School Transcript Study and 12,000 transcripts of 1982 graduates who participated in the second follow-up of the High School and Beyond Study (HS&B) as the sophomore cohort. This transcript study was conducted by Westat, Inc., sponsored by the National Center for Education Statistics.

Population Coverage

The target population was defined as graduates from public and private high schools who were in grade 11 in the 1985–86 school year. The school universe (National Assessment of Educational Progress (NAEP) was restricted to regular schools, excluding special education schools, prison schools, and schools whose curriculum was limited to vocational education. As the survey collected transcript records of graduates, those who did not graduate from high school and those who quit school early were excluded. The graduate transcript analysis excluded handicapped students in the participating schools from data collection. These students were excluded because the High School Transcript Study and HS&B used different methods of defining handicapped students.

Sampling

For the 1987 graduate transcripts, the school and student samples obtained for the 1985–86 NAEP main assessment of the grade 11 cohort were used. The NAEP sample design used a four-staged stratified probability sampling method that was very similar to the one used in the 1990 NAEP main sample. The 1990 NAEP sample design is reported elsewhere in the technical notes of Appendix B.

The 1982 high school graduate transcripts were collected for members of the HS&B sophomore cohort who were selected to be in the second follow-up survey conducted in 1984. The sampling technique of HS&B is reported elsewhere in the technical notes of Appendix B.

Sample Size

From the original 1986 NAEP school sample, 433 schools returned transcripts. From the HS&B schools, transcripts were received from 1,720 schools, of which 949 schools were those selected for HS&B schools in the base year and 771 schools were those to which the HS&B students transferred. From these schools, transcript records for 22,732 high school graduates of 1987 and 11,770 high school graduates of 1982 were obtained.

Data Collection Method

Transcript data were collected by contacting the schools of sampled students; no personal contacts were made with students. Each course appearing on a student's transcript was assigned a six-digit code based on the course content and level. The coding system followed the Classification of Secondary School Courses that covers 1,800 course codes. In addition, some adaptations were made to distinguish levels of courses and to expand vocational education course codes. Student demographic information on sex, grade, age, graduation status, and race and ethnicity was also collected as reported in the transcripts.

Sample Weighting

Weights were assigned to the transcript of each student by taking into account the school's probability of selection in the sample and the student's conditional probability of selection within the sampled schools, then these were adjusted for school and student nonresponse. Additionally, poststratification adjustments were made on the subpopulations of race and ethnicity, region, and size of community to reflect the known population estimates.

Estimation of Sampling Error

Because students were sampled in cluster from schools and were not selected independently of each other, a special method that takes account of the complex sample design, the jackknifed method, was used to estimate standard errors. Jackknifed standard errors were reported for estimates of course-taking and completion (as represented by mean credits earned and mean percents of students earning credits) and for estimates of the changes from 1982 to 1987.

Technical Document Reference

Judy Thorne, *A Nation at Risk Update Study as Part of the 1987 High School Transcript Study*, Westat, 1988; and Judy Thorne et al., *Technical Report: High School Transcript Study, 1987*, The National Center for Education Statistics, U.S. Department of Education, 1989.

Longitudinal Study of American Youth (LSAY), 1987 to 1990

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Overview

The Longitudinal Study of American Youth (LSAY) was conducted by the Social Science Research Institute at Northern Illinois University, sponsored by the National Science Foundation. The Nation's secondary public school students were examined for their attitudes toward and expectations of science and mathematics as areas of study and career choices; the relationship between these attitudes and expectations and student achievement was also studied. LSAY began in 1987 with about 6,000 students in 7th and 10th grades and was followed up annually from 1988 to 1991 to measure changes as the students moved into higher grades.

The core student data collection covered in-school (course-taking) and out-of-school (informal activities) opportunities for learning science and mathematics, occupational conceptions and career choices, and related home and school environments. Further background and contextual information was gathered by inviting the students' parents, their science and mathematics teachers, and their principals to participate in the survey.

Population Coverage

The target population consisted of public school students who were in 7th or 10th grade in the 1987–88 school year. Excluded were private schools, special schools, Bureau of Indian Affairs schools, and Department of Defense schools.

Sampling

A two-staged stratified probability sampling method was used.

School sampling (Stage 1): The sampling frame of public high schools was prepared from the national directory of public high schools from Quality Education Data. The list of schools was stratified into 12 sampling strata based on the geographic region and degree of urbanicity. Based on the target number of schools to be selected from each stratum, which was determined by the high school student population in the stratum, schools were selected systematically from each stratum. On the average, 4.3 schools were selected from each stratum, yielding a target school size of 54. Schools ineligible or declining to participate were replaced by those of similar size and adjacent zip code to ensure proximity to the original selection.

Middle schools were included in the survey based on their feeder relationship to the sampled high schools and so did not constitute a representative sample of the national population of middle schools. Information on the feeder middle schools was obtained from school officials of the sampled high schools.

Student sampling (Stage 2): From each selected middle and high school, 60 students were randomly selected for the 7th- and 10th-grade sample. For refusals, a systematically drawn subsample of students (usually 10) was used.

Teacher sample: Two teacher samples were selected for the study; one was composed of all science and mathematics teachers in the sampled schools, and the other was a subsample of that group consisting of science and mathematics teachers who had the sampled students in their class. In the base year, all 1,330 science and mathematics teachers in the sampled middle and high schools were invited to respond to teacher background questionnaires. In the follow-up years, only new science and mathematics teachers who joined the teaching staff in the participating schools were asked. The subsample of science and mathematics teachers who had the sampled students in their class was asked to complete the class questionnaire on the subjects they taught. The teacher sample was chosen based on the student-teacher-school linkage and so did not constitute a representative sample of the population of science and mathematics teachers.

Sample Size and Response Rate

School: 51 high schools and 52 middle schools were finally selected. The initial high school response rate was 70% (38 out of 54 initial selections), and 13 high schools were added as replacements.

Student

Sample (Base Year)	Grade 7	Grade 10
Original Selection	2,987 (100%)	2,935 (100%)
Number Responded	2,640 (88%)	2,254 (77%)
Replacement	475	575
Final Sample	3,116	2,829

Response rates of students and parents broken down by instrument in the base year and in follow-up years

Sample	Grade 7 Cohort	Grade 10 Cohort
1987–88 Base Year		
Student Questionnaire	100	100
Science Achievement Test	99	96
Mathematics Achievement Test	98	96
Parent Interview	79	79
1988–89 First Follow-up		
Student Questionnaire	88	75
Science Achievement Test	88	73
Mathematics Achievement Test	88	78
Parent Interview	80	73
1989–90 Second Follow-up		
Student Questionnaire	88	77
Science Achievement Test	78	67
Mathematics Achievement Test	78	67
Parent Interview	71	59

Teacher

All science and mathematics teacher samples in the participating schools

Sample	Number of Teachers Invited	Number of Teachers Responded	Percent Response Rate
1987–88 Base Year	1,330	1,021	76
1988–89 First Follow-up	329[1]	191	58
1989–90 Second Follow-up	295[1]	152	52
Total	1,954	1,364	70

[1]New teachers only.

Subsample of science and mathematics teachers having LSAY students in their class

Sample	Number of Classes Asked	Number of Classes Responded	Percent Response Rate
1987–88 Base Year	2,831	2,081	74
1988–89 First Follow-up	2,336	1,699	73
1989–90 Second Follow-up	2,139	1,802	84

Data Collection Method

Student questionnaires and achievement tests were administered to each participant. Nonresponding students were solicited by telephone for critical items. Students who moved to another school during the survey period were retained in the study and contacted for the student questionnaire and test. When the 10th graders graduated, they were interviewed by phone or mail for the questionnaire but did not take the achievement test. Students who had graduated early, dropped out of school, or quit the study were not retained in the study for the following years.

All mathematics and science teachers in the participating schools were mailed the teacher questionnaire in 1988. In the following years, the teacher questionnaire was sent only to mathematics and science teachers new to the participating schools. A different form of teacher questionnaire was mailed each year to a subset of mathematics and science teachers who had the participating students in their classes. Nonrespondents to the first mailing were solicited again by a second mailing. The teacher data were collected only from science and mathematics teachers of students who remained in the original school sample. Teachers in schools to which LSAY students moved after the first year were not invited to join the study because of the sheer number of new teachers to be incorporated.

Parents of each participating student were interviewed by telephone. For two-parent households, the parent interviewed was rotated annually, while in single-parent households the single parent was interviewed each year.

The principal questionnaire was mailed in the first year to the principals at the participating middle and high schools and followed up by mail and telephone. The response rate was 94%.

Sample Weighting

Each student was weighted by the probability of attending a sampled school, given the school being sampled from a stratum multiplied by the inverse of the ratio of the sample size to the total student population. Weights were computed separately for the base and follow-up years. For the base year, weights were computed based on the number of students who completed the questionnaire, which was equal to the sample size. For the first and second follow-ups, the subsample of students who completed one or more of the questionnaires and test was used.

Estimation of Sampling Error

Standard errors of the sampling variances were computed by using the Taylor Series Expansion technique. The root design effect, produced by the ratio of the standard errors estimated by the Taylor technique to the simple random sampling errors of equal size, was approximately 1.5 for simple proportions and 3.0 for simple means.

Technical Document Reference

Jon D. Miller et al., *LSAY Codebook: Student, Parent, and Teacher Data for Cohort One for Longitudinal Years One, Two, and Three (1987–1990)*, 2 Vols., Social Science Research Institute, Northern Illinois University, 1991.

National Assessment of Educational Progress (NAEP), 1969 to 1990

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Introduction

The National Assessment of Educational Progress (NAEP) is conducted by Educational Testing Service sponsored by the National Center for Education Statistics (NCES). NAEP includes a series of national sample surveys assessing American students in subject areas of reading, mathematics, science, writing, social studies, history, etc. Beginning in 1969, the project was carried out annually through 1980 then continued on a biennial basis from 1980 to 1990. From inception to date, NAEP has undergone extensive changes in the sampling methodology, population coverage, assessment areas, assessment instruments, and data collection. In the following table, the scope of the NAEP survey and its change are briefly introduced based on the years in which science or mathematics was assessed.

Since 1986, NAEP has included both the main and long-term trend assessments in the survey. The main assessment estimated student achievement at a cross-sectional time point of the assessed year. The 1990 main assessment used current assessment methodology and specifications and employed a framework more closely based on the National Council of Teachers of Mathematics standards. Because this framework differed in various ways from that used for previous mathematics assessments, the 1990 main assessment formed the beginning of a new time series. The 1992 and 1994 mathematics assessments are designed to link to the 1990 assessment.

The long-term trend assessment estimated the current status of achievement in such a way as to bridge to the previous status of achievement and measure changes over time. To make the results comparable to previous ones, the trend assessment employed the same sampling and assessment methodology as used in the past years.

In addition to the national main and long-term trend assessment, the 1990 NAEP conducted a voluntary state-level trend assessment of 8th-grade public school student achievement in mathematics based on representative samples within each of 37 participating states, two territories, and the District of Columbia.

Although the main, trend, and state assessments of 1990 showed some common features in the survey design, each evolved differently to suit its unique objectives. In the following section, the statistical aspects of these three assessments are treated separately. While this technical report on NAEP mainly addresses the 1990 assessment, the previous assessments are briefly introduced when necessary.

Academic Year	Subject	Grade 3	Grade 4	Age 9	Grade 7	Grade 8	Age 13	Grade 11	Grade 12	Age 17
1969–70	Science			X			X			X
1972–73	Science			X			X			X
	Math			X			X			X
1976–77	Science			X			X			X
1977–78	Math			X			X			X
1981–82	Science			X			X			X
	Math			X			X			X
1985–86	Science (main)	X		X	X		X	X		X
	Math (main)	X		X	X		X	X		X
	Science (trend)		X	X		X	X	X		X
	Math (trend)		X	X		X	X	X		X
1988	Science (trend)			X			X	X		X
	Math (trend)			X			X	X		X
1990	Science (main)		X	X		X	X		X	X
	Math (main)		X	X		X	X		X	X
	Science (trend)			X			X			X
	Math (trend)			X			X			X
	Math (state)					X				

NAEP 1990 Main Assessment, Mathematics and Science

Overview

The main assessment of the 1990 NAEP was conducted on a nationally representative sample of students in public and private schools from three age and grade cohorts. NAEP collected information on student background, teacher characteristics, and classroom and school environments from teacher and principal questionnaires. The teacher and school data were linked to the student achievement and background data to examine the relationships between them.

The student assessment instrument of the main assessment was organized by using a special design called balanced incomplete block (BIB) design, which is a variation of the matrix sampling scheme. In the matrix sampling design used by NAEP prior to 1984, there were a number of distinct booklets, with each booklet containing a unique set of items (called blocks); all students in an assessment session were assessed with the same booklet. Each booklet was presented in a large number of sessions and to a representative sample of students. However, this mode of booklet distribution created a large number of isolated subsamples of students tested on limited items and, consequently, reduced the comparability and generalizability of the outcomes. Also, such a design increased the sampling variability by implementing the identical instrument on students selected in clusters within schools.

The BIB design adopts a different method of item distribution and booklet assignment to remedy these shortcomings of the matrix sampling design. In the BIB design, the full pool of items is divided into sets called blocks. Assessment booklets are created from these blocks such that each booklet contains three blocks, each block appears equally often across the booklets in each of the three possible positions (1st, 2nd, and 3rd), and each pair of blocks appears together in exactly one booklet. The booklets are then assigned to students within an assessment session so that typically, each student in an assessment session receives a different booklet. This design reduces sampling variability by minimizing within-school cluster effects and, because all pairs of items are taken by representative samples, allows for the estimation of correlations between all items. In the 1990 assessment, each test item generated responses from approximately 2,600 students that constituted a representative random subsample. The design enhanced the comparability of results across subpopulations of students and the precision of estimate inferences for the population.

Population Coverage

The target population in 1990 consisted of all students in public and private schools who were 9, 13, and 17 years old or in grades 4, 8, and 12. Also included were students in Bureau of Indian Affairs and Department of Defense schools. Excluded were those not in school because of early graduation or dropout. Students identified as having limited English proficiency and learning disabilities were excluded based on specific guidelines. A student with Limited English Proficiency (LEP) could be excluded if the student was a native speaker of a language other than English, had been enrolled in an English-speaking school for less than two years, and was judged incapable of taking part in the assessment. Students receiving special education with the Individualized Education Plan (IEP) could be excluded only if they were mainstreamed less than 50% of the time in academic subjects and/or were considered unassessable by the IEP team. About one-half of the LEP and IEP students were excluded from the assessment. The exclusion rate ranged from 4% (age 17) to 6% (ages 9 and 13) of initially selected students.

Sampling

A four-staged stratified sampling design was used.

Primary sampling unit sampling (Stage 1): The Nation was divided into geographic primary sampling units (PSUs) based on population size and community type in the 1980 population census. This approach yielded about 1,000 PSUs where the PSUs were either a metropolitan statistical area (MSA), or a county or a group of counties. A sample of 97 geographic primary sampling units (PSUs) were selected from the universe.

This sample consisted of 34 certainty PSUs and 63 noncertainty PSUs. Certainty and noncertainty units were determined by the size; as it was cost-effective to include large units in the sample, those units were selected with certainty. Certainty PSUs were composed of the 28 largest PSUs and 6 large PSUs from the southeast and west with 20% of black and/or Hispanic students or more. The noncertainty PSUs sampled were drawn from the subuniverse of noncertainty PSUs further stratified by additional socioeconomic characteristics, such as minority population, manufacturing industry employment, and per capita educational expenditure.

School sampling (Stage 2): The public schools (including Bureau of Indian Affairs and Department of Defense schools) and private schools within the 97 PSUs having any grade in the range of 2 to 12 were listed in the frame of schools, yielding a total of 38,456 schools. For public schools, the Common Core of Data for 1988 (collected by NCES) and Quality Education Data (QED) served as the basis of the school sample frame. For private schools, school lists of the 1988 Schools and Staffing Survey and QED were complementarily used as primary sources, and additional lists were drawn from telephone directories of metropolitan areas chosen for the PSU sample.

From the sampling frame, a sample of schools was selected for each age cohort with probabilities proportional to school size. Private schools were oversampled as were public schools with minority enrollment in excess of 15% in order to increase the reliability of the estimates of these subgroups. The adjustments for oversampling were made in weighting for students.

In each of the sampled PSUs, a minimum of 3 or 4 schools was selected to balance the representation of all sampled PSUs in the school sample. From the original sample, schools ineligible to participate or refusing to participate were replaced by schools with similar characteristics.

Assignment of assessment sessions to schools (Stage 3): At the third stage, schools were assigned to each session type (print or tape session). This procedure was conducted to assign the target number of students for each age cohort to each session type and to ensure that each session type was administered in each PSU thereby giving each student an equal chance of being selected for a session type.

Student sampling (Stage 4): From a consolidated list of all age-eligible and grade-eligible students within the selected schools, students were systematically selected to form two random half-samples for each age and grade cohort, one assessed in the winter session and the other in the spring session. For each age class, a maximum number of 150 (age 9) and 200 (ages 13 and 17) students were selected from each school. From the originally selected students, those determined by the school to have difficulties with the assessment, based on the exclusion criteria, were dropped. They were not replaced by other students, and an excluded student questionnaire was filled out.

Teacher sampling: The teacher sample was not selected independently from teacher population but on the basis of their link with the sampled students in order to associate the teacher characteristics with student achievement. Selected teachers were the mathematics (grades 4 and 8) and science (grade 8) teachers of students sampled for the main mathematics or science assessment, except for excluded students and students not taking the test. Because the sampling method for teachers was intended to obtain a sample of teachers representative of students assessed but not to obtain a representative teacher sample, the results of teacher questionnaires should not be used to infer teacher population parameters.

Sample Size and Response Rate

			Student				
	School		Mathematics		Science		Overall Response
Sample	Number[1]	Percent	Number[2]	Percent[3]	Number[2]	Percent[3]	Rate[4] (%)
Grade 4	527	88.3	8,902	92.9	6,314	92.9	82.0
Grade 8	406	86.7	8.888	89.1	6,531	89.1	77.2
Grade 12	304	81.3	8,862	81.3	6,337	81.3	74.8

[1]Schools responding to assessment out of original selections before replacement

[2]Student sample size finally achieved after replacement

[3]Student response rate for all four subjects combined

[4]Overall response rate taking into account school and student response rates

	Number Assessed		
Sample	Mathematics	Science	Percent Assessed
Age 9/grade 4	8,790	8,418	92.9
Age 13/grade 8	8,634	8,709	89.1
Age 17/grade 12	8,406	8,445	81.3

471

Data Collection Method

Student assessment instruments with background questions were group administered. Teacher questionnaires were completed and returned by the mathematics (grades 4 and 8) and science (grade 8) teachers who had the participating students in class. School characteristics and policy questionnaires and principal questionnaires were mailed to each school with sampled students and filled out by the principal or administrative staff.

Sample Weighting

The base weight assigned to each student was an inverse of the probability of selection in the sample. The probability was the product of the four-staged probability of the sampling: the probability that the PSU was selected; the probability that the school was selected in a given PSU; the probability that the school was assigned to the specific session; and the probability that the student was selected for the session. The base weight was adjusted for nonresponse and poststratification. Poststratification was performed to make the estimates of the total number of students correspond to the census estimates of the population and subpopulations of race, ethnicity, region, age, and grade. The census estimates were available from the U.S. Census and Current Population Survey.

Estimation of Sampling Error

Because the sampling design allowed cluster selection (students within schools and schools within PSUs) and weight adjustments of nonresponse and poststratification, the commonly used method—computing sampling variability under the assumption of simple random sampling—could not be used. Instead, a more rigorous procedure, the jackknifed method, was used and accounts for the sample design and weight adjustments. Standard errors of science and mathematics proficiency means are reported in the 1990 NAEP Technical Report for the subpopulations of sex, race and ethnicity, grade, and age.

Technical Document Reference

The National Center for Education Statistics, *The NAEP 1990 Technical Report,* U.S. Department of Education, 1992; The National Center for Education Statistics, *The State of Mathematics Achievement,* U.S. Department of Education, 1991; and The National Center for Education Statistics, *The 1990 Science Report Card,* U.S. Department of Education, 1992.

NAEP 1990 Trend Assessment, Mathematics and Science

Overview

NAEP conducted national trend assessments of student achievement in the subject areas of mathematics and science as a continuation of the long-term project of measuring changes in student achievement from the previous assessments. To make the achievement results comparable across assessments, the trend assessment replicated the population definition and coverage, the sampling methodology, and the test items of the 1986 trend assessment.

Population Coverage

The target population consisted of all students in public and private schools who were 9, 13, and 17 years old. The modal grade definition of each age group used in the main assessment was not used. The exclusion criteria were similar to those used in the main assessment but less rigorously defined. The excluded students were non-English speaking, mentally disabled, or functionally disabled and therefore judged incapable of performing in the assessment situation. The exclusion rate of the trend sample was 4.4% (age 17) to 5.5% (age 13) and 6.1% (age 9).

Sampling

As with all NAEP national samples, the four-stage stratified sampling method was used. Starting with the same sampling frame of 97 PSUs, the samples of schools were drawn from all the PSUs in a manner similar to that used for the main sample. A notable difference was that the high minority enrollment was not used as an additional stratum classifying schools, although school size was still considered. The minimum sample size from each PSU was 3 for each age cohort, whereas the maximum sample size of students within a school was about 160 grade- and age-eligible students. Finally, based on the same methods, schools and students were randomly assigned to assessment sessions.

Sample Size and Response Rate

Sample	School		Student			Percent Overall[4]
			Math	Science		
	Number Invited	Percent[1] Assessed	Number Invited[2]	Number Invited[2]	Percent Assessed[3]	
Age 9	NA	87.0	6,235	6,235	92.5	80.5
Age 13	NA	89.0	6,649	6,649	90.2	80.3
Age 17	NA	79.0	4,411	4,411	82.1	64.9

NA: Not available.

[1]Schools participating in assessment out of originally selected schools before replacement

[2]Student sample size finally achieved after replacement

[3]Student response rate of all four subjects combined

[4]Overall response rate taking into account school and student response rates

All bridge samples (all subjects)

Response Rate	Age 9	Age 13	Age 17	Overall
School	88.1	90.5	80.7	86.3
Student	92.4	90.4	81.2	87.0
Overall student response	81.4	81.8	65.5	74.2
Number of responding students	16,295	17,557	22,765	56,397

Data Collection Method

Unlike the 1990 main assessment session in which students were administered different booklets containing selected item blocks according to the BIB design, all students in a trend session were assessed on the same booklets through paced tape administration. Test items from the 1986 trend assessment were replicated to make the results comparable across assessments.

Sample Weighting and Estimation of Sampling Error

The same procedures were used as in the main assessment sample.

Technical Document Reference

The National Center for Education Statistics, *The NAEP 1990 Technical Report*, U.S. Department of Education, 1992; and The National Center for Education Statistics, *Trends in Academic Progress*, U.S. Department of Education, 1991.

NAEP 1990 Trial State Assessment, Mathematics

Overview

In the winter of 1990, NAEP conducted a state-level mathematics assessment on a trial basis for public school 8th-grade students, relying on a collaborative effort among State Education Agencies, NCES, Educational Testing Service, Westat, and National Computer Systems. The survey was performed on state-representative samples of schools and students from 40 jurisdictions (37 states, the District of Columbia, Guam, and the Virgin Islands) to allow for state-by-state comparisons of student achievement. As with the main assessment, the trial state assessment collected contextual information relevant to student achievement by administering student background questionnaires and teacher and principal questionnaires.

The extent of comparability between results of the NAEP national assessment and state assessment can be considered primarily in terms of the level of representativeness of samples and sampling methodology used. The presence of significant variabilities among states in demographic and socioeconomic status, size, urbanicity, and minority percentages affects the probability of each school and student being selected from the whole national population or from the state population under a given selection criterion. The difference is increased by the use of discrepant sampling methods in each assessment—primary sampling unit construction, the application of certainty and noncertainty PSU sampling, and stratifying variables. Therefore, the nationally representative sample cannot be reduced to the aggregate of the state-representative sample, nor can a subsample representative of an individual state be drawn from the national sample of students. Thus, comparisons of results of the nationally representative sample and the state-representative sample should be kept at a minimum.

Population Coverage

The target population for each of the 40 participating jurisdictions consisted of 8th-grade students enrolled in public schools in that jurisdiction. Private school students and students with Limited English Proficiency (LEP) or Individualized Education Plan (IEP) were excluded from the survey.

Sampling

A two-staged stratified probability sampling was used for the student sample.

School sampling (Stage 1): The public school lists from the Common Core of Data and Quality Education Data formed the basis for constructing the school sampling frame. Once schools were clustered into two strata using ZIP code and county designations, schools within each cluster were stratified by urbanicity, 8th-grade enrollment size, minority attendance rate, and median household income based on 1980 census data, and a systematic sample was selected proportionate to size.

Student sampling (Stage 2): From all sampled schools in each state, a student sample size of 30 was drawn systematically. The school administrator in each participating school determined the exclusion of students having LEP or IEP from the student sample. The average exclusion rate of the sampled students was 5.1%, ranging from 8.23% (California) to 2.44% (Montana).

Sample Size and Response Rate

Schools: Of a total of 3,716 (100%) eligible schools from the originally selected school sample (3,853), 3,496 (94.1%) schools agreed to participate. After substitution for refusals, 3,596 (96.8%) schools in 40 jurisdictions participated in the assessment.

Students: Of 118,858 students from the original and supplemental sample, 107,309 (100%) students were invited after exclusion and withdrawal, and 100,849 (94%) students were finally assessed.

Data Collection Method

The same methods were used as in the main assessment sample.

Sample Weighting

The base weight assigned to each student was the inverse of the probability that the student's school was selected and that the student was selected within the school; then it was adjusted for school and student nonresponse. Using special measures, the weight was adjusted in order to alleviate an effect previously introduced that minimized the overlap between the 1990 NAEP national assessment school sample and the NELS:88 follow-up school sample of 8th-grade students.

Technical Document Reference

Stephen L. Koffler, *The Technical Report of NAEP's 1990 Trial State Assessment Program,* The National Center for Education Statistics, U.S. Department of Education, 1991.

47

National Education Longitudinal Study of 1988 (NELS:88)

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Overview

The National Education Longitudinal Study of 1988 (NELS:88) was conducted by the National Center for Education Statistics as part of the long-term national education project, including both the National Longitudinal Study of the High School Class of 1972 and the High School and Beyond Study, to study the educational, vocational, and personal development of students as they move through the grades. NELS:88 began with a baseline assessment of academic achievement and school experience of 8th graders and followed up on a biennial basis to observe how the 8th-grade experience affected later educational and occupational attainment.

The base year study obtained participation from 1,057 public and private schools and 24,599 students. The instruments administered in the base year study included the student questionnaires combined with cognitive tests and parent, teacher, and school administrator questionnaires. As a complementary component of NELS:88, teacher transcript data were also gathered to examine science and mathematics teachers' characteristics, their qualifications, and their preparation for teaching. The first follow-up survey was conducted in 1990 for the 8th-grade cohorts as 10th graders, and the second follow-up was performed in 1992 for the cohorts as seniors. For the follow-ups, a dropout questionnaire was added to the existing instruments to obtain information about the characteristics of dropouts from the 8th-grade cohorts and their return to school.

Population Coverage

The school population was restricted to regular public and private schools with the 8th grade students. A supplementary sample of Hispanic and Asian/Pacific Islander students (and their parents and teachers) was included, but schools operated by the Bureau of Indian Affairs were excluded. Special education schools for the disabled, area vocational schools that did not enroll students directly, and schools for dependents of U.S. personnel overseas were also excluded. Students identified as mentally disabled, having physical or emotional problems, or having a language barrier were also excluded from the sample.

Sampling

Student sample: A two-staged stratified probability sample design was used for sampling students. In the first stage, the universe of schools (about 40,000) including the 8th grade, prepared from the Quality Educational Data lists, was stratified on the factors of region, urbanicity, and minority percentage. From the universe, 1,655 public and private schools identified as eligible were sampled, and of the eligible schools, 1 057 schools participated in the survey. Also, a special unduplicating method was applied to minimize overlapping of the school sample with the schools that participated in The National Assessment of Educational Progress (NAEP). The second stage included random sampling of 24–26 students from each sampled school after excluding students (5.4%) determined by schools as having physical, emotional, or language problems. Students of Hispanic or Asian/Pacific Island origin were oversampled to ensure the quality of estimates of these subgroups.

Teacher sample: The base year teacher sample comprised the mathematics, science, reading, and social studies teachers who had the sampled students in their classes. This sampling method, utilizing the student-teacher link, was employed to allow the association of the student data with the related teacher data. Because the teacher sample did not represent the population of all 8th-grade teachers, the results should not be treated as the estimates for the teacher population as a whole. Approximately one-half (11,414) of the students surveyed had a mathematics teacher surveyed and the other one-half (10,868) had a science teacher surveyed. Overall, 91% of the students selected had either a mathematics or science teacher surveyed.

School administrator sample: The head administrators of all eligible schools containing grade 8 constituted the universe of school administrators. A head administrator entered the sample if his/her school was selected as an eligible NELS:88 school.

Sample Size and Response Rate

School

Sample	Target Sample Size	Eligible	Agreed to Participate	Replacement	Finally Achieved
Public	800	774 (100%)	522 (67%)	295	817
Private	232	228 (100%)	176 (77%)	64	240
Total	1,032	1,002 (100%)	698 (70%)	359	1,057[1]

[1] 1,057 schools participated at some level, although usable data were received for only 1,052. For 1,035 schools, both student and school administrator data were collected.

479

Questionnaire Completion Rate[1] of Student, Parent, Teacher, and School Administrator

Survey Instrument	Number Completed	Weighted Completion Rate (Percent)
Student Questionnaires	24,599	93.4
Student Tests	23,701	96.5
Parent Questionnaires	22,651	93.7
Teacher Ratings of Students	23,188	95.9
Teacher Questionnaires	5,193	NA
School Administrator Questionnaire	1,035	98.9

NA: Not available.

[1]The numbers and completion rates reported are based on the records in the public use data file where auxiliary parent, teacher, and school data were excluded for the students who did not participate.

Data Collection Method

Each student was administered the student questionnaire and the achievement test. Self-administered teacher and school administrator questionnaires were completed and returned by the selected teachers and school officials. Telephone follow-ups were made for the teachers and officials who did not return a questionnaire. Parent questionnaire packets were carried home by students and delivered to one parent of each student who was best informed about the student's educational activities and plans. Thus, the parent respondent was essentially self-selected. Nonresponse follow-up was made by telephone for households with telephones, and by mail and in person for households lacking telephones.

Sample Weighting

The weighting scheme was designed to compensate for unequal probabilities of selection into the sample and to adjust for nonresponse. The school weight, applied to school administrator data, was derived from the product of the inverse of the school's probability of selection into the sample; the probability of nonselection into the NAEP sample; and a nonresponse adjustment factor intended to adjust for the fact that some of the sampled schools did not return a completed questionnaire. The student weight, applied to the student questionnaire and used in conjunction with parent data, was computed as the product of the inverse of the probability of the student's and his/her school's selection and a nonresponse adjustment factor intended to adjust for the fact that some of the sampled students did not participate.

Estimation of Sampling Error

To account for the effect of the complex sample design on the precision of sample estimates, standard errors were calculated using the Taylor series approximation and reported in the technical documentation. To measure the impact of departures from simple random sampling, the design effect was also computed and reported for each data set and subgroup.

Technical Document Reference

Bruce D. Spencer et al., *Technical Report: NELS:88 Base Year Sample Design Report*, The National Center for Education Statistics, U.S. Department of Education, 1990; Steven J. Ingels et al., *NELS:88 Base Year Student Component Data File User's Manual*, The National Center for Education Statistics, U.S. Department of Education, 1990.

4 0

National Longitudinal Study of the High School Class of 1972 (NLS-72)

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Overview

The National Longitudinal Study of the High School Class of 1972 is one of the earliest national longitudinal surveys conducted by the National Center for Education Statistics (NCES). It examines the relationships between educational and vocational development of high school students and familial, social, and institutional background factors. The study began in 1972 with a national probability sample of 19,001 senior students, and NCES conducted five follow-up studies for the 1972 senior cohort in subsequent years (1973, 1974, 1976, 1979, and 1986). The students sampled were administered a questionnaire and an achievement test, and schools were contacted to provide data on student records and school characteristics.

Population Coverage

The target population comprised all 12th-grade students in public and private schools in the nation during the 1971–72 school year. Detailed information on the criteria used for population inclusion and exclusion is not available in the published documents.

Sampling

A two-stage stratified random sampling design was used. In the first stage, schools were sampled without replacement from 600 strata. The strata were based on school type, geographic region, size, proportion minority enrollment, income level, and urbanicity. For all strata except the smallest size stratum, schools were selected with equal probability; small schools (under 300 enrollment) were selected with probability proportional to enrollment. Two schools were selected from each of the 600 strata, and 18 students were selected randomly from each of the sampled schools. Schools in low-income areas or with high minority enrollments were oversampled to enhance the reliability of the estimates for the disadvantaged student population.

Sample Size and Response Rate

In the base year, 949 schools out of 1,200 originally selected schools agreed to participate, achieving a response rate of 79%. In addition, 121 schools were selected from the backup school sample, and a total of 1,070 schools finally participated in the survey. In the first follow-up, the

481

response rate increased to 96% with 1,153 schools participating. The final sample size was 1,300 schools, adding 147 schools from the backup sample.

From the sample schools, 23,451 seniors were sampled in the base year, 16,683 of whom completed the student questionnaire, yielding a completion rate of 71%. In the first follow-up, an extensive tracing operation was conducted by mail and telephone; 23,020 individuals of the senior cohort whose addresses were known received the student questionnaire, and 21,350 (93%) returned the questionnaire.

Data Collection Method

In the base year, student tests and questionnaires were group administered to the participating students. The student questionnaire gathered data on students' family background, educational and work experiences, plans, aspirations, and attitudes. From a Student's School Record Information Form, base year data were also obtained on high school curriculum, GPA, credit hours taken, and ability level. A school questionnaire provided information on each participating high school. For the follow-ups, two forms of questionnaire were designed for self-administration by students. Form A was mailed to each sample member who responded to the base year student questionnaire. Students who did not complete the student questionnaire in the base year received Form B, which contained extra questions to supplement missing base year information. The first-round questionnaire return rate by mail was 61%, and subsequent telephone interviews increased the completion rate to 93%.

Sample Weighting

Weighting was carried out to compensate for the unequal probabilities of selection, retention (for the follow-up surveys), and nonresponse. The weights of the base year were based on the inverse of the selection probabilities in two stages of sample selection and adjusted for nonresponse. The follow-up weight was calculated based on the inverse of the product of selection probability for the base year sample and the probability of retention in the follow-up sample and then adjusted for noncompletion.

Estimation of Sampling Error

Sampling error estimates for the base year and follow-ups were estimated by using the Taylor series approximation. The design effect was also calculated for each estimate for all survey waves. The estimates of standard errors and design effects can be found in the technical documents associated with each follow-up study.

Technical Document Reference

The National Center for Educational Statistics, U.S. Department of Education, *National Longitudinal Study of the High School Class of 1972: Base-Year and First Follow-up Data File Users Manual*, 1975; and Bruce Spencer et al., *The National Longitudinal Study of the High School Class of 1972 (NLS-72) Fifth Follow-up (1986) Sample Design Report*, The National Center for Education Statistics, U.S. Department of Education, 1987.

National Survey of Science and Mathematics Education (NSSME or Weiss Study), 1985–86

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Overview

The National Survey of Science and Mathematics Education was conducted by Iris Weiss, sponsored by the National Science Foundation, to gather information on teachers' instructional preparation and classroom practices, and on school curriculum and course enrollment based on nationally representative samples of principals and teachers teaching mathematics or science in grades K to 12.

Population Coverage

The target population included all public and private school teachers teaching science and/or mathematics in any grades from K to 12. Science and mathematics teachers were defined as follows: in grades K to 9, teachers teaching only science and/or mathematics and teachers teaching all subjects in a self-contained class setting were included; and in grades 10 to 12, teachers teaching only mathematics topics and/or science topics (biology, chemistry, physics, earth science and other science) were included. Excluded were teachers in schools not maintaining any K to 12 grades, preschools, schools for special education, adult education, and vocational/technical tracks.

Sampling

A two-stage stratified probability sampling design was used, and separate sampling frames were constructed for three grade ranges (K to 6, 7 to 9, and 10 to 12).

School sampling (Stage 1): The school sampling frame was constructed from the school list of Quality Education Data. For each grade range, schools were stratified by eight criteria: region, state, urbanicity, school type, white student enrollment, per-student instructional dollars, percentage of students below the poverty line, and school size. From the ordered frame, the school sample was drawn for each grade range using a sequential sampling procedure to make the sample reflect the same proportional distribution of the stratification factors as found in the sampling frame.

Teacher sampling (Stage 2): For the sampled schools, a list of teachers teaching science and/or mathematics was prepared for each grade range with indications of subjects taught by each teacher as reported by school officials. In grades K to 6 and 7 to 9, teachers teaching all subjects as well as subject specialist teachers were included in the list. Within each frame, the probability of a teacher

453

being selected within the school was computed after adjustment to the school nonresponse; teachers were selected proportional to the probability. Teachers teaching both science and mathematics were assigned randomly to the science and mathematics subsample and asked to respond only for the assigned subject portion of their class.

Sample Size and Response Rate

425 schools were sampled from each grade range, and a total of 6,156 teachers participated. The response rate achieved was 75% for teachers and 86% for principals. The subject and grade composition of the teacher sample is presented in the following table.

Subject	Grade Range			Total
	K–6	7–9	10–12	
Science	986	942	1,500	3,428
Mathematics	988	940	800	2,728
Total	1,974	1,882	2,300	6,156

Data Collection Method

Teacher questionnaires and principal questionnaires were mailed to and returned by teachers and principals of the sampled schools. Telephone follow-ups were used to obtain responses from nonresponding teachers and principals.

Sample Weighting

For teachers, two sampling weights were considered, depending on the teacher population covered. The total teacher weight was assigned for estimates accounting for the total population of teachers teaching science and/or mathematics. The science/mathematics teacher weight was used for estimates accounting for the population of science teachers and for the population of mathematics teachers.

The total teacher weight was computed by the inverse of the product of the probability of the school being selected and the conditional probability of the teacher being selected, given that the school was selected. For the science/mathematics teacher weight, different weights were assigned to teachers who taught both science and mathematics and to the rest of teachers who taught only science, taught only mathematics, or taught all subjects in self-contained classes. For teachers who taught both science and mathematics, the weight was computed as the inverse of three factors of probability, i.e., the probability of the school being selected, the conditional probability of the teacher being selected, and the conditional probability of the teacher being assigned to the science subsample or mathematics subsample. For the rest of the science teachers, the same weighting procedure used for the total teacher weight was employed.

Estimation of Sampling Error

Generalized sampling errors were reported for the teacher and principal samples of each grade range. The design effect, the ratio of the variance of the sample design used in a study to the variance of the simple random sample design of equal size, was as follows: 1.1 for grades K to 6 teacher sample; 2.4 for grades 7 to 9 teacher sample; 1.7 for grades 10 to 12 teacher sample; 1.5 for grades K to 6 principal sample; and 2.4 for grades 7 to 12 principal sample.

Technical Document Reference

Iris Weiss, *Report of the 1985–86 National Survey of Science and Mathematics Education*, Research Triangle Institute, 1987.

Schools and Staffing Survey (SASS), 1987–88

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Overview

The Schools and Staffing Survey (SASS) was conducted by the Bureau of Census sponsored by the National Center for Education Statistics during the 1987–88 school year to measure the critical aspects of teacher supply and demand, the composition of the administrator and teacher work force, and the status of teaching and schooling generally. The survey had four components: the teacher demand and shortage survey, the school survey, the school administrator survey, and the teacher survey. The SASS sample comprised approximately 13,000 schools and administrators, 65,000 teachers, and 5,600 local education agencies (LEAs). The 1988–89 SASS teacher follow-up study examined teacher attrition and retention in public and private schools and obtained information on teachers who stayed in or left the teaching profession.

Population Coverage

For each of the four components of the survey, the definitions of eligibility and ineligibility were applied as follows:

Teacher Demand and Shortage (TDS) Survey

1. **Public LEA**—An LEA was defined as a government agency administratively responsible for providing public elementary and/or secondary instruction and operating under a public board of education. The definition included districts that operated only one school and ones that did not operate schools but did hire teachers.
2. **Private School**—A private school was defined as a school not in the public system that provided instruction for any of grades 1 to 12. The definition excluded instruction that was given exclusively in a private home.
3. **Out-of-Scope**—An LEA or private school was considered out-of-scope if it did not employ elementary or secondary teachers. If it was undetermined whether a private school operated in a private home, but it was evident that its enrollment was less than 10 students or it had only one teacher, the school was excluded. If a private school was classified as out-of-scope for the School Survey, it was automatically excluded for the TDS Survey.

School Survey

1. **Public School**—A public school was defined as an institution that provided primary and/or secondary instruction, had one or more teachers, was located in one or more buildings, received public funds as primary support, and was operated by an education agency. Prison schools and schools operated by the Bureau of Indian Affairs and the Department of Defense were included.

2. **Private School**—See TDS for definition.

3. **Out-of-Scope**—A public or private school was considered out-of-scope if it did not have any students in any of grades 1 to 12. Schools offering only kindergarten were excluded. A private school was excluded if it operated in a private home that was used as a family residence. If it was undetermined whether a private school operated in a private home, but it was evident that it had less than 10 students or had only one teacher, the school was excluded. If an LEA was classified as out-of-scope, its schools were also considered out-of-scope.

School Administrator Survey

A school administrator sample case was considered out-of-scope if the school did not have an administrator. If a sample administrator's school or LEA was considered out-of-scope, the administrator was automatically excluded.

Teacher Survey

A teacher was defined as any full-time or part-time teacher teaching any subject in any grade(s) from K to 12. Itinerant teachers who taught at more than one school and long-term substitute teachers who were filling the role of a regular teacher on an indefinite basis were included.

A sample teacher was considered out-of-scope if he/she was a short-term substitute, a student teacher, a nonteaching specialist (e.g., guidance counselor, librarian), an administrator, a teacher's aide, or a person in some other professional or support staff position. If a school or LEA was considered out-of-scope, all teachers from that school or LEA were excluded.

Sampling

A two-staged stratified probability sampling method was used to select the school, LEA, administrator, and teacher sample.

School sampling (Stage 1): National lists of public and private schools were prepared in two separate sampling frames. For public schools, the public school listing from Quality Education Data (QED) was used to construct the school sampling frame. All public schools in the list were stratified by state and grade level (elementary, secondary, and combined). Within each stratum, schools were further sorted by the variables of LEA urbanicity, LEA percent minority, LEA ZIP code, highest grade, and school enrollment. Then, schools were selected from each stratum by systematic sampling with probability proportionate to the number of teachers in each school.

The private school sampling frame was constructed from the 1986 QED private school list supplemented by the current lists obtained from 17 private school associations. The updated list of schools was stratified by state, grade, and affiliation and selected with probability proportionate to the square root of the number of teachers in school. Another list of schools was made by an area frame of schools for 75 geographic regions selected from a universe of 2,497 regions. In the selected regions, eligible private schools were listed after a telephone directory search and inquiry at local educational offices. The same sampling procedure was used to select schools.

LEA sampling (Stage 2): To enhance the reliability of the school and teacher estimates, LEAs were sampled at a later stage than the schools. Based on the 1986 QED file, the LEA sample was selected primarily by linking it to the sample public schools. Each Bureau of Indian Affairs and Department of Defense school formed a separate LEA. Some LEAs not associated with schools were selected to account for the teachers teaching in schools in LEAs different from their hiring LEAs. LEAs were stratified by the same variables used for the school sampling and then selected with probability proportional to the number of teachers reported on the QED file.

Teacher sampling (Stage 2): A list of teachers was prepared for the sampled schools, including all full-time and part-time teachers, itinerant teachers, and long-term substitute teachers. Within each school, teachers were stratified by experience, grade, and subject. On average, five or six teachers were selected from each public or private school. The public and private teacher sample was selected using identical methods except that new teachers in private schools were oversampled. In addition to this basic teacher sample, bilingual and ESL (English as a Second Language) teachers were selected independently from the main sample to obtain more reliable results for this subgroup of teachers. For schools that did not provide teacher lists (12% of the private schools and 4% of the public schools), no teachers were selected.

In the teacher follow-up study, teachers who participated in the base year were stratified by state, urbanicity, subject, enrollment size, and affiliation (private school teachers only). Within each stratum, teachers were selected with a probability proportionate to the teacher base weight created by the inverse of the probability of selecting a teacher in the base year SASS teacher sample.

Sample Size and Response Rate

Sample Size

1987–88 Base Year Sample	Public	Private	Total
Public School District	5,592	—	5,592
School	9,317	3,513	12,830
Teacher	56,698	11,595	68,293
1988–89 Teacher Follow-up Sample	**Current Teacher[1]**	**Former Teacher[2]**	**Total**
Teacher	4,185	2,987	7,172

— Not applicable [1]Stayers and movers [2]Leavers

Weighted Final Response Rate (Percent)

Sample	Public	Private
1987–88 Base Year		
Teacher Demand and Shortage	90.8[1]	66.0
School Administrator	94.4	79.3
School	91.9	78.6
Teacher	86.4	79.1
1988–89 Teacher Follow-up		
Total	97.3	96.0
Current Teacher Form	97.5	96.6
Former Teacher Form	93.6	93.1

[1]Response rate of public LEAs

Data Collection Method

Teacher demand and shortage questionnaires were mailed to the sampled LEAs and private schools, and nonresponses were followed up by a second mailing and telephone interview. The TDS Survey gathered information on aggregate demand for both new and continuing teachers, district and school policies on teacher salary, compensation, retirement, hiring, and other factors affecting supply and demand for teachers.

The school questionnaire and administrator questionnaire, which were completed by the principal or administrative staff, provided information on school programs, staffing patterns and teacher turnover, and student characteristics.

The teacher questionnaire asked public and private school teachers about background characteristics, qualifications and preparation, career plans, income sources, working conditions, and perceptions of the teaching profession.

The teacher follow-up study collected information on the occupational changes of the 1988 base year teacher sample. First, the SASS school was contacted to determine the present occupational status of teachers who were selected for the teacher sample in the 1988 SASS. The teacher status form, asking whether the teacher stayed in the same school, moved to another school, or left the teaching post, was completed by school principals and heads. Based on the information on teacher status provided by principals, a sample of teachers who remained in teaching received the current teacher questionnaire by mail, while teachers who left received the former teacher questionnaire.

459

Item Response Rate

Survey	Range (%)	Items with Over 90% Response Rate (%)	Items with Less Than 75% Response Rate (%)
1987–88 Base Year			
Teacher Demand and Supply			
Public	40–100	74	12
Private	16–100	70	18
Administrator Survey			
Public	70–100	86	2
Private	72–100	89	2
School Survey			
Public	43–100	64	11
Private	11–100	56	8
Teacher Survey			
Public	64–100	90	1
Private	60–100	89	1
1988–89 Teacher Followup			
Current Teacher Form	78–100	96	4[1]
Former Teacher Form	86–100	97	0[1]

[1]Percent of items with a response less than 80%.

Imputations were calculated for most missing items on the TDS and school files by using the values of the most similar respondent in terms of urbanicity, percent minority, and enrollment. The data on the administrator and teacher file were not imputed for missing items.

Sample Weighting

The school weight was computed using four factors: the base weight (the inverse of the probability of selection of the school) with adjustments for sampling duplication, school nonresponse, and known sample frame totals. The weight for the public school district data and school administrator was computed in the same way as the school weight. The teacher weight considered seven factors: the base weight, sampling duplication adjustment, school noninterview adjustment, bilingual oversampling factor, late mail return adjustment, teacher-within-school noninterview adjustment, and known frame total number of schools.

Estimation of Sampling Error

Standard errors were estimated using a balanced repeated replication procedure that reflected the effect of the complex design and reported for key estimates. Also, the SASS technical documents provide their frame evaluation vis-a-vis the Common Core of Data and the QED file for the estimates of schools, LEAs, and teachers.

Technical Document Reference

Steven Kaufman, *Technical Report: 1900 Schools and Staffing Survey Sample Design and Estimation,* The National Center for Education Statistics, U.S. Department of Education, 1991; Charles H. Hammer and Elizabeth Gerald, *Aspects of Teacher Supply and Demand in Pubic School Districts and Private Schools: 1987–88,* The National Center for Education Statistics, U.S. Department of Education, 1991; and Sharon A. Bobbitt et al., *Characteristics of Stayers, Movers, and Leavers: Results from the Teacher Followup Survey, 1988–89,* The National Center for Education Statistics, U.S. Department of Education, 1991.

431

State Indicators of Science and Mathematics Education 1990, The Council of Chief State School Officers (CCSSO)

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Overview

In an effort to develop state-by-state data on key indicators of the condition of science and mathematics education in public schools, the Council of Chief State School Officers (CCSSO) requested all 50 states and the District of Columbia to provide data on public schools. Each state's department of education collected public school data using its own survey instruments and reported the information on a common report form prepared by CCSSO.

The data consisted of state-level information about student, teacher, and school characteristics with respect to course enrollments, teacher assignments in science, mathematics, computers, classroom conditions, and state policies on graduation requirements and teacher certification. Data collection began in 1989–90, continued in 1991–92, and will recur on a biennial basis.

Population Coverage

The CCSSO data collection on public schools is not a sample survey; with one exception (Idaho), it encompasses the universe of public schools, teachers, and students in each participating state. In each state, data reporting covered only the public schools; hence, private schools and their teachers and students are excluded from data collection. Detailed information on the guidelines used for excluding public schools or on the question of whether states used their own or common criteria is not available in the related documentation.

Sampling

Not applicable.

Data Collection Method

Each participating state used its own data collection instrument and reported the data on a common report form, prepared by CCSSO and verified by the state, to meet the CCSSO specifications and definitions. All states collected universe data on the indicators, with the exception of one state (Idaho) which used a sampling method. A total of 46 states and the District of Columbia reported at least one of the items requested. To produce national estimates for each indicator, estimates of the nonresponding states were obtained by imputation. Because data collection relied on the departments of education in each reporting state, responsibility for the accuracy and verification of the data rests with the reporting state agency.

Approximately one-half of the states that provided data on course enrollments, teacher assignments, and other teacher characteristics drew the information from the Local Education Agency Personnel System, a questionnaire completed by teachers. Other states reported course enrollment data and teacher data through separate school-level forms. All states reporting on teacher certification status used computerized state certification files.

Response Rate

On average, 99% of schools and teachers responded to the questionnaires administered by the state education agency.

Sample Size and Response Rate

Not applicable.

Sample Weighting and Estimation of Sampling Error

Not applicable.

Technical Document Reference

Rolf Blank and Melanie Dalkilic, *State Indicators of Science and Mathematics Education—1990,* Council of Chief State School Officers, State Education Assessment Center, 1990.

International Studies, K–12

The First International Mathematics Study (FIMS), IEA, 1964

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Overview

The First International Mathematics Study (FIMS) was the International Association for the Evaluation of Educational Achievement's first attempt to develop acceptable cross-national test instruments and to identify factors associated with differences in student achievement in mathematics. The study was carried out in twelve countries in 1965, and the U.S. study was conducted by the University of Chicago.

Population Coverage

Two target populations of the study were defined in terms of age and grade level. Population 1 was defined as students at age 13 (Population 1A) or students in the grade where the majority of 13-year-olds were to be found (Population 1B). The second population was defined as all students who were in the final year of secondary school (Population 3) and was subdivided into two groups. The first subgroup, called specialist mathematics students (Population 3A), included students studying mathematics as an integral part of their coursework for future training or as part of preuniversity studies; the second subgroup, called nonspecialist mathematics students (Population 3B), included students either studying mathematics as a complementary part of their studies or not studying mathematics.

Sampling

A two- or three-stage stratified probability sampling method was used depending on the complexity and size of each nation. The details of the sample procedures and execution results are unknown. Data on the sample design are largely unavailable in the published documents. Detailed information about sample exclusions, refusals, and response rates is also unknown.

Sample Size and Response Rate

The achieved sample sizes and effective sample sizes for selected countries are reported in tables 2 to 5 for four population groups. Response rates are not available for any country in the published documents, so the representativeness of the samples cannot be determined.

The effective sample size refers to the equivalent simple random sample size accounting for the complex design that is produced by dividing the achieved sample size by the design effect. As shown in the tables, the effective sample sizes are reasonably large for Population 1A (8th grade) and Population 1B (age 13). But for mathematics specialist and nonspecialist samples, five countries (Belgium, Finland, France, the Netherlands, and Sweden) achieved an equivalent sample size far below the IEA standard of 400 students. Thus, the samples of these countries should not be regarded as representative of the defined population, and the interpretation of the achievement scores should be made with caution.

Data Collection Method

In each participating country, the national center was responsible for sampling design, instrument administration, data collection, and any necessary modifications or adaptations in the survey procedures. The completed materials (student questionnaires and tests, teacher and school questionnaires) were collected by the national centers, where the data were recorded on cards or machine-readable sheets. The recorded data, accompanied by national coding schemes for checking, were sent to the international center for data editing, analysis, and compilation.

Sample Weighting

It was reported that data from the student samples were weighted to compensate for the unequal probability of selection of students, but detailed information on the weighting procedures is not available in the related technical documents.

Estimation of Sampling Error

Tables 2 to 5 present the standard errors and design effects for Populations 1A, 1B, 3A, and 3B in the selected countries. The reported standard errors were computed based on the simple random sampling (SRS) formula. To compute the proper estimate of standard errors that account for the complex sampling design, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

Technical Document Reference

Torsten Husen, *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*, Vol. I, John Wiley & Sons, 1967.

Table 1. Summary of target populations covered in six international studies

Study	Year conducted	Target population										
										Grade 12		
		Age 9	Grade 4	Age 10	Grade 5	Age 13	Grade 8	Age 14	Grade 9	All	Math/Sci. specialist	Non-specialist
IEA First Mathematics	1964					X	X			X	X	X
IEA First Science	1970-1971			X				X		X	X	
IEA Second Mathematics	1980-1982						X				X	
IEA Second Science	1983-1985			X				X		X	X	X
IAEP	1988					X						
IAEP	1991	X				X						

437

438

Table 2. Sample characteristics of selected countries: IEA First International Mathematics Study, Population 1A (grade 8)

Country	School		Student		Standard error (SRS)[1] of mean achievement score	Design effect	Approximately effective sample size
	Sample size	Response rate	Sample size	Response rate			
Belgium	61	NA	1,732	NA	.04	2.9	599
England	182	NA	3,033	NA	.03	2.9	1,049
Finland	111	NA	1,156	NA	.05	2.9	400
France	125	NA	2,761	NA	.04	4.4	626
Japan	210	NA	2,050	NA	.03	2.0	1,046
Netherlands	90	NA	429	NA	.08	2.9	148
Scotland	73	NA	5,464	NA	.04	8.4	650
Sweden	80	NA	3,345	NA	.04	5.3	632
United States	395	NA	6,424	NA	.02	2.9	2,223

[1]Standard errors were computed based on the sample random sampling (SRS) formula. To compute the proper estimate, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

NA Not available

Source. Torsten Husen (ed.). *International Study of Achievement in Mathematics: A Comparison of Twelve Countries,* Vol. 1, p. 158, Table 9.2, 1967.

Table 3. Sample characteristics of selected countries: IEA First International Mathematics Study, Population 1B (age 13)

Country	School		Student		Standard error (SRS)[1] of mean achievement score	Design effect	Approximately effective sample size
	Sample size	Response rate	Sample size	Response rate			
Belgium	61	NA	2,645	NA	.04	4.0	661
England	82	NA	3,179	NA	.03	2.9	1,100
Finland	111	NA	1,325	NA	.05	3.2	409
France	124	NA	3,850	NA	.05	9.6	401
Japan	210	NA	2,050	NA	.03	2.0	1,046
Netherlands	90	NA	1,443	NA	.05	3.6	400
Scotland	73	NA	5,949	NA	.04	9.6	619
Sweden	80	NA	3,712	NA	.04	6.3	594
United States	395	NA	6,733	NA	.02	2.9	2,330

[1]Standard errors were computed based on the sample random sampling (SRS) formula. To compute the proper estimate, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

NA Not available

Source: Torsten Husen (ed.), *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*, Vol. 1, p. 158, Table 9.2, 1967.

Table 4. Sample characteristics of selected countries: IEA First International Mathematics Study, Population 3A (mathematics specialists in the final secondary grade)

Country	Percent of age cohort in school	Mathematics specialist		School		Student		Standard error (SRS)[1] of mean achievement score	Design effect	Approximately effective sample size
		As percent of age cohort	As percent of grade cohort	Sample size	Response rate	Sample size	Response rate			
Belgium	13	4	31	30	NA	519	NA	.07	2.6	203
England	12	5	42	77	NA	1,031	NA	.04	1.7	610
Finland	14	7	50	27	NA	460	NA	.06	1.7	272
France	NA	NA	NA	14	NA	337	NA	.06	1.2	279
Japan	57	8	14	91	NA	818	NA	.05	2.0	417
Netherlands	NA	NA	NA	30	NA	491	NA	.07	2.6	192
Scotland	18	5	30	63	NA	1,422	NA	.04	2.3	632
Sweden	23	16	69	23	NA	1,024	NA	.05	2.6	400
United States	70	18	26	149	NA	1,660	NA	.04	2.6	648

[1]Standard errors were computed based on the sample random sampling (SRS) formula. To compute the proper estimate, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

NA Not available

Sources. Torsten Husen (ed.), *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*, Vol. 1, p. 160, Table 9.5, 1967; D. Robitaille and A. Taylor, "Changes in Patterns of Achievement Between the First and Second Mathematics Studies," in *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics*, edited by D. Robitaille and R. Garden (Oxford: Pergamon Press, 1989), 156.

Table 5. Sample characteristics of selected countries: IEA First International Mathematics Study, Population 3B (non-mathematics students in the final secondary grade)

Country	School		Student		Standard error (SRS)[1] of mean achievement score	Design effect	Approximately effective sample size
	Sample size	Response rate	Sample size	Response rate			
Belgium	43	NA	1,004	NA	.06	3.6	278
England	84	NA	1,906	NA	.03	1.7	1,128
Finland	24	NA	482	NA	.06	1.7	285
Japan	349	NA	4,372	NA	.03	4.0	1,093
Scotland	64	NA	2,123	NA	.04	3.2	655
Sweden	20	NA	320	NA	.05	0.8	395
United States	155	NA	2,152	NA	.04	3.2	664

[1]Standard errors were computed based on the sample random sampling (SRS) formula. To compute the proper estimate, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

NA Not available

Source: Torsten Husen (ed.), *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*, Vol. 1, p. 160, Table 9.6, 1967.

5?5

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The First International Science Study (FISS), IEA, 1970 to 1971

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Overview

The First International Science Study (FISS) was launched by IEA in 1970 as part of a larger research project of the Six Subject Survey (science, reading, literature, English as a foreign language, French as a foreign language, and civics education). The study was designed to examine the international status and quality of science education and to relate educational outcomes to the social and economic conditions of each nation. With 19 developed and less-developed countries participating, data were collected on the national educational system, school curriculum, science teaching, and student cognitive achievement from a total of 137,000 students and 26,000 teachers from 6,900 schools.

The project was one of IEA's earliest efforts to develop workable international science assessment instruments. In a cross-national study of this sort, however, the heterogeneity of the educational systems makes it difficult to form sound international comparisons of student achievement. Because the unique characteristics of the school and social system influence the outcomes of education, the results cannot be interpreted in isolation from these forces. This difficulty is also compounded by the technical problems of sampling and data collection, such as deviant sampling procedures, unstandardized procedures of instrument administration, and nonresponse. Therefore, international comparisons of student achievement should be made with great caution. In this volume, international comparisons are presented for several countries selected on the similarity of their educational systems and practices. Chapter 1 presents the guidelines used to select countries and discusses the methodological aspects of international comparisons.

Population Coverage

The target populations consisted of three groups of students. Population 1 and Population 2 were defined by the age level. Population 1 consisted of 10-year-old students from 17 educational systems, and Population 2 consisted of 14-year-old students from 19 systems. Population 4 used a grade definition: all students in the final grade of secondary school, from 19 systems. In five nations, not including the United States, Population 4 was divided into three subpopulations of students specializing in biology, chemistry, or physics.

Because the study was based on the in-school population, those who did not attend school were excluded from the targeted population in each nation. Students in special schools or classes for physically or mentally disabled children and students in extremely small schools were excluded. In addition to these common exclusion guidelines, other exclusion criteria were employed at the discretion of the national centers to suit the characteristics of individual educational systems. This approach resulted in discrepancies in the rules applied to population exclusion. Except for a few nations, information on the detailed exclusion guidelines and exclusion rates is not available from the published documents of the study.

Sampling

A two- or three-stage stratified cluster sampling method was used, depending on the size and complexity of the country involved. In the first stage, schools were stratified on the common factors of school size, school type, region, and coeducational status; within each stratum, schools were selected with a probability proportional to the size of the school. Extra stratifying factors were added in nations where other dimensions of school stratification operated. For the U.S. sample, the first stage of sampling involved the sampling of communities or regions. Within the primary sampling units of regions, the sampling method followed the procedures used for two-stage sampling.

In the second stage, students were randomly selected from the sample schools with a probability inversely proportional to the size of the school. From each school, 30 students were to be selected. For Population 4 in France and Sweden, the sample units were intact classes, not individual students.

The teacher sample comprised teachers who were teaching the students in the sample. In large schools, an independent sample of teachers was also taken. Data collected from the teacher sample were averaged for the school and were not intended to link with students.

Sample Size and Response Rate

Tables 6 to 8 present the sample size of schools, teachers, and students, and the response rates achieved at each age-group for the selected countries. For each of the three target populations, high response rates were achieved in Australia, Finland, Hungary, and Japan. Four countries (England, Italy, the Netherlands, and the United States) showed low school response rates and, consequently, low overall response rates despite relatively high student response rates. These four nations failed to meet the IEA standard of 85% response rate. The samples of these countries should not be considered representative of the defined population, and international comparison of student achievement should be made with caution.

Data Collection Method

Completed achievement tests and questionnaires from students, teachers, and school administrators were collected by the school coordinator and returned to the national center in each nation. National centers prepared the data either on the prescribed cards or on tape and sent it to the international data processing center. The national centers of each participating country were responsible for checking all the data relating to the countries, ensuring the credibility and accuracy of the data, and reporting the data.

Sample Weighting

The sample weights were equal to the reciprocals of the overall probabilities of selection at the two stages of sampling, adjusted for school-level and student-level nonresponse. For detailed descriptions on weighting procedures used for each population, see G.F. Peaker, *An Empirical Study of Education in Twenty-One Countries: A Technical Report* (1975).

Estimation of Sampling Error

For Population 2, the estimates of jackknifed standard errors and design effects of the mean science achievement score are reported for some of the selected nations in table 7. For other target populations, the sampling errors and design effects are unknown.

Technical Document Reference

L.C. Comber and J.P. Keeves, *Science Education in Nineteen Countries: An Empirical Study*, IEA, 1973; and Gilbert F. Peaker, *An Empirical Study of Education in Twenty-One Countries: A Technical Report*, Vol. 8, Almqvist and Wiksell, 1975.

Table 6. Sample characteristics of selected countries: IEA First International Science Study, Population 1 (age 10)

Country	School		Student		Overall response rate[1]	Teacher sample size
	Sample size	Response rate	Sample size	Response rate		
England	162	79	3,573	92	73	1,301
Finland	97	97	1,305	99	97	350
Hungary	152	99	4,858	96	95	846
Israel	110	97	1,887	95	92	664
Italy	298	73	4,503	67	49	373
Japan	250	100	2,467	100	100	1,552
Netherlands	60	66	1,629	98	65	166
Scotland	105	98	2,169	94	92	1,129
Sweden	98	99	2,009	97	96	665
United States	239	68	5,479	94	64	1,632

[1]Taking account of school and student response rates.

Source: Gilbert Peaker, *An Empirical Study of Education in Twenty-One Countries: A Technical Report*, pp. 36-37, 1975.

Table 7. Sample characteristics of selected countries: IEA First International Science Study, Population 2 (age 14)

Country	School		Student			Teacher sample size	Standard error of mean achievement score	Design effect
	Sample size	Response rate	Sample size	Response rate	Overall response rate[1]			
Australia	221	99	5,301	97	96	1,638	3.4	5.8
England	146	66	3,256	96	60	1,498	NA	NA
Finland	77	100	2,325	98	98	496	3.3	3.6
Hungary	210	100	7,026	94	94	1,520	4.2	7.8
Israel	125	91	1,958	88	80	334	NA	NA
Italy	[illegible]	86	7,383	97	83	1,152	NA	NA
Japan	196	98	1,945	100	98	752	NA	NA
Netherlands	50	52	1,236	94	49	141	NA	NA
Scotland	70	95	1,982	89	85	819	5.9	4.8
Sweden	95	96	2,475	95	91	1,157	3.4	3.6
United States	142	57	6,870	80	46	992	NA	NA

[1]Taking account of school and student response rates.

Source: Gilbert Peaker, *An Empirical Study of Education in Twenty-One Countries: A Technical Report*, pp. 36, 37, 44, and 45, 1975.

Table 8. Sample characteristics of selected countries: IEA First International Science Study, Population 4 (final secondary grade)

Country	School		Student			Teacher sample size
	Sample size	Response rate	Sample size	Response rate	Overall response rate[1]	
Australia	194	99	4,197	93	92	1,600
England	70	32	2,274	83	27	867
Finland	77	100	1,807	82	82	630
Hungary	39	100	2,855	98	98	451
Israel	71	84	863	97	81	238
Italy	253	70	16,437	87	61	1,538
Netherlands	38	39	1,164	95	37	179
Scotland	69	88	1,328	91	80	978
Sweden	142	95	2,988	95	90	2,131
United States	114	43	5,200	81	35	816

[1]Taking account of school and student response rate.

Source: Gilbert Peaker, *An Empirical Study of Education in Twenty-One Countries: A Technical Report*, pp. 36-37, 1975.

The Second International Mathematics Study (SIMS), IEA, 1980 to 1982

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Overview

The Second International Mathematics Study (SIMS) was conducted by IEA to examine student achievement and conditions of learning mathematics in the international context and to investigate changes in the learning and teaching environments of mathematics following international educational reforms carried out after the first study. The study involved a total of 125,000 students, 6,000 teachers, and 4,000 schools from 20 countries (educational systems) around the world.

For the sake of comparisons, SIMS almost replicated the first mathematics study. But the second study incorporated significant changes in examining international differences in student achievement. First, it expanded survey instruments to collect information about classroom teaching, curriculum practices, and course tracking. Second, eight educational systems, including the U.S., conducted a longitudinal study by administering two tests (a pretest at the beginning of the school year and a posttest at the end of the same school year) to allow examination of changes in student performance during one school year. Third, the study measured international differences in the levels of student achievement associated with the specified grade, not age, and student tests were taken by random samples of mathematics classes in each country, not by random samples of students in sampled schools.

The test items and topics were arranged to reflect the content of mathematics instruction in a broad range of countries. However, the national curricular emphasis differed from one country to another, and as a result, the fit between the tests and the curriculum varied significantly. Thus, in interpreting the achievement levels of nations, teachers' evaluation of the opportunity to learn should be considered as a backdrop for student performance.

Population Coverage

The target population consisted of two populations defined by grade. Population A was defined as all students in the grade where the majority of 13-year-olds are to be found in the 18 nations (8th grade in the U.S.). Population B was defined as all students in the terminal grade of secondary school who were enrolled in advanced mathematics courses. Nonspecialist mathematics students were not included in the second study.

In Scotland, both of the two highest grades were considered as terminal years of secondary schooling because students proceed to university from each of these levels. Achievement scores for Scotland Population B might have been higher if only the higher grade of the two had participated.

Because the study used the school-based definition of target population, age-eligible children who did not attend school were excluded from the sampling frame of each country. Students in special schools for physical and mental disabilities and students in geographically remote areas were excluded. The rate of exclusion from Population A for these reasons ranged from less than 1% to about 5% of age-eligible children. (See table 9.) In the Netherlands, a substantial group of Population A students (20%) were not included in the defined population, and data from the Netherlands should be compared with other nations with caution. For the final secondary grade, the in-school population ranged from 17% (England and Wales) to 92% (Japan) of the age cohort with the United States at 82%. Of the in-school population, mathematics specialists constituted 13% (Japan) to 50% (Sweden) with 15% for the United States. (See table 10.)

Sampling

A two- or three-stage stratified cluster sampling was used. Stratification of schools was conducted by geographical region, school type, and other factors determined by each national center as having some significance for education in each system. Within the sampling frame, schools were randomly selected with probability proportional to size of the target grade students. Within the sample schools, intact classrooms were selected with equal probability.

The United States employed a three-stage stratified cluster sampling, the primary sampling units being school districts. School districts were stratified into seven strata by school type, metropolitan status, and geographic region and were selected with probability proportional to the size of the target grade population in the district. Within the selected school district, schools were randomly drawn with probability proportional to their size; within each school, two intact classrooms were selected per sampled school with equal probability. Twice as many school districts were selected as needed to compensate for the expected 50% cooperation rate. The oversampling and low response rate at the district level may introduce bias to the data from the United States.

In Scotland and England/Wales, the sampling units were students, not classes, for the Population A and Population B sample. Scotland did not draw a fresh sample for Population A but conducted a follow-up sampling of an existing national sample of students. For a detailed description of the sampling procedures for all participating countries, see Robert Garden, *Second IEA Mathematics Study: Sampling Report* (1985).

Sample Size and Response Rate

The achieved sample size and response rate for selected countries are reported in tables 9 and 10. For Population A, the school response rates exceeded the IEA standard of 85% in most countries except Belgium, England/Wales, and the United States. However, the student response rates did not meet the standard in three of the four nations whose rates were known. For Population B, the school response rate was low in Belgium, Scotland, and the United States.

The U.S. samples of Population A and Population B achieved response rates below the IEA standard at the district, school, class, and student levels. By this criterion, the U.S. samples may not have been representative of the target population. Another way to judge the representativeness of the U.S. sample is to compare the effective sample size to the IEA-required sample size (400). The effective sample size is a sample size equivalent to the size of a simple random sample, produced by dividing the achieved sample size by the design effect. The effective sample sizes of the U.S. were estimated as 506 and 570 for Population A and B, respectively, exceeding the IEA criterion of minimum sample size (Suter and Phillips, 1985).

Data Collection Method

Data from students, teachers, and school administrators were collected by each national center and sent to the International Coordinating Center on a computer tape in a prescribed format, accompanied by documentation including modification to the international form and any delctions. Data sets that contained errors and were sent without adequate documentation were transformed into interpretable data sets by editing. At some national centers, data loss occurred at data collection or preparation stages. In these cases, achieved samples were examined for bias, and the very few cases in which bias seemed present or possible were reported in Garden (1985).

Sample Weighting

Weighting was conducted to compensate for the unequal probability of selection due to sample nonresponse, oversampling, and undersampling. Data from the Population A sample for Scotland was not weighted, because sampling was not by selection of schools or classes and no stratification was conducted.

Test results were weighted by class for those systems selecting one intact class from each school. For those selecting two intact classes, the two classes were treated as a school cluster and weights applied at the school level. Content coverage (opportunity-to-learn) data, collected from mathematics class teachers, were weighted. Data on other teacher variables and student backgrounds were not weighted because the effect of weighting was negligible.

Estimation of Sampling Error

Tables 9 and 10 present the standard errors and design effect for each target population in the selected countries. The reported standard errors were computed based on the simple random sampling (SRS) formula. To compute the proper estimate of standard errors that account for the complex sampling design, the SRS standard errors should be multiplied by the square root of the design effect presented in the next column.

Technical Document Reference

Robert Garden, *Second IEA Mathematics Study: Sampling Report*, The National Center for Education Statistics, U.S. Department of Education, 1985; D.F. Robitaille and Robert Garden (eds.), *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics*, Pergamon, 1989; and Kenneth J. Travers and Ian Westbury, *The IEA Study of Mathematics I: Analysis of Mathematics Curricula*, Pergamon, 1989.

Table 9. Sample characteristics of selected countries: IEA Second International Mathematics Study, Population A (grade 8)

Country	Percent of in-school age cohort excluded from the defined population	Mean age	School		Class		Teacher sample size	Student		Standard error of mean achievement score (core item)	Design effect	Approx. effective sample size
			Sample size	Response rate	Sample size	Response rate		Sample size	Response rate			
Belgium (Flemish)	0.6	14.2	158	80	158	NA	158	3,103	NA	0.54	13.55	230
Belgium (French)	NA	14.5	108	86	108	NA	108	3,103	NA	0.63	14.30	217
England and Wales[1]	NA	14.1	94	82	--	--	244	2,678	84	0.58	10.27	260
Finland	1.0	13.8	98	95	206	94	206	4,484	NA	0.38	10.87	411
France	5.0	14.2	187	99	365	99	362	8,889	NA	0.19	7.38	1,201
Japan	4.0	13.5	213	97	213	97	213	8,091	NA	0.16	3.69	2,187
Netherlands	20.0	14.4	236	100	236	100	236	5,500	NA	0.47	16.80	327
Scotland[1]	3.6	14.0	76	NA	--	--	354	1,356	67	NA	--	--
Sweden	NA	13.9	96	96	188	94	186	3,585	88	0.37	10.83	332
United States	NA	14.1	150	83	280	78	280	6,858	76	0.44	15.48	442
District[2]	--	--	93	50	--	--	--	--	--	--	--	--

[1]The sampling units were students, not classes. In some schools, all teachers with students in the sample completed the questionnaires, and in others only some teachers did.

[2]School districts were oversampled (twice as many as needed) to allow for the expected 50% refusal rate.

NA Not available

-- Not applicable

Source: Robert Garden, *Second IEA Mathematics Study: Sampling Report*, pp. 132-133, 1987.

Table 10. Sample characteristics of selected countries: IEA Second International Mathematics Study, Population B (mathematics specialists in the final secondary grade)

Country	Percent of age cohort in school	Mathematics specialist		School		Class		Teacher sample size	Student		Standard error of mean achievement score (core items)	Design effect	Approx. effective sample size
		As percent of age cohort	As percent of grade cohort	Sample size	Response rate	Sample size	Response rate		Sample size	Response rate			
Belgium (Flemish)	65	9-10	25-30	131	87	197	NA	197	2,859	NA	0.18	2.91	982
Belgium (French)	NA	14	NA	87	77	153	NA	151	2,062	NA	0.21	2.22	929
England and Wales[1]	17	6	35	312	90	--	--	678	3,578	NA	0.12	1.41	2,538
Finland	59	15	38	81	92	81	92	81	1,550	88	0.20	2.00	775
Japan	92	12	13	192	93	207	100	207	7,954	100	0.19	6.47	1,174
Scotland[1]	43	18	42	54	81	--	--	272	1,501	NA	0.14	1.20	1,251
Sweden	24	12	50	127	98	134	NA	127	2,712	93	0.16	1.96	1,384
United States	82	13	15	150	69	252	83	252	4,671	77	0.15	3.04	1,537
District[2]	--	--	--	93	48	--	--	--	--	--	--	--	--

[1]The sampling units were students, not classes.

[2]School districts were oversampled (twice as many as needed) to allow for the expected 50% refusal rate.

NA Not available

-- Not applicable

Sources: Robert Garden, *Second IEA Mathematics Study: Sampling Report*, pp. 134-135, 1987; and Curtis McKnight et al., *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective*, p. 16, Table 1, 1987.

The Second International Science Study (SISS), IEA, 1983 to 1985

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Overview

IEA conducted the Second International Science Assessment (SISS) in 1983–1985 involving 24 educational systems (23 nations) around the world. Improving on the research methods of the first IEA science study and expanding its scope and coverage, the second study was designed to compare student achievement across nations and across assessments. In all, 260,830 students, 22,612 teachers, and 9,578 schools were included in the study.

To facilitate comparisons, the second study replicated the definitions, techniques, and instrumentations used in the earlier study. However, significant modifications were introduced for the test and questionnaire items to reflect changes in the international curriculum during the time since the first study.

As in other IEA international comparative studies of widely different educational systems, the general study design could not be followed in every country. Significant modifications were made in the areas of target populations, population exclusion, and sampling methods to allow for national differences in educational systems. The discrepancies resulted in a lack of comparable samples and may have reduced the comparability of the sample results across nations.

Population Coverage

Three target populations were defined for the study. Population 1 and Population 2 comprised both age and grade groups. Population 1 was defined as all students at age 10 or in the grade where most 10-year-olds were to be found (5th grade in the U.S.) in 19 educational systems, and Population 2 was defined as students at age 14 or in the grade where most 14-year-olds were to be found (9th grade in the U.S.) in 24 systems. The age definition corresponded to that used for the first IEA science study. But an age-group was typically spread through a range of grades in most countries, which made it harder to draw student samples. For this reason, the grade definition was used as an alternative in most countries.

Population 3 depended on a grade level; it was defined as all students in the final year of secondary school (12th grade in the U.S.) in 19 systems. Population 3 was divided into subpopulations of students specializing in biology (3B), chemistry (3C), physics (3P), earth science (3E), general science (3X), and students not studying any science subject (3N).

As the target population was defined based on the in-school population, children who did not attend school were excluded from the student universe for each country. Tables 11 to 13 present the estimated percentage of the age cohort in school at each age level. At age 10, the target (in-school) population represented 99% of the age cohort in all selected educational systems. At age 14, the proportion of the in-school age-eligible population declined in two countries (Hungary to 92% and Italy to 72% at grade 9), whereas other countries continued to have about 99% of the age cohort still in school. For Populations 1 and 2, the out-of-school exclusion rate was kept to a minimum.

By the final year of secondary school, however, the percentage of the age cohort in school decreased sharply in all selected educational systems: 20% to 80% of the age cohort no longer attended school, depending on the system. The representation rate was worse for the science specialist students in countries that employed strict criteria in admitting students to specialized science classes. (See tables 14 to 16.) Final-year secondary school students studying advanced science subjects represented only 1% to 40% of the age cohort. The exclusion of a majority of the age cohort from Population 3 and its subpopulations and the great variation in the uncovered proportion of the age cohort across the educational systems limit the value of international comparisons of final-year student achievement.

Other criteria for excluding certain in-school students from the target population were decided by each national center. Overall, the exclusion criteria varied from country to country, making it very difficult to draw comparable targeted populations across countries. The exclusion rate for each target population is reported in the tables. For the detailed exclusion guidelines in each nation, see pp. 171–179 in T. Neville Postlethwaite and David E. Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries* (1992).

Sampling

A two- or three-stage stratified cluster (class) sampling was used by each national center to suit the sample design to each target population to be tested. The first stage involved sampling of schools from a stratified sampling frame with a probability proportional to the school size. Stratification of schools was conducted by school type, size, geographical region, and other factors determined by each national center as having some significance for education in that system. Replacement schools were typically drawn by selecting the next school within the same stratum to ensure proximity to the original selections. Within the sample schools, intact classrooms were selected with equal probability in most countries. In three countries (Australia, England, and Italy). individual students, not classrooms, were selected at random from each school.

The United States conducted two phases of sampling and testing. The first phase, conducted in 1983, used the same two-stage classroom sampling. But due to a very low response rate from schools, a second data collection effort was made in 1986 by the Research Triangle Institute. In the second phase, a three-stage stratified cluster sampling was used. The primary sampling units were counties or groups of counties selected with probability proportional to the size of the target grade population. Within the sample of 70 county primary sampling units, schools were stratified by school type, metropolitan status, and geographic region and were selected with probability proportional to size of the target population in school. Within each school, one intact classroom was selected per sampled school. For a detailed description of the sampling procedures for all participating countries, see pp. 179–185 in T. Neville Postlethwaite and David E. Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries* (1992).

Sample Size and Response Rate

Tables 11 to 13 present the achieved sample size of schools and students and the response rates for each target population. For all three target populations, a majority of nations showed low school and student response rates, failing to meet the IEA standard of 80%–85% response rate for both schools and students. The samples of Australia, England, Israel, Italy, Norway, Sweden, and the United States commonly had substandard response rates, while high response rates were achieved in Finland, Hungary, and Japan. In most countries, the effective sample sizes of science specialists in the final year of secondary school were too small once the design effect was accounted for. (See tables 14 to 16.) These combined problems of high nonresponse and small effective samples may have seriously undermined the representativeness of the samples and cast doubt on the reliability of the test results for the countries marked by those problems.

Data Collection Method

Data collection and data reporting were managed by the national centers located in each participating country. The national centers collected data from the national instruments (national case study questionnaire and curriculum ratings), school instruments filled out by school administrators, teacher instruments (teacher questionnaire and opportunity-to-learn questionnaire), and student instruments (student questionnaire, attitude questionnaire, achievement test). The compiled data were sent to the International Coordinating Center for data verification and analysis.

Sample Weighting

Weights were assigned to student test scores and other student data to correct for the unequal probability of selection of students and schools and were adjusted for school and student nonresponse. Estimates of teachers and school data were not weighted. Data on Israel were unweighted because no population figures were known.

Estimation of Sampling Error

Tables 11 to 16 report jackknifed sampling errors and design effect of the mean scores of the science test for each population.

Technical Document Reference

T. Neville Postlethwaite and David E. Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries,* 1992; and John P. Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984,* 1992.

Table 11. Sample characteristics of selected countries: IEA Second International Science Study, Population 1 (age 10)

Country	Percent of age cohort in school	Excluded students as percent of in-school age cohort	Mean age	Grade tested	School: Sample size	School: Response rate	Student: Sample size	Student: Response rate	Standard error of mean achievement score (core 24 items)	Design effect	Approx. effective sample size
Australia	99	1.1	10:6	4, 5, 6	220	78	4,259	67	0.73	6.7	630
England	99	1.0	10:3	5	181	66	3,748	62	0.70	5.3	709
Finland	99	9.0	10:10	4	106	96	1,600	86	0.62	2.3	711
Hungary	99	6.2	10:3	4	100	100	2,590	95	0.96	7.3	355
Israel[1]	99	2.5	10:9	5	86	90	2,351	NA	1.00	NA	NA
Italy	99	7.7	10:9	5	119	58	5,156	84	1.06	16.8	307
Japan	99	2.0	10:7	5	221	99	7,924	99	0.28	2.3	3,522
Norway	99	1.0	10:11	4	91	62	1,305	54	1.25	NA	NA
Sweden											
(Gr. 3)	99	1.0	9:10	3	75	71	1,336	70	0.89	2.6	522
(Gr. 4)	99	1.0	10:10	4	64	70	1,449	74	0.65	2.6	566
United States											
Phase 1 (1983)	99	NA	NA	5	121	48	2,909	46	NA	6.7	430
Phase 2 (1986)	99	NA	11:3	5	123	88	2,822	77	0.75	NA	NA

[1]Covered the Hebrew-speaking schools only.

NA Not available

Sources. Postlethwaite and Wiley, *The IEA Study of Science II. Science Achievement in Twenty-Three Countries*, p. 171, 172, 187, and 197, 1992; and Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

Table 12. Sample characteristics of selected countries: IEA Second International Science Study, Population 2 (age 14)

Country	Percent of age cohort in school	Excluded students as percent of in-school age cohort	Mean age	Grade tested	School: Sample size	School: Response rate	Student: Sample size	Student: Response rate	Standard error of mean achievement score (core 30 items)	Design effect	Approx. effective ample size
Australia	98	2.1	14:5	8, 9, 10	233	84	4,917	74	0.63	7.3	674
England	98	1.2	14:2	9	147	60	3,118	53	0.73	6.3	499
Finland	99	11.7	14:10	8	90	97	2,546	90	0.43	2.6	994
Hungary	92	3.0	14:3	8	99	99	2,515	93	0.85	7.3	345
Israel[1]	99	2.5	14:9	9	74	74	2,082	69	1.14	NA	NA
Italy											
(Gr. 8)	99	NA	13:11	8	224	75	4,622	77	0.71	8.4	550
(Gr. 9)	72	NA	14:8	9	72	69	1,398	75	1.43	8.4	166
Japan	99	3.5	14:7	9	199	99	7,610	95	0.29	2.3	3,382
Netherlands	99	2.0	15:6	9	224	92	5,025	86	0.86	13.7	367
Norway	99	1.0	15:10	10	77	65	1,420	59	0.52	NA	NA
Sweden											
(Gr. 7)	99	1.0	13:10	7	71	60	1,557	53	0.76	4.0	389
(Gr. 8)	99	1.0	14:10	8	69	60	1,461	52	0.74	4.0	365
United States											
Phase 1 (1983)	99	NA	NA	9	88	34	1,958	31	NA	9.6	204
Phase 2 (1986)	99	NA	15:3	9	119	85	2,519	69	0.91	NA	NA

[1]Covered Hebrew speaking schools only.

NA Not available

Sources: Postlethwaite and Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries*, pp. 5, 172-175, 188, and 197, 1992; and Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

Table 13. Sample characteristics of selected countries: IEA Second International Science Study, Population 3 (final secondary grade)

				School		Student				
Country	Percent of age cohort in school	Mean age	Grade tested	Sample size	Response rate	Sample size	Response rate	Standard error of mean achievement score (core 30 items)	Design effect	Approx. effective sample size
Australia	39	17:3	12	165	80	5,057	69	0.56	4.8	1,045
England	20	18:0	13	127	49	3,737	41	0.54	4.0	934
Finland[1]	41 (63)	18:6	12	86	94	3,638	90	0.47	2.9	1,259
Hungary[1]	18 (40)	18:0	12	77	96	2,001	89	1.06	10.2	195
Israel	65	17:6	12	68	56	1,982	40	1.20	NA	NA
Italy	34	19:0	12, 13	317	69	6,848	75	0.81	13.7	500
Japan[1]	63 (89)	18:2	12	193	96	6,561	91	1.13	21.2	310
Norway	40	18:9	12	165	77	1,597	50	0.76	NA	NA
Sweden	28	19:0	12	119	68	4,033	62	0.83	9.6	420
United States[2]										
Phase 1 (1983)	83	NA	12	164	NA	4,774	NA	NA	7.8	609
Phase 2 (1986)	83	17:7	12	100	NA	1,729	NA	--	--	--

[1]The percentage of age cohort in school, including vocational schools, is presented in parentheses.

[2]In Phase 1, the United States assessed the core test and physics only. In Phase 2, it did not assess the core test but the specialized subject test of biology, chemistry, and physics on a reduced number of items.

NA Not available

-- Not applicable due to nonparticipation

Sources: Postlethwaite and Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries*, pp. 6, 175-179, 188, and 197, 1992; and Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

Table 14. Sample characteristics of selected countries: IEA Second International Science Study, Population 3B (biology specialists in the final secondary grade)

Country	Biology specialists as percent of age cohort	Mean age	School: Sample size	School: Response rate	Student: Sample size	Student: Response rate	Standard error of mean achievement score (core 30 items)	Design effect	Approx. effective sample size
Australia	18	17:1	164	83	1,631	72	0.50	2.3	725
England	4	18:0	123	NA	884	NA	0.74	3.2	273
Finland	41	18:7	43	94	1,652	84	0.51	2.9	572
Hungary	3	18:0	71	NA	301	NA	1.13	2.6	118
Israel	26	17:7	54	73	879	60	1.98	NA	NA
Italy	4	19:5	12	NA	147	NA	3.49	9.0	16
Japan	12	18:1	38	95	1,212	90	1.70	14.4	84
Norway	4	18:11	52	NA	276	NA	0.96	NA	NA
Sweden	5	18:11	73	NA	619	NA	0.77	2.0	316
United States Phase 2 (1986)	12	17:5	43	92	659	77	1.68	7.3	90

NA Not available

Sources: Postlethwaite and Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries*, pp. 6, 190, and 192, 1992; and Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

Table 15. Sample characteristics of selected countries: IEA Second International Science Study, Population 3C (chemistry specialists in the final secondary grade)

Country	Chemistry specialists as percent of age cohort	Mean age	School		Student		Standard error of mean achievement score (core 39 items)	Design effect	Approx. effective sample size
			Sample size	Response rate	Sample size	Response rate			
Australia	12	17:3	164	82	1,177	77	0.81	2.6	460
England	5	18:0	123	NA	892	NA	0.82	2.6	348
Finland	16	18:6	44	96	971	83	0.87	4.0	243
Hungary	1	18:1	56	NA	143	NA	2.19	2.6	56
Israel	8	17:7	16	38	243	30	4.13	NA	NA
Italy	1	19:2	24	NA	217	NA	4.76	9.6	23
Japan	16	18:2	43	100	1,468	93	2.66	23.0	64
Norway	6	18:11	46	NA	283	NA	1.16	NA	NA
Sweden	6	19:0	119	NA	1,172	NA	0.70	2.6	458
United States Phase 2 (1986)	2	17:8	40	76	537	70	2.60	10.9	49

NA Not available

Sources: Postlethwaite and Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries*, pp. 6, 191, and 197, 1992; and Keeves (ed.), *The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

Table 16. Sample characteristics of selected countries: IEA Second International Science Study, Population 3P (physics specialists in the final secondary grade)

Country	Physics specialists as percent of age cohort	Mean age	School		Student		Standard error of mean achievement score (core 38 items)	Design effect	Approx. effective sample size
			Sample size	Response rate	Sample size	Response rate			
Australia	11	17:3	163	82	1,073	76	0.68	2.3	477
England	6	18:0	125	NA	917	NA	0.60	2.0	468
Finland	14	18:7	42	91	810	83	0.90	3.6	224
Hungary	4	18:0	75	NA	398	NA	1.50	4.0	100
Israel	12	17:7	36	48	472	45	1.42	NA	NA
Italy	13	19:2	120	NA	1,766	NA	0.89	7.8	225
Japan	11	18:2	36	92	1,187	89	1.85	16.0	74
Norway	10	18:11	55	NA	443	NA	1.06	NA	NA
Sweden	13	19:0	119	NA	1,168	NA	0.63	2.3	519
United States									
Phase 1 (1983)	(1)	NA	158	32	2,719	22	NA	6.3	435
Phase 2 (1986)	1	17:10	35	76	485	64	2.07	8.4	58

NA Not available

Sources: Postlethwaite and Wiley, *The IEA Study of Science II: Science Achievement in Twenty-Three Countries*, pp. 6, 192, and 197, 1992; and Keeves (ed.), *The IEA Study of Science III. Changes in Science Education and Achievement: 1970 to 1984*, pp. 296-297, 1992.

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Overview

The first International Assessment of Educational Progress (IAEP) in science and mathematics was conducted by the Educational Testing Service (ETS) in 1988, sponsored by the National Center for Education Statistics. The study involved samples of 13-year-olds from five countries and four Canadian provinces. The study gathered broad information about background factors that may relate to achievement, such as classroom practices, home and school environments, and student attitudes. Opportunity-to-learn data were also collected from teachers to examine the extent to which students were exposed to the test content through school curriculum and possibly to provide a backdrop for interpreting the test results. The study adopted the methods of testing, data collection, and data analysis developed by the National Assessment of Educational Progress (NAEP) for student assessment in the United States.

Assessment items were selected from the pool of 281 mathematics and 188 science questions used in the 1986 NAEP. National experts reviewed the items to evaluate the fit between school curriculum and test items, translation problems, and local adaptation. A set of 90 mathematics and 83 science items were selected and pilot tested in every location; finally, 63 mathematics and 60 science items were selected that represented the content and skills commonly taught in participating countries.

Population Coverage

The target population was defined as all students at age 13 in the participating nations. From this population, students who did not read or speak the language of assessment were excluded. Also excluded were students who were identified as educable mentally disabled and functionally disabled. The exclusion rates of nations are not available in the related technical documents. For detailed information about the population definition and exclusion, see IAEP, *A World of Differences: Technical Report* (1989).

Sampling

A two- or three-stage stratified cluster sampling method was used. In the first stage, schools with any age-eligible students were used as the sampling frame. Schools in the frame were stratified by region, urbanicity, school type, size, and other variables of interest in the given system and were selected with probability proportional to size of the target-age students. In the second stage, a list of students eligible for testing was prepared by the sample schools, and 20 to 25 students were randomly selected from each school. In one Canadian province (French-speaking New Brunswick), the sampling units were whole classes.

The U.S. sample design differed from the standard IAEP design used for other nations. The U.S. school sample consisted of the schools that were selected for the winter half-sample of the 1988 NAEP assessment. The 1988 NAEP sampling used a three-stage stratified design. The primary sampling units (PSUs) were a metropolitan statistical area (MSA), a single non-MSA county, or a group of contiguous counties. The PSUs were stratified by region, metropolitan status, and minority enrollment percentage; and 94 PSUs were selected, composed of 30 certainty PSUs and 64 noncertainty PSUs. Certainty units refer to those included in the sample with certainty because of their sheer size and importance. Within each of the selected PSUs, public and private schools that contained eligible 13-year-olds or an 8th grade were listed in the sampling frame. In the subsequent stages of selection, similar procedures were followed. For detailed information about sampling procedures for all participating systems, see IAEP, *A World of Differences: Technical Report* (1989).

Sample Size and Response Rate

Table 17 presents the achieved sample size and response rates of schools and students in the participating educational systems. The combined response rate ranged from 66% (United Kingdom) to 92% (South Korea), with the United States at 78%. Samples with response rates below 85% should not be regarded as representative of the target-age population.

The low school response rate of the United States was partly due to the unique method used for the instrument administration. Due to use of the spiraled bundle administration method, two IAEP booklets were spiraled within a total set of 38 different test booklets of the 1988 NAEP survey. Because a participating school tested an average of 25 students, not all schools administered the entire set of IAEP booklets. This approach resulted in a low response rate at the school level.

Data Collection Method

Students were given two assessment booklets, one for mathematics and one for science, along with a student background questionnaire asking about their instruction, attitudes, and schoolwork-related home activities. In the United States, the mathematics and science assessments were administered to separate groups of students. Completed assessments and questionnaires were returned to a central location within each country. Data files were created by each country following a prescribed format. The files were sent both to Quebec for data checking and analysis and to ETS in the United States for weight calculation.

Sample Weighting

The sample weights were equal to the reciprocals of the overall probabilities of selection at the two stages of sampling, adjusted for school-level and student-level nonresponse. The detailed weighting procedures used in each nation were reported in *A World of Differences: Technical Report* (1989).

Estimation of Sampling Error

Jackknifed standard errors were computed for the achievement score and other background items asked of students and reported in *A World of Differences: Technical Report* (1989). Standard errors of the percent of items correctly answered in mathematics and science for each country are presented in table 17.

Technical Document Reference

The International Assessment of Educational Progress, *A World of Differences: Technical Report*, Educational Testing Service, 1989.

Table 17. Sample characteristics of participating countries: International Assessment of Educational Progress 1988, Age 13

Country	School		Student					Standard error of mean percent correct	
	Response rate		Sample size		Response rate		Overall response rate[1]		
	Mathematics	Science	Mathematics	Science	Mathematics	Science		Mathematics	Science
Canada[2]	96	96	14,979	14,880	93	93	90	2.7	2.8
Ireland	97	97	2,253	2,244	90	90	87	3.7	3.5
South Korea	94	94	2,243	2,243	98	98	92	2.7	2.9
Spain	89	89	1,756	1,756	98	98	87	4.6	4.3
United Kingdom	70	70	2,202	2,202	94	94	66	3.5	3.7
United States	87	87	905	859	90	90	78	4.5	4.8

[1] Taking account of school and student response rates.

[2] Four Canadian provinces participated: British Columbia, New Brunswick, Ontario, and Quebec. The reported sample size is the total number of students assessed in these provinces. The response rate and standard error of proficiency means are computed by the average of within-province response rates and standard errors.

Sources: IEAP, *A World of Differences: Technical Report*, pp. 31-32, 1989; and IEAP, *A World of Differences: An International Assessment of Mathematics and Science*, pp. 90-91, 1989.

539

540

International Assessment of Educational Progress (IAEP), 1991

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Overview

The second International Assessment of Educational Progress (IAEP) in science and mathematics involved samples of 9- and 13-year-olds from 20 countries during the 1990–91 school year. As with the first IAEP study, the second study was conducted by Educational Testing Service, sponsored by the National Center for Education Statistics. Compared to the first IAEP, the second study was broader in scope, content coverage, background information collection, age groups, and nations participating. As with the first study, the IAEP adopted the methods of testing, data collection, and analysis developed by the National Assessment of Educational Progress (NAEP).

The second project consisted of four surveys: (1) a main assessment of 13-year-old students in mathematics and science; (2) an assessment of 9-year-old students in mathematics and science; (3) an assessment of 13-year-old students' ability to use equipment and materials to solve problems; and (4) a short test of 13-year-old students' geographical knowledge. All countries participated in the main assessment; participation in the other assessments was optional. The study also developed three background questionnaires for students, schools, and educational systems to gather information on home resources, within-school resources and curriculum, and national contexts for education.

To enhance the validity of the results, IAEP aimed to develop adequate assessment instruments that could apply to curriculum and instructional practices equally well regardless of national setting. A pool of the most relevant and appropriate test items was prepared by national educational experts who reviewed and evaluated existing NAEP items and items submitted from the participating countries and pilot tested in all of the participating countries, with one exception (Slovenia). Through the sifting process, about 70 test items were selected for each subject area for each age group.

To improve the validity of the data, cluster analysis and differential item functioning (DIF) analysis were employed to minimize the potential effect of cultural, linguistic, and curricular differences on the test results and thereby eliminate the country-by-topic and country-by-item interaction from data analysis and reporting. These two techniques, cluster and DIF analysis, were applied to responses for each test item from each population. Items detected as outliers by these techniques were removed from subsequent data analysis. IAEP data analysis reports focused on the items that were most likely to be reliable and appropriate for international comparison.

Population Coverage

The target populations were defined as all 9- and 13-year-old children who attended school, public or private. Exclusion of the age-eligible population from the universe came mainly from four factors. First, because the study used the school-based definition of target population, age-eligible children who did not attend school were excluded. The percent of age-eligible children not in school ranged from 0% to 4% at age 9 and 0% to 6% at age 13 in the selected countries. (See tables 18 and 19.)

The second exclusion factor affected some nations where the study was limited to subpopulations of specific language or ethnic groups or to political or geographic regions. These nations were Israel (Hebrew-speaking schools) and Spain (Spanish-speaking schools except in Cataluña). As the tables indicate, the target population of Israel and Spain covered 71% and 80%, respectively, of the age cohorts in the nation. For other nations where the defined population was the whole country, the second and third columns of the tables show the same coverage rate.

Third, within the defined population, students in too-small schools and remote schools were not included in the frame for sampling convenience. Fourth, from the in-school age-eligible population, those who had physical, mental, and language difficulties were excluded from student sampling. In addition to these exclusionary factors, the standard guidelines excluded the following students: those who had received fewer than two years of instruction in the language of the assessment; those who were identified by tests as educable mentally disabled; and those who were functionally disabled. The exclusion rate due to these ineligibilities ranged from 0% to 6.2%.

Sampling

A two-stage stratified cluster sampling was used. In the first stage, the sampling frame of schools having any age-eligible students was prepared. Schools in the frame were stratified into 55 strata by school size, type, and geographic region, and from each strata two schools were selected with probability proportional to the size of target-age students in the school. In the second stage, a list of age-eligible students was prepared for each sampled school. Within each school, approximately 30 to 35 students were systematically selected to form two random half-samples for mathematics and science. The total sample size for each country was typically 1,650 students in each subject at each age level.

The sample design of the United States followed the standard IAEP design. The 1989 Quality Education Data files were used to construct the sampling frames of public and private schools. Schools in the list were stratified by geographic region, urbanicity, and type of control, and similar procedures were used for the school and student selections. Complete descriptions of the sampling procedures for all participating countries are reported in *IAEP Technical Report* (1992).

Sample Size and Response Rate

Tables 18 and 19 present the achieved sample size and response rates of schools and students for each subject and each age. As for the overall response rate that accounts for the two sampling stages, all nations achieved an 85% or higher cooperation rate for age 9 in both mathematics and science, with one exception—the United States (74%). At age 13, the overall response rate ranged from 71% (the United States) to 99% (South Korea). Samples with a response rate below 85%

(Jordan, Scotland, and the United States) should not be regarded as representative of the target age population. The low response rates of the U.S. samples may have interfered with producing reliable estimates of student achievement.

Data Collection Method

Data collection and data reporting were managed by the national assessment center located in each participating country. At each age, random samples of students were administered either a science or mathematics booklet, and in each subject students were assessed on the same booklet and paced through the session. One common block of items was asked of both age groups to compare achievement across age levels. In accordance with standard formats and IAEP requirements, completed test instruments and questionnaires were sent to the national center to develop a preliminary data file. Data files were returned to the IAEP Data Processing Center for data verification and item analyses to identify problems in the data files.

Sample Weighting

The sample weights were equal to the reciprocals of the overall probabilities of selection at the two stages of sampling, adjusted for school-level and student-level nonresponse. The detailed weighting procedures used in each nation are reported in *IAEP Technical Report* (1992).

Estimation of Sampling Error

Jackknifed standard errors were computed for the achievement score and other background items asked of students and reported in the related technical document. Tables 18 and 19 present standard errors of the percent of items correctly answered in mathematics and science for each country. Technical documentation also indicated that the coefficient of variance of the item percent correct was calculated for each item for each population.

Technical Document Reference

The International Assessment of Educational Progress, *IAEP Technical Report*, Educational Testing Service, 1992.

Table 18. Sample characteristics of selected countries: International Assessment of Educational Progress 1991, Age 9

Country	Percent of age cohort in school	Percent of age cohort in the nation included in the sampling frame	Percent of age cohort in the defined population included in the sampling frame	School: Sample size	School: Weighted response rate	Student: Mathematics: Sample size	Student: Mathematics: Response rate	Student: Mathematics: Overall response rate[1]	Student: Science: Sample size	Student: Science: Response rate	Student: Science: Overall response rate[1]	Standard error of mean percent correct: Mathematics	Standard error of mean percent correct: Science
Canada	96–100	74	97	797	97	9,365	95	92	9,362	95	92	0.5	0.4
Hungary	98	99	99	144	100	1,632	94	94	1,607	93	93	0.6	0.5
Ireland	100	94	94	126	94	1,261	97	91	1,282	98	92	0.8	0.7
Israel	99	71	93	116	100	1,612	96	96	1,627	96	96	0.7	0.7
South Korea	99	95	95	114	100	1,630	98	98	1,638	98	98	0.6	0.5
Slovenia	96	97	97	113	100	1,609	94	94	1,593	93	93	0.6	0.5
Spain	100	80	96	110	89	1,624	95	85	1,620	95	85	1.0	0.7
Taiwan	98	97	97	110	100	1,814	99	99	1,799	98	98	0.8	0.5
United States	99	97	97	105	80	1,489	93	74	1,464	92	74	1.0	0.9

[1]Taking account of school and student response rates.

Sources: IAEP, *Learning Science*, p. 129 and 132; and IAEP, *Learning Mathematics*, p. 134.

Table 19. Sample characteristics of selected countries: International Assessment of Educational Progress 1991, Age 13

Country	Percent of age cohort in school	Percent of age cohort in the nation included in the sampling frame	Percent of age age cohort in the defined population included in the sampling frame	School: Sample size	School: Weighted response rate	Student: Mathematics: Sample size	Student: Mathematics: Response rate	Student: Mathematics: Overall response rate[1]	Student: Science: Sample size	Student: Science: Response rate	Student: Science: Overall response rate[1]	Standard error of mean percent correct: Mathematics	Standard error of mean percent correct: Science
Canada	94–100	94	95	1,373	97	19,691	94	91	19,738	94	91	0.6	0.4
France	100	98	98	103	93	1,768	97	90	1,787	98	91	0.8	0.6
Hungary	98	99	99	144	100	1,632	93	93	1,623	92	92	0.8	0.5
Ireland	100	93	93	110	96	1,654	94	90	1,657	94	90	0.9	0.6
Israel	96	71	90	110	98	1,583	95	93	1,584	95	93	0.8	0.7
Jordan	99	96	96	106	85	1,580	99	84	1,588	99	84	1.0	0.7
South Korea	96	97	97	110	100	1,637	99	99	1,635	99	99	0.6	0.5
Scotland	100	99	99	92	82	1,564	90	74	1,584	92	75	0.9	0.6
Slovenia	95	97	97	114	100	1,596	95	95	1,598	95	95	0.8	0.5
Spain	100	80	96	109	93	1,624	96	89	1,609	95	88	0.8	0.6
Taiwan	90	100	100	108	100	1,780	98	98	1,786	99	99	0.7	0.4
United States	99	98	98	96	77	1,407	92	71	1,404	92	71	1.0	1.0

[1]Taking account of school and student response rates.

Sources: IAEP, *Learning Science*, p. 130 and 133; and IAEP, *Learning Mathematics*, p. 135.

Higher Education Studies

The Cooperative Institutional Research Program (CIRP) 1990 National Norms Study

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Overview

The Cooperative Institutional Research Program (CIRP) is a national longitudinal study of the American higher education system. Established in 1966 by the American Council on Education, CIRP includes 1,300 institutions, over seven million students, and more than 100,000 faculty. The freshman and follow-up surveys have been administered annually since the study's inception 26 years ago, permitting analysis and reporting of trends data for the entire period.

Since 1972, the CIRP freshmen surveys have been conducted by the Higher Education Research Institute (HERI) at the University of California, Los Angeles. Each year, CIRP surveys approximately 250,000 first-time full-time (FTFT) freshmen from approximately 400 participating institutions.

The 1990 Student Information Form is a student self-report questionnaire comprising 39 multiple choice items. The questionnaire obtains data from students in eight areas: academic skills and preparation; demographic trends; high school activities and experiences; educational and career plans; majors and careers; attitudes; student values; and means of financing education.

Population Coverage

Surveyed institutions were identified from the universe of postsecondary institutions in the Opening Fall Enrollment portion of the Higher Education General Information Survey (HEGIS). An institution was considered eligible if it was operating at the time of the HEGIS survey and had an FTFT freshman class of at least 25 students.

The CIRP National Norms Study considers data from two- and four-year colleges and universities; most proprietary, special vocational, or semiprofessional institutions are not included. Consequently, the survey universe consists of institutions of higher education rather than all postsecondary institutions.

The CIRP Norms Study sample is derived from students attending institutions that volunteered to participate in the study. As such, it is not a random sample of the U.S. population of higher education institutions and students. As a result, survey findings may not present trends in the Nation as a whole.

Results of the 1990 survey are based on the responses of 194,181 FTFT freshmen from 382 participating institutions.

Sampling

Institutions are sorted into 37 strata based on race (predominantly white versus predominantly black), type (two-year, four-year, university), control (public, private nonsectarian, Roman Catholic, and Protestant), and selectivity level. Selectivity is defined by the average composite SAT score (i.e., mathematics and verbal scores combined) of the entering class. The averages are then sorted into three achievement levels: low-medium; medium-high; and high-very high. (For two-year colleges, enrollment is used in place of selectivity.)

Information about the FTFT population and the method of survey administration is obtained from participating institutions at the time they return their completed surveys. In the event that an institution does not return FTFT information, these data are imputed from the most recent Opening Fall Enrollment survey.

Data Collection Method

Each year, HERI invites the participation of all institutions that meet the study's criteria for inclusion. Generally, institutions pay to participate in the study. Each institution receives the survey forms by mail and assumes responsibility for their distribution and administration to students. Although the method of administration varies across institutions, most students receive and complete the survey in a proctored setting.

Response Rate

Survey results are based on the responses of students from an essentially self-selected population of institutions. Consequently, most questions about an institutional response rate do not apply.

Regarding student response rates, an institution is included in the survey sample if it meets the survey criteria for providing a representative sample of its FTFT student population. The minimum acceptable student response rate varies by type of institution: 85% for four-year colleges, 75% for universities, and 50% for two-year colleges.

Sample Weighting

The trends data are weighted to provide a normative picture of the American college freshman population. Weighting is a two-step procedure. In the first step, the counts of male and female FTFT respondents for each institution are divided by that institution's male and female FTFT count. When applied, the resulting weights bring the male and female respondent counts up to the total counts for each institution.

The weighted counts for all participating institutions in each stratification cell are then summed and divided into the national male and female FTFT counts for all institutions in that stratification cell. The resulting between-institutions weights bring the male and female counts for each stratification cell up to the total national counts for that stratification cell.

Once weighted counts for each stratification cell have been computed, the counts are combined to form comparison groups or norm groups. Norm groups are hierarchically organized, allowing participating institutions to compare their results at different levels of specificity.

Sampling Error

Standard error calculations assume a random sampling of students. Because participants in this study are self-selected rather than sampled randomly, it cannot be determined whether they constitute a reasonable estimate of the population. Standard errors are reported in terms of plus or minus percentage points. Refer to Table E1 of the technical documentation for a listing of the standard errors for norm groups of various sizes.

Nonsampling Error

Item nonresponse

The technical documentation neither addresses the issue of item nonresponse nor describes imputation strategies used, if any, to adjust for nonresponse.

Other sources

Other sources of nonsampling error include institutional response bias, changes in the survey instrument over time, and changes in the survey stratification scheme. Institutional response bias stems from the fact that institutions were not sampled randomly from the institutional universe. Moreover, nonrepeat participation and year-to-year variation in the quality of data collected by institutional participants may account for some of the systematic variation in results across time.

Second, revisions of the survey itself may compromise longitudinal comparisons of responses to specific survey items. However, each of the survey items has been evaluated for each year it occurs to determine whether year-to-year changes reflect actual changes in the population or are artifacts of question wording and/or sequence. Major revisions occurred for items in the following domains: career, major, religion, high school grades, estimated parental income, and financial aid. Additionally, revisions were made to a number of items dealing with student opinions, projected future activities, and perceived goals and values.

Finally, substantial changes in the stratification scheme were made in 1968, 1971, and 1975, including the addition of cells for historically black colleges and for public and private universities and the use of selectivity levels. These changes resulted in corresponding changes to the weights applied to individual institutions over the period 1966–1975, giving them greater or lesser influence over the national normative results.

Technical Document Reference

E.L. Dey, A.W. Astin, and W.S. Korn, *The American Freshman: Twenty-Five Year Trends, 1966–1990,* Higher Education Research Institute, University of California at Los Angeles, 1991.

CIRP 1988 (1984 and 1986 College Freshmen) National Norms Study Follow-up Survey

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Overview

The Cooperative Institutional Research Program (CIRP) is a national longitudinal study of the American higher education system. Established in 1966 by the American Council on Education, CIRP includes 1,300 institutions, over seven million students, and more than 100,000 faculty.

Each year, CIRP surveys approximately 250,000 first-time full-time (FTFT) freshman from approximately 400 participating institutions. Since 1982, CIRP has conducted annual follow-ups of entering classes from two and four years earlier. Data used in the present report are from the follow-up of the 1984 and 1986 college freshmen surveyed during the summer of 1988.

The 1988 Follow-up Survey of College Students is a student self-report questionnaire that contains 25 multiple choice items (plus 20 optional items targeting specific schools). The questionnaire obtains data from students in eight areas: (1) satisfaction with college, (2) talent development during college, (3) involvement in the college experience, (4) college expectations and outcomes, (5) career changes, (6) changes in life goals, (7) attitudinal changes, and (8) retention.

Population Coverage

The universe for the 1988 follow-up study consisted of 500,000 college students who had completed the surveys as freshmen in the fall of 1984 and 1986. Of those sampled, 50,865 students responded to the follow-up survey: 24,454 from the 1984 cohort and 26,411 from the 1986 cohort.

Sampling

Students were sampled from each of the two cohorts of FTFT freshman who responded to the initial survey in the fall of 1984 and 1986. To maximize the representativeness of each cohort, sampling focused on obtaining approximately 175 respondents in each of the 23 stratification cells used in the freshman survey, with approximately equal numbers of men and women. Based on patterns of response obtained in previous follow-up surveys, a sample size that would be expected to yield the desired number of men and women respondents in each stratification cell for each cohort was computed. A sample of this size was then randomly selected from the population of freshman survey respondents included in the National Norms for 1984 and 1986. (Refer to the summary of the CIRP 1990 National Norms Study in this Appendix for a discussion of the freshman survey methodology.)

Data Collection Method

Follow-up questionnaires were mailed to students' home addresses in the summer of 1988. A second wave of questionnaires was sent to nonrespondents in the early fall. In addition, rosters of student names were sent to the CIRP institutional representatives requesting the following information on each student: degree earned (if any), number of years completed, admission test scores (SAT or ACT), and whether the student was still enrolled. These "registrar data" were used to correct for questionnaire nonresponse bias and to study retention.

Response Rate

Response rates to the registrar's survey approached 53% for the 1984 cohort and 57% for the 1986 cohort. Responses to the mailed questionnaires were substantially fewer: 26% and 28% for the 1984 and 1986 cohorts, respectively. (Refer to technical documentation, Tables A1 to A4, for response rates delineated by sex, race/ethnicity, norm group, selected freshman characteristics.)

Sample Weighting

Weighting was conducted to correct for the substantial rates of survey nonresponse. In the present sample, students who responded to the survey had higher high school grade point averages, higher overall SAT scores, and higher retention rates (i.e., completion of four years for the 1984 cohort and remaining enrolled for the 1986 cohort). Collectively, these differences indicate a bias among respondents toward students who were more "successful" in college, thereby producing relatively optimistic estimates of retention, academic performance, and satisfaction. To provide a more realistic account, the sample data were weighted to estimate how the nonrespondents would have answered the follow-up questions had they responded.

Three sources of information were used to adjust for nonresponse biases: (1) the CIRP freshman survey data, (2) the stratification cell of the student's institution, and (3) the registrar's data. The weighting procedures for the questionnaire data involved three stages. Final student weights were computed in the first two stages; the third stage produced adjustments for institutions.

In the first stage, a series of regression analyses was carried out to remove any biases reflected in either the CIRP freshman survey or the registrar's data. This procedure gave the greatest weight to those respondents who most resembled the nonrespondents in terms of CIRP freshman and registrar's data. In the second stage, the weights obtained from the first stage were adjusted to equal the number of questionnaires distributed within stratification cells. The product of the two weighting factors is the final weight for each student.

In the third stage, the weighted totals in each stratification cell were inflated to equal the total number of FTFT freshmen entering colleges in that cell in either 1984 or 1986. (Refer to technical documentation, Appendix A, for a complete description of these weighting procedures.)

Weights for the registrar's data were computed in a similar fashion, except that the first step was skipped.

Sampling Error

All findings presented are based on the weighted data. This approach should be taken into account when interpreting results, given the high rates of student nonresponse.

Nonsampling Error

Item nonresponse

The technical documentation does not address the issue of item nonresponse.

Other sources

One possible source of nonsampling error in the follow-up survey is the conversion of students' ACT scores to SAT equivalents, using an equipercentile method. Equipercentile equating involves determining which scores on two instruments have the same rank. This process engenders some equating error. For example, when the ACT mathematical subtest (ACT-M) score was converted to the SAT equivalent, the resulting correlation between the SAT-M (mathematical score) and converted ACT-M (mathematical score) was 0.85, not a perfect correlation (i.e., r=1.00). Refer to technical documentation, Appendix B, for the conversion table. Also refer to summary of the CIRP freshman survey in this technical appendix for a brief overview of other potential sources of nonsampling error.

Technical Document Reference

A.W. Astin, W.S. Korn, E.L. Dey, and S. Hurtado, *The American College Student, 1988 National Norms for 1984 and 1986 College Freshmen*, Higher Education Research Institute, University of California at Los Angeles, 1990.

Graduate Record Examination (GRE)

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Overview

The Graduate Record Examination (GRE), conducted by Educational Testing Service, is a standardized educational test required by many colleges and universities for admission of students into graduate studies. Two types of tests are offered: a General Test and Subject Tests in 16 disciplines. The General Test measures developed abilities, whereas the Subject Tests measure achievement in particular fields of study.

First offered in 1952, the GRE was "normed" on a reference group of college seniors at 11 undergraduate institutions. Test data from this initial group of examinees were used to establish a scale against which the performance of subsequent examinees is measured. Test results for the individual examinee are reported as numbers compared with the distribution of scores of all examinees. Thus, the scores are "norm referenced."

Because GRE scores are standardized, they permit comparison of performance. For this reason, graduate programs use GRE scores to select applicants as well as predict students' academic performance.

The GRE General Test yields separate scores for general verbal, quantitative, and analytic abilities related to success at the graduate level of education. The test consists of seven 30-minute sections and requires 3 hours and 30 minutes of testing time. Scores are based on the number of correct answer choices selected. General Test scores may range from 200 (low) to 800 (high).

GRE Subject Tests yield total scores, and some yield subscores that permit assessment of strengths and weaknesses and thus facilitate guidance and placement. Each test deals with knowledge of undergraduate-level subject matter required as preparation for graduate study in that field. Subject Test scores may range from 200 (low) to 990 (high).

Because the GRE is an educational test, not a survey, many of the categories below are not applicable.

Population Coverage

Between October 1, 1987, and September 30, 1990, 711,170 students took the GRE General Test, excluding those who were not U.S. citizens. (Refer to technical documentation, Table 5, for examinees delineated by race/ethnicity).

GRE examinee groups represent a self-selected sample of students who take the test in preparation for entrance into graduate studies. Not all college graduates or graduate school applicants take the GRE tests, and the students who do take them are not necessarily representative of all college graduates or of all graduate school applicants.

Sampling

Not applicable.

Data Collection Method

Tests are administered five times a year, in February, April, June (General Test only), October, and December. Students pay a fee to take all or parts of the test.

Response Rate

Not applicable.

Sample Weighting

Refer to technical documentation for a listing and discussion of weights applied to GRE composite scores to predict first-year graduate grade point average.

Sampling Error

Because the GRE is not a survey, the issue of sampling error deals with the sampling of items (from a content domain) rather than with the sampling of respondents (e.g., persons, institutions) from a population.

In Classical Test Theory, a person's test score is an **estimate** of the level of the person's knowledge or ability in the area tested. Theoretically, the test contains only a sample of items drawn from a potentially infinite domain of all possible items measuring that particular knowledge or ability. If it were possible for each person to take all possible forms of a test, the average score over those forms would be a completely accurate measure of the person's knowledge or ability in the area that the test measures—a "true score."

In this context, the standard error of measurement provides the means for estimating the average difference (root mean square) between the observed and the "true" test scores of a large group of examinees. (Refer to technical documentation, Table 7, for a listing of the standard errors of measurement both for single scores and for differences between scores.)

Nonsampling Error

Item nonresponse

Not applicable.

Other sources

Refer to technical documentation for a thorough description of the test development process.

Technical Document Reference

Educational Testing Service, *GRE 1991–92 Guide to the Use of the Graduate Record Examinations Program*, 1991.

Higher Education Survey (HES), "The Survey of Science, Mathematics, Engineering, and Technology in Two-Year and Community Colleges," 1990

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Overview

The Higher Education Survey (HES) was conducted by Westat, Inc., and sponsored by the National Science Foundation (NSF), the U.S. Department of Education, and the National Endowment for the Humanities. The survey was established to obtain information from higher education institutions on topics of interest to Federal policymakers and the educational community.

HES collects data on the following aspects of science, mathematics, engineering, and technology programs in two-year and community colleges: prevalence of course and program offerings, number and education of faculty, use of part-time faculty, teaching loads of faculty, and Division heads' perceptions of difficulties in hiring faculty, identification of problems, and evaluation of programs.

HES 1990 comprised 11 multipart items divided among three sections: Type of Program and Course Offerings (Section A), Faculty (Section B), and Problems and Evaluation (Section C).

Population Coverage

The HES universe consisted of 1,093 institutions representative of the 3,212 colleges and universities in the United States. For the portion of the survey on two-year and community colleges, HES studied a sample of 336 two-year and community colleges. Of these, 13 two-year institutions had no science, mathematics, or technology courses and were considered out-of-scope for the study.

Sampling

Institutions were sampled from a survey universe of approximately 1,093 institutions divided into two nationally representative subsamples. Institutions were stratified by control (private versus public), enrollment (less than 1,500; 1,500 to 5,999; and 6,000 or more), and region (northeast, central, southeast, and west).

Data Collection Method

The HES system maintains a panel of 1,093 institutions divided into two subsamples, each of which is nationally representative of the 3,212 colleges and universities in the United States. Each institution in the panel has identified an HES campus representative who serves as the survey coordinator. The campus representative facilitates data collection by identifying the appropriate respondents for each survey and distributing the questionnaire to those persons.

Questionnaires were mailed in January of 1989 to the HES coordinators with instructions that each part of the survey be answered by persons from the appropriate science, mathematics, and engineering and technology divisions. Telephone follow-up data collection was continued until April.

Response Rate

The final sample consisted of 295 institutions, yielding a 91% response rate for eligible institutions. Refer to technical documentation, Table A-1, for a delineation of the sample by institutional characteristics.

Sample Weighting

Data were weighted to produce national estimates. The sample was selected with probabilities proportionate to the square root of enrollment. Institutions with larger enrollments had higher probabilities of inclusion and lower weights.

The initial sampling weight assigned to schools for estimation purposes was equal to the reciprocal of the overall probability of selecting the school for the sample. Within a stratum, the initial weight was computed as the ratio of the number of schools in the population in the stratum to the number of schools sampled from that stratum. To obtain the final weight, the initial weight was multiplied by a school nonresponse-adjustment factor equal to the total number of sampled (and eligible) schools in the stratum divided by the number of responding (and eligible) schools in that stratum. The effect of this adjustment was to increase the initial weights by approximately 9%.

Sampling Error

Refer to technical documentation, Table B-2, for a listing of standard errors and confidence intervals for selected questionnaire items.

Nonsampling Error

Item nonresponse

The item response rate was 97% or higher for all variables with the exception of Question 4, which asked for the highest degree earned of full- and part-time faculty in each of the specific subject areas. Responses for Question 4 ranged from 93 to 99%.

Other sources

Steps were taken to minimize nonsampling errors due to differential interpretation of items. The questionnaire was pretested with respondents similar to those who completed the survey, and the questionnaire and instructions were reviewed by NSF. Manual and machine editing of the questionnaires was conducted to check data for accuracy and consistency. Telephone calls were made to clarify cases with missing or inconsistent items; data were rekeyed with 100% verification.

Technical Document Reference

M. Cahalan, E. Farris, and P. White, *Science, Mathematics, Engineering, and Technology in Two-Year and Community Colleges* (Higher Education Survey Report No. 9), The National Science Foundation, 1990.

The Integrated Postsecondary Education Data System (IPEDS) 1986 to 1989 Completions Survey

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Overview

The Integrated Postsecondary Education Data System (IPEDS) was first administered in 1986 as a supplement to and replacement for its predecessor, the Higher Education General Information Survey (HEGIS). Begun in 1966, HEGIS was an annual universe survey of institutions listed in the current *NCES Education Directory, Colleges and Universities*.

IPEDS consists of several integrated components that obtain information on types of postsecondary institutions, student participants, programs offered and completed, and the human and financial resources involved in the delivery of postsecondary education. The IPEDS Completions Survey replaces and extends the HEGIS Degrees and Other Formal Awards Conferred Survey.

The IPEDS Completions Survey contains two parallel forms designated C1 and C2, which are administered to a census of institutions offering degrees at the bachelor's level and above (C1 survey) and all two-year institutions (C2 survey). For less than two-year institutions, an abbreviated survey, CN, is used. A subset of common items (Part A) serves as the anchor across all three forms.

Population Coverage

Census

The higher education portion of IPEDS is a census of all accredited two- and four-year postsecondary educational institutions in the United States and its outlying areas. The survey universe consists of 5,804 institutions for the 1986–87 administration, 5,730 institutions for the 1987–88 administration, and 5,619 institutions for the 1988–89 administration. Institutions accredited by agencies other than those recognized by the Secretary, U.S. Department of Education, and/or institutions that are not accredited are not included in the survey universe.

A certain number of institutions move in and out of the universe as their accreditation status changes from year to year. A biennial directory of postsecondary institutions links institutions across years to estimate institutional attrition and retention.

Sample

In addition to the census of four-, two-, and public less-than-two-year postsecondary institutions, a sample survey has previously been used to collect information from other technical and vocational institutions. The result is a nationally representative sample of private less-than-two-year schools. These include both private nonprofit and private for-profit institutions. Beginning with 1993, the sample will be dropped and the entire universe will be surveyed.

The survey sample of private less-than-two-year schools consists of 740, 873, and 907 institutions for the 1986–87, 1987–88, and 1988–89 administration periods, respectively.

Sampling

A nationally representative sample of private less-than-two-year institutions is drawn using an interval sampling technique after sorting the sampling frame by stratum, sector (private nonprofit and private for-profit), and ZIP code. The probability of selection is proportionate to the square root of enrollment (i.e., sample drawn proportionate to size).

Data Collection Method

The sampling unit for both the census and sample portions of the survey is the institution. Surveys are mailed to and returned by institutions on an annual basis. Follow-up of nonrespondent sample institutions is conducted using a computer-assisted telephone interviewing (CATI) system.

All data are derived from the self-reports of responding institutions based on information retained in their administrative records. Consequently, data verification is largely at the discretion of the reporting institution, particularly with regard to the reporting of student race/ethnicity categories and program classification. Data for institutions are checked for consistency with their prior year's responses.

Response Rate

An institution is defined as a respondent if it reports totals by award level and sex. The overall survey response rate is calculated as the ratio of the number of completed survey forms to the number of institutions remaining in the universe (after deletions of "out-of-scope" schools). Overall response rates are 76.5%, 74.3%, and 76.3% for the 1986–87, 1987–88, and 1988–89 years, respectively. Response rates for accredited institutions (the former HEGIS universe) are approximately 10–15% higher than the overall response rates.

Additionally, response rates are calculated for each institutional level: four-year, two-year, public less-than-two-year, and private less-than-two-year. Response ranges are 52.1% to 84.6%, 59.7% to 83.0%, and 71.1% to 82.2% for 1986–87, 1987–88, and 1988–89, respectively. In all cases, four-year institutions had the highest return rate. NCES cautions that some of the response rates by level of institution are below the NCES publication criteria for tabulations and data analysis and may not be nationally representative.

When a previously surveyed census institution fails to return the survey, data are imputed from its previous year's survey, when available.

Sample Weighting

Base weights are the inverse of the projected sampling probabilities. Sample weights for non-HEGIS responding institutions are obtained by adjusting the base weights to account for nonresponse by other institutions in the sector and stratum. HEGIS institutions, sampled with certainty, have sample weights of 1.00. Data for nonresponding HEGIS institutions are imputed. The weights of responding institutions are adjusted to reflect nonresponse.

National estimates may be obtained by multiplying the value for each institution by its respective sampling weight and then summing the weighted values across institutions. This procedure yields a weighted value that reflects not only that institution but also other like institutions not included in the sample.

Data Definition and Classification

IPEDS' classification of degrees by field of study conforms to the Federal Government's Classification of Instructional Programs (CIP) guidelines. Implemented in 1981, CIP replaced the earlier HEGIS taxonomy. CIP data collected in 1981 have been crosswalked to the HEGIS taxonomy to maximize data continuity.

The use of CIP codes affects data accuracy and comparability in two ways that may compromise the analysis of trends over time. First, each school is required to translate its institutional disciplinary taxonomy into CIP codes, but to date, there is no technical documentation to support the accuracy and uniformity (across institutions) in this process. Second, the CIP classification was revised in 1985 and again in 1991–92. IPEDS data have been crosswalked for the 1981 to 1985 time frame to facilitate comparisons with the previous HEGIS degree classification data and again for comparisons between the 1985 and 1991 revisions of CIP. Data reported for these previous years have already been crosswalked on the NCES data tapes for each survey year.

Sampling Error

Because IPEDS collects census data on all four-year, two-year, and public less-than-two-year postsecondary educational institutions, the issue of sampling error applies only to the sample of private less-than-two-year institutions.

Standard errors are estimated by a balanced repeated replication procedure, which takes into account both the complexities of the sampling design and the weighting of institutions. Standard errors and confidence intervals for the national completions estimates are reported in the NCES technical documentation for each survey year.

Nonsampling Error

Item nonresponse

Existing technical documentation does not delineate the number or percentage of nonresponses by item category. However, the technical documentation for the 1986–87 Completions Survey notes that the item nonresponse rate was "substantial" for the racial/ethnic category data. In general, adjustments to correct for nonresponse are made by replacing the missing response with the average response of the similar responding institution subgroup.

Other sources

In addition to item nonresponse, there are several other potential sources of nonsampling error that may compromise the reliability and comparability of the survey results. These factors are (1) definitional difficulties (i.e., the institution's classification of degrees by discipline may not correspond to the CIP codes used by IPEDS); (2) differential interpretation of survey items; (3) errors by institutions providing data, both random and systematic; and (4) errors made in recording the data.

To date, no measure of the nonsampling error from such sources is available. However, results of the 1979 HEGIS Completions validation study identified the major sources of nonsampling error as differences between the NCES program taxonomy and taxonomies used by the institutions, classification of double majors and double degrees, operational problems, and survey timing. Collectively, these nonsampling sources contributed to an error rate of 0.3 percent overreporting of bachelor's degrees and 1.3 percent overreporting of master's degrees. These differences varied greatly among fields. Fields that had large differences were business and management, education, engineering, letters, and psychology.

Technical Document Reference

Unpublished technical documents for the 1986–87, 1987–88, and 1988–89 survey years are available from NCES upon request.

National Center for Education Statistics, *Race/Ethnicity Trends in Degrees Conferred by Institution of Higher Education: 1980–81 Through 1989–90* (NCES 92-039), Office of Educational Research and Improvement, U.S. Department of Education, 1992.

583

IPEDS 1986 and 1988 Fall Enrollment Survey

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Overview

The Integrated Postsecondary Education Data System (IPEDS) was first administered in 1986 by the National Center for Education Statistics (NCES) as a supplement to and replacement for its predecessor, the Higher Education General Information Survey (HEGIS). Begun in 1966, HEGIS was an annual universe survey of institutions listed in the current *NCES Education Directory, Colleges and Universities*.

IPEDS consists of several integrated components that obtain information on types of postsecondary institutions, student participants, programs offered and completed, and the human and financial resources involved in the delivery of postsecondary education.

The IPEDS Fall Enrollment Survey replaces and extends the previous HEGIS "Fall Enrollment and Compliance Report of Institutions of Higher Education."

The IPEDS Fall Enrollment Survey has two versions designated EF1 and EF2, which are administered to a census of accredited institutions offering degrees at the bachelor's level and above (EF1 survey) and all two-year institutions (EF2 survey). A third survey, designated CN, includes unaccredited institutions, with data matching the EF2 questionnaire.

The scope of data collected by each of the survey forms varies by level of institution, with four-year institutions reporting the most detailed data and less-than-two-year institutions reporting the least. Specifically—

- *EF2 (two-year institutions):* Enrollment data are requested by race and sex for both full- and part-time students and degree-seeking versus non-degree-seeking categories.
- *EF1 (four-year institutions):* In addition to the detail requested from two-year schools, four-year schools are requested to further delineate enrollments by degree level (undergraduate, graduate, and first-professional). In even-numbered years, enrollment data are collected for 10 selected fields of study for the Office of Civil Rights.

Population Coverage

Institutional Level

Census The census portion of the survey covers the universe of all accredited four-year, all accredited two-year, and all public less-than-two-year postsecondary educational institutions in the

United States and its outlying areas. For the 1986 and 1988 administrations, this universe consists of 5,901 and 4,256 institutions, respectively. Institutions accredited by agencies other than those recognized by .he Secretary, U.S. Department of Education. and/or by institutions that are not accredited are not included in the universe.

A certain number of institutions move in and out of the universe as their accreditation status changes from year to year. A directory of postsecondary institutions provides the information needed to estimate institutional attrition and retention.

Sample In addition to the census portion of postsecondary institutions, a sample survey collects data from a nationally representative sample of private less-than-two-year schools. The sample includes both private nonprofit and private for-profit institutions. For the 1986 and 1988 administrations, the survey sample consists of 1,001 and 755 private less-than-two-year schools, respectively. Beginning in 1993, IPEDS is being expanded to request data from all institutions, and the sample will be dropped.

Student Level

At the level of the individual student enrollment, IPEDS includes the following categories of students: students enrolled in courses creditable toward a degree or other formal award; students enrolled in courses that are part of a vocational or occupational program, including those enrolled in off-campus centers; and high school students enrolled in regular college courses for credit. This classification excludes students enrolled exclusively in courses not creditable toward a formal award or vocational program, students exclusively auditing classes, and students studying at a foreign university and/or any foreign branch campus.

Sampling

A nationally representative sample of private less-than-two-year institutions is drawn using an interval sampling technique after sorting the sampling frame by stratum, sector (private nonprofit and private for-profit), and ZIP code. The sample is drawn proportionate to size, with size defined as the square root of total enrollment.

Data Collection Method

Data for both the census and sample portions of the survey are obtained from the participating institutions. Surveys are mailed to and returned by institutions on an annual basis.

Data from the sampled private less-than-two-year schools are primarily collected using a computer-assisted telephone interviewing (CATI) system. These sample data are collected for total enrollment only, by race/ethnicity and sex of student. Some schools provide total enrollment by sex but not by race/ethnicity. Follow-up of nonrespondent sample institutions is conducted by telephone and letter.

All data are derived from the self-reports of responding institutions, based on information retained in their administrative records. Consequently, data verification depends largely on reporting institution, particularly with regard to the reporting of student race/ethnicity categories and program classification. Data for institutions are checked for consistency with their prior year's responses.

Response Rate

The overall survey response rate is calculated as the ratio of the number of completed survey forms to the number of institutions remaining in the universe (after deletions of "out-of-scope" schools). Overall response rates are 78.7% and 74.3% for 1986 and 1988, respectively. Response rates for accredited institutions (the former HEGIS universe) are approximately 10-15 percent higher than the overall response rates. Additionally, response rates are calculated for each institutional level: four-year; two-year; public less-than-two-year; and private less-than-two-year. These are listed below:

Institution type	Survey year	
	1986	1988
4-Year	81.2%	82.7%
2-Year	76.9%	68.2%
Less-than-2-Year Public	70.7%	58.4%
Less-than-2-Year Private (Sample)	81.1%	74.8%

An institution is considered to be a respondent if it supplies total enrollment data by sex. When a previously surveyed census institution fails to respond, data are imputed from their previous survey year, when available. For nonrespondent institutions with no previous survey data, a "hot deck matching" procedure is used to impute values from responding institutions that match the nonrespondent with regard to sector (public, private nonprofit, or private for-profit) and enrollment size.

Sample Weighting

For the sample of the private less-than-two-year schools, base weights are the inverse of the projected sampling probabilities. For the nonresponding institutions, the sample weights are adjusted in lieu of imputations for nonresponse.

National estimates may be obtained by multiplying the value for each institution by its respective sampling weight and then summing the weighted values across institutions. This procedure yields a weighted value that characterizes not only that institution but also other like institutions not included in the sample.

Data Definition and Classification

Issues of data definition and classification refer to two data categories: major field of study and race/ethnicity.

Major Field of Study

Enrollments for four-year institutions are reported by 10 selected major fields of study taken directly from the Federal Government's Classification of Instructional Programs (CIP) guidelines.

They are architecture and environmental design, business and management, engineering, dentistry, medicine, veterinary medicine, law, life sciences, mathematics, and physical sciences. CIP, first used in 1981, replaced the earlier HEGIS taxonomy. CIP data collected in 1981 have been crosswalked to the HEGIS taxonomy to maximize data continuity.

The use of CIP codes affects data accuracy and comparability in two ways that may influence the analysis of trends over time. First, each school is required to translate its institutional disciplinary taxonomy into CIP codes, but, to date, there is no technical documentation to help institutions convert the disciplinary information accurately and uniformally.

Second, the CIP classification was revised in 1985 and again in 1991–92. IPEDS data have been crosswalked for the 1981 to 1985 time frame to facilitate comparisons with the previous HEGIS degree classification data and again for comparisons between the 1985 and 1991 revisions of CIP. Data reported for these previous years have already been crosswalked on the NCES data tapes for each survey year. A crosswalk between HEGIS and IPEDS Fall Enrollment data items is available from NCES upon request.

Race/Ethnicity

As of 1990, racial/ethnic data are collected annually rather than biennially. Moreover, a new category, "Race/Ethnicity Unknown," was added to the previous taxonomy. To allow for analysis of racial/ethnic enrollment trends, the race/ethnicity unknown data are distributed across all racial/ ethnic groups in proportion to the reported data, resulting in an increase in enrollment counts (with increases ranging from 239,000 for whites to 2,000 for American Indians/Alaskan natives).

Sampling Error

Because IPEDS collects census data on four-year, two-year, and public less-than-two-year postsecondary educational institutions, the issue of sampling error applies only to the sample of private less-than-two-year institutions.

Standard errors are estimated by a balanced, repeated replication procedure, which takes into account both the complexities of the sampling design and the weighting of institutions. Standard errors and confidence intervals for the national completions estimates are reported in the NCES technical documentation for each survey year.

Nonsampling Error

Item nonresponse

In general, imputations for item nonresponse are performed for census institutions that provide only a partial response. The existing technical documentation does not delineate nonresponses by item category. However, the technical documentation for the 1986 Fall Enrollment Survey reports that item nonresponse rate was "substantial" for the enrollment figures for racial/ethnic category data. Elsewhere, it is reported that less than 1% of total enrollment was affected by imputation strategies used in 1986 through 1990 to adjust for missing and incomplete racial/ethnic data.

For responding institutions with incomplete or missing racial/ethnic data, imputation involves a two-stage process. In the first stage, differences between reported totals and racial/ethnic details are rectified by distributing the differences in direct proportion to the reported distributions by sex for each institution. In the second stage, the remaining unknowns are eliminated by accumulating the reported racial/ethnic total enrollments by state, level, control, and gender; calculating the percentage distributions; and applying these percentages to the reported total enrollments of institutional respondents (in the same state, level, and control) who did not supply race/ethnicity data.

Other sources

In addition to item nonresponse, there are several other potential sources of nonsampling error that may compromise the reliability and comparability of the survey results. These include—

(1) Interpretative problems for some data elements, particularly with regard to degree status and remedial course enrollment data elements. Specifically, some institutions cannot reliably report whether a student has enrolled to obtain a degree. This deficiency may lead to an overcounting of students in the non-degree-seeking and/or "unclassified" categories. Similarly, although the information on remedial enrollment is meant to reflect those students who are enrolled exclusively in remedial courses, it may double count students who are enrolled in one or more such courses, potentially leading to an inflated count of remedial-level enrollments.

(2) Definitional difficulties concern potential discrepancies between the institution's classification of degrees by discipline and the 10 selected CIP codes designating major field of study. However, because enrollment data by field of study are requested from four-year institutions only, this is not an issue for the survey universe as a whole.

Other potential sources of nonsampling error are—

(3) Differential interpretation of survey items.

(4) Errors by institutions providing data, both random and systematic.

(5) Errors made in recording the data. To date, no measure of the nonsampling error from such sources is available.

Technical Document Reference

Unpublished technical documents for the 1986 and 1988 survey years are available from NCES upon request.

National Center for Education Statistics, *Trends in Racial/Ethnic Enrollment in Higher Education: Fall 1980 through Fall 1990* (NCES 92-024), Office of Educational Research and Improvement, U.S. Department of Education, 1992.

The National Postsecondary Student Aid Study (NPSAS), "Undergraduate Financing of Postsecondary Education," 1986–87

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Overview

The National Postsecondary Student Aid Study (NPSAS) was established by the U.S. Department of Education to address critical questions concerning financial aid allocated to students enrolled in U.S. postsecondary institutions. NPSAS was first administered in the fail of the 1986–87 academic year after a national field test in 1985–86.

The NPSAS is a 99-item student survey. Items obtain information on students' enrollment characteristics, financial aid status, cost of college attendance, and demographic and socioeconomic characteristics.

Population Coverage

The full-scale study involved 59,886 students selected from 1,074 postsecondary institutions. At the institutional level, this population coverage excluded correspondence schools, schools that do not serve postsecondary students, U.S. service schools, and schools whose postsecondary program(s) lasted three months or less.

Students were sampled from a universe of all students enrolled in for-credit courses either in a degree or formal award program or in a vocational or occupation-specific program. The sample included both part- and full-time students and aided and nonaided students but excluded students also enrolled in a high school program.

Sampling

The sampling plan for the NPSAS involved a three-stage process—area sampling, institutional sampling, and student sampling—that clustered units at two of the sampling stages, stratified sampling units at each stage, and assigned differential selection probabilities for students at different levels.

Area Sampling

The primary sampling unit was the cluster, defined as a three-digit ZIP code area with a minimum of seven postsecondary institutions and a total enrollment of at least 1,000 students. Clusters were formed from 162 postsecondary institutions sampled with certainty from the former Higher

583

Education General Information Survey (HEGIS) universe of all U.S. accredited four-year postsecondary institutions as well as from additional postsecondary institutions whose students were eligible for Pell grants.

A total of 361 clusters was formed. The first step in sampling the clusters was to select the largest clusters with certainty. Each cluster was assigned a measure of size based on the total number of students and the number of students in each institutional type. A function of these numbers was used as the measure of size for each cluster to ensure adequate representation of smaller specialized institutions. Fifty clusters were large enough to be sampled with certainty because their total enrollments exceeded one-half of the sampling interval.

Next, 35 strata were formed of approximately equal size, where size was the sum of the measures of the size of all the clusters in the stratum. Within each stratum, clusters were sorted by state and, within state, by size. Two clusters were sampled from each stratum, with the probability of selection for each cluster proportionate to its size. The final sample of 120 clusters consisted of 50 clusters selected with certainty and 70 clusters selected with probability proportional to their measure of size.

Institutional Sampling

The institutional sampling frame consisted of 7,814 schools comprising all identified postsecondary institutions in the selected clusters. Institutions were classified into 11 strata for sample selection. Ten strata were based upon institutional control (public, private not-for-profit, and private for-profit) and type, defined as highest degree awarded (doctoral, four-year, two-year, less than two-year). The eleventh stratum comprised institutions whose students were ineligible for Pell grants, regardless of the type or control of the institution. If a total enrollment figure was not available, it was imputed from that of a similar institution, based on type and control.

If the size of an institution in a stratum exceeded the sampling interval for that stratum, then the institution was selected with certainty. A total of 346 institutions was sampled with certainty at this stage. The remaining 7,450 institutions were sorted by cluster and size and then sampled with probability proportionate to size within a stratum.

The initial sample of 1,310 institutions consisted of 162 first-stage certainty institutions, 346 second-stage certainty institutions, and 802 second-stage noncertainty institutions. These were contacted by telephone to verify the level, control, and enrollment that had been used in sample selection and to solicit participation in the study. Of those contacted, about 21% were reclassified on the basis of the two design variables—type and/or control—and an additional 13% were discarded because they did not meet the criteria for inclusion.

The final sample of institutions included a special supplemental sample for New York State, drawn from a sampling frame of schools provided by the New York State Department of Higher Education.

Student Sampling

Within each participating institution, students were identified from fall 1986 enrollment lists, stratified by level (undergraduate, graduate, and first professional) and systematically sampled. Differential sampling rates were prespecified and applied to each student level. Sampling rates for graduate and first professional students were three to seven times the rate for undergraduates.

When lists did not contain information on student grade level, all students were sampled at the undergraduate rate for that school.

The initial student sample selection process yielded approximately 55,500 students: 47,000 undergraduate, 6,500 graduate, and 2,000 first professional students. To bolster the first professional sample and thus the reliability of the sample estimate, additional first professional students were sampled. This process identified 2,280 additional first professional students. (Refer to technical documentation, Table B.2, for a breakdown of the student sample by institutional type and control.)

Data Collection Method

Institutional

Institutional records provided the following data for each sampled student: fall 1986 enrollment, registration, and financial aid status. All data were collected on site by trained NPSAS data collectors, using a standard data collection form.

The level of available administrative data varied by institution and, within institution, by student. The proportion of missing data on registration record items ranged from 1.2% for credit- or contact-hour enrollment to 46% for high school completion information.

Of the students sampled, 33,000 (55%) had a financial aid record for fall 1986. Financial aid records were reviewed for the student's aid status, type, source, amount of aid awarded as of fall 1986, length of award (number of months each aid award covered), and family financial status, if applicable.

To compensate for the time lapse between designation of eligibility for an award and specification of an award amount, fall financial award data were updated in the summer of 1987 at the end of the 1986–87 federal financial aid program fiscal year. Updating of financial aid records affected approximately 37% of the original forms.

Student

Questionnaires were mailed to each of the 59,886 students sampled. Nonrespondents received reminders by mail and eventually a second questionnaire at the end of the 1986–87 academic year. Students who did not respond to the mail follow-up were contacted for telephone interviews.

Response Rate

At the institutional level, the overall response rate was 92%, calculated as the number of participating schools divided by the number of eligible schools. Response rates delineated by institutional type and control ranged from 86% to 96%.

At the student level, the unweighted student response rate for the questionnaire mail-out was 71%, calculated as the number of students who responded divided by the total number of students in the sample.

Additionally, a weighted student response rate was calculated as the product of the institutional response rate and the student questionnaire response rate. The overall weighted response rate was 67%. This rate ranged from 49% to 69%, depending upon institutional type and control.

Sample Weighting

The production of student-level estimates was accomplished in steps. First, student-level estimates were obtained by using weights that reflected the probability of a student's selection. Additionally, a ratio adjustment was made based on information from the 1986–87 Integrated Postsecondary Education Data System (IPEDS) and the 1985–86 HEGIS.

Because students were selected in a multistage manner, the student weight was the product of the reciprocals of the probabilities of selection at each stage. The first nonresponse adjustment was related to the institutional-level nonresponse rate. A ratio adjustment technique was used to adjust for institutional-level nonresponse and to reduce the variance of the estimates for institutions that could be matched to the IPEDS/HEGIS universe. For non-IPEDS/HEGIS institutions, the inverse of the weighted response rate was used.

Second, student records were weighted by the product of the adjusted institution weight and the within-institution student weight. The within-institution student weight was the inverse of the probability of selection of the student within the institution.

For the student questionnaire, an additional nonresponse adjustment was needed to reflect the fact that only approximately 72% of students completed the form. The student questionnaire weight was the product of the record data weight and a student-level nonresponse adjustment. The student questionnaire nonresponse adjustment was the inverse of the weighted response rate. The student questionnaire weights were used to produce the national estimates of the number of students by their characteristics.

Sampling Error

The reliability of the sample estimates was assessed using a stratified, jackknife replicate approach. This procedure involved first calculating the coefficient of variation (CV) or the standard error of the estimate divided by the estimate. As such, the CV represents the variability of an estimate expressed as a percent of the estimate. While estimated CVs may be used to determine the standard error of the estimate, the technical documentation reports sampling error in CVs rather than standard errors. (Consult the existing technical documentation for CVs delineated by selected institutional and student characteristics.)

Nonsampling Error

Item nonresponse

Imputations for item nonresponse are delineated in the technical documentation by data element, when applicable, under the heading "Data Adjustments." However, imputations for item response were generally not necessary because of the multiple sources of data that were available for each student (i.e., both institutional records and students' survey responses). If institutions or students reported amounts in some categories but not others, a zero was imputed for the categories where no amounts were reported.

Other sources

Estimates of students who received aid and the distribution of aided students among different types of postsecondary institutions are based on postsecondary enrollment for the fall semester only and not for the entire academic year. As a result, some estimates may differ substantially from numbers in federal financial aid program reports, which represent data for the full school year. Refer to the technical documentation for comprehensive comparisons of NPSAS estimates with those derived from other national postsecondary data sources—IPEDS/HEGIS, Pell Program Data, and Guaranteed Student Loan Program Data.

Technical Document Reference

R. Korb, N. Schantz, P. Stowe, and L. Zimbler, *Undergraduate Financing of Postsecondary Education: A Report of the 1987 National Postsecondary Student Aid Study* (CS 88-239), U.S. Department of Education, 1988.

The National Survey of Postsecondary Faculty (NSOPF), "Profiles of Faculty in Higher Education Institutions," 1988

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Overview

The National Survey of Postsecondary Faculty (NSOPF) was cosponsored by the National Center for Education Statistics (NCES) and the National Endowment for the Humanities to provide reliable and current data for postsecondary faculty, education researchers, planners, and policymakers. The NSOPF, first conducted in the 1987–88 academic year, gathers information regarding the backgrounds, responsibilities, workloads, salaries, benefits, and attitudes of both full- and part-time faculty in postsecondary institutions. In addition, information is gathered from institutional- and departmental-level respondents on such issues as faculty composition and turnover. as well as recruitment, retention, and tenure policies.

The survey will be repeated in the 1992–93 academic year to allow assessment of changes over time in institutional policies and faculty characteristics, behaviors, and attitudes. At this time, the program will be renamed the National Study of Postsecondary Faculty.

The 1988 NSOPF contained three major components: (1) a survey of institutional-level respondents in a stratified random sample of 480 institutions; (2) a survey of a stratified random sample of 11,013 eligible faculty members within the participating institutions; and (3) a survey of a stratified random sample of 3,029 eligible department chairpersons (or their equivalent) within the participating institutions.

All data are derived from self-reports of responding institutions and institutional faculty and department chairpersons. Consequently, data verification depends largely on the respondents.

Population Coverage

Institutional Level

The survey universe consists of all nonproprietary U.S. postsecondary institutions that grant two-year (associate's) degrees or higher degrees and whose accreditation at the higher education level is recognized by the U.S. Department of Education. This includes religious, medical, and other specialized postsecondary institutions, as well as two- and four-year nonspecialized institutions. Based on the 1987 Integrated Postsecondary Education Data System (IPEDS), this universe contains a total of 3,159 institutions.

Faculty Level

Eligible faculty are those who had instructional duties related to for-credit courses given at the sample institution during the 1987 fall term. This definition excludes faculty on sabbatical as well as those teaching courses slated for the spring semester (but not the fall).

In the case of faculty whose eligibility status was unknown, eligibility was estimated by applying the percentage of eligible "known" respondents to that of the "unknowns." This estimation procedure, which assumes that all who refused or could not be located were eligible for inclusion, resulted in an estimated total of 11,071 eligible sample members.

Sampling

The institutional sample was divided into 12 primary strata based on level of degree offered, emphasis placed on research, and control (public versus private). Within each stratum, institutions were ordered on the basis of size—defined as approximate number of faculty—and divided into substrata. The strata were then randomly selected.

Sampling procedures for faculty varied by institutional level, beginning with selection from the institution lists. For four-year institutions, faculty were stratified by employment status (full- versus part-time) and program area. Sampling fractions varied as a function of the program area, employment status, and the number of faculty in the institution. Full-time faculty were sampled at a higher rate than part-time faculty, and larger sampling fractions were used in smaller, as opposed to larger, schools.

For two-year, religious, medical, and other specialized institutions, faculty were stratified by employment status only. Again, full-time faculty were sampled at a higher rate than part-time faculty. Faculty from these schools can be poststratified into fields of study (which can in turn be collapsed into program areas) based on their questionnaire responses.

Data Collection Method

The first stage of the data collection process involved obtaining each sampled institution's agreement to participate and, subsequently, their institutional lists of faculty and department chairpersons. A total of 449 (94%) of the 480 institutions sampled agreed to participate and sent lists of faculty and department chairpersons, as appropriate. Faculty were sampled from these lists.

Data collection procedures consisted of an initial mailing, three follow-up mailings, telephone reminder calls, and telephone calls to complete the questionnaire.

Response Rate

Questionnaire responses were obtained from 424 institutions (88%), 2,423 department chairpersons (80%), and 8,383 faculty members (76%). Response rates for faculty in four-year institutions are further delineated by type and control of institution and department program area. Response rates across program areas range from 67% to 80%; response rates across institution type and control range from 70% to 84%.

Sample Weighting

The probability of selecting a particular faculty member was a function of (1) the probability of selecting a given institution from the NSOPF-defined IPEDS universe, (2) the number of faculty on the faculty list provided by a participating institution, and (3) the sampling rate for faculty within a particular employment status (full- or part-time) and program area (in four-year colleges).

Weights for sampled faculty were calculated as the inverse of the probability of selection. In general, weights were adjusted for two levels of nonresponse: institutional nonresponse and individual faculty nonresponse. Sample weights sum to the total number of faculty in the NSOPF-defined IPEDS universe of institutions, as projected from the lists of total faculty provided by participating institutions.

Sampling Error

For each subsample comparison, standard errors were adjusted for the covariance between the subgroup and the total group. Refer to the technical documentation, Appendix B, for a listing of the standard errors for principal variables of interest—faculty age group, average number of hours worked, average faculty income, faculty distribution by sex, type, and control of institution, and faculty distribution by faculty type and type of institution.

There are some discrepancies between the faculty estimates projected on the basis of institutional lists and those estimated from the NSOPF institutional respondent survey. Although the scope of the discrepancy is not reported, it is noted that, for some institutions, the number of faculty on the lists "differed considerably" from the number of faculty reported in the actual survey.

Nonsampling Error

Item nonresponse

Imputations for item nonresponse involved supplying the missing response with the response of a randomly selected matched respondent. Criteria for matching respondents included employment status (full- versus part-time), tenure status, academic rank, sex, minority/nonminority status, program area, and institutional stratum. If no respondent was found who matched all of these characteristics, categories were progressively collapsed until a match was found.

Other sources

In addition to item nonresponse, other potential sources of nonsampling error include the institutions' inability to provide accurate information due to incomplete or out-of-date records, refusal to provide information, differences in interpreting the questions, respondent errors, and errors made in recording the data. To date, there are no estimates of nonsampling error for these data.

Technical Document Reference

C.H. Russell, J.S. Fairweather, and R.M. Hendrickson, *Profiles of Faculty in Higher Education Institutions, 1988* (NCES 91-389), Office of Educational Research and Improvement, U.S. Department of Education, 1991.

New Entrants Survey, 1990

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Overview

The New Entrants Survey, along with the Experienced Sample Survey and the Survey of Doctorate Recipients, constitutes the National Science Foundation Scientific and Technical Personnel Data System (STPDS). A major objective of STPDS is to develop national estimates and identify characteristics of the total population of scientists and engineers in the United States.

The New Entrants Survey provides national estimates of the recent bachelor's and master's degree recipients in science and/or engineering (S&E) fields who have newly entered the U.S. labor force. First conducted in 1974, the New Entrants Survey has been conducted nine additional times at approximately 2-year intervals. These 10 surveys have interviewed bachelor's and/or master's degree recipients in all 19 academic years between 1971 and 1989.

The purpose of the 1990 New Entrants Survey was to collect graduate school enrollment and labor force data on recent college graduates in S&E fields. The 1990 survey consisted of 35 items that obtained data on students' educational history, employment, and demographic characteristics.

Population Coverage

The survey provides a national sample of recent college graduates for two periods—those graduated between July 1, 1987, and June 30, 1988 (1988 graduating class), and those graduated between July 1, 1988, and June 30, 1989 (1989 graduating class). Data were also obtained on a third cohort of graduates: those graduating between July 1, 1984, and June 30, 1985.

Institutions were drawn from the Higher Education General Information Survey (HEGIS) and/or Integrated Postsecondary Education Data System (IPEDS) survey universe. Only those institutions with bachelor's and master's degree recipients in science-related and/or engineering fields of study were included in the 1990 New Entrants survey universe. This excludes all doctoral degree recipients and recipients of degrees in fields other than science or engineering. Finally, as in the previous survey years, underrepresented minorities (i.e., blacks and Hispanics) and foreign students were oversampled.

Sampling

The study employed a two-stage probability sample of graduates. In the first stage, 273 universities and colleges with graduates in the science and engineering fields were selected as the primary sampling unit (PSU). This sample included 179 institutions sampled with certainty and 94 noncertainty PSUs. The latter were sampled with probabilities proportional to measures of size.

In selecting the noncertainty PSUs, stratification was imposed by geographic region, public/private status, whether agricultural curricula were offered, and percent of engineering graduates. The noncertainty PSUs included a special stratum consisting of nine predominantly minority universities—six black and three Hispanic—that were selected with probabilities proportional to measures of size.

The second stage of sampling involved the selection of graduates within PSUs. The sampling frame consisted of lists of graduates supplied by the universities chosen in the first stage sample. The lists generally included data on degree received, major field of study, year of graduation, and mailing address. Within "Hispanic" PSUs, all students were oversampled by a factor of two.

Data Collection Method

Sampled institutions were contacted by mail and by telephone and asked to provide a list of graduates for all three academic years, to include date of graduation, degree, and major field of study for each graduate. Of the 273 institutions contacted, 260 (95%) returned lists that were sufficiently accurate and complete to use. (Refer to technical documentation for institutional response rates delineated by academic year and student degree level.)

Based on these lists, questionnaires were mailed to an initial sample of 39,545 graduates (including out-of-scope graduates). Four separate waves of questionnaires and/or reminder postcards were sent (as needed) to each sample member, followed by a computer-assisted telephone interview (CATI) for nonrespondents.

Response Rate

A total of 25,686 graduates was sampled from the 1988 and 1989 cohorts. Of these, 18,834 (73%) responded to the survey. Because they were found to be out of the survey scope, 2,028 respondents (11%) were eliminated from the sample. The final sample consisted of 16,806 graduates or approximately 65% of those originally sampled. (Refer to technical documentation for estimations of the weighted response rate.)

A total of 13,859 graduates was sampled from the 1985 cohort. Of these, 6,796 (49%) responded to the survey. (Refer to technical documentation for estimations of the weighted response rate.)

Sample Weighting

Weight adjustments were used to compensate for both institutional and individual nonresponse. The basic sampling weight was the inverse of the probability of selection. The basic sampling weight reflected the conferred degree and major field of study stratum in which the graduate was sampled. It also accounted for design features, such as the oversampling of blacks and Hispanics and the multiple chances for selection because of duplication.

The final weighting for the survey was based on the product of four weights: (1) the basic sampling weight, (2) the nonresponse weight adjustment for unreturned questionnaires, (3) the nonresponse weight for uncooperating schools (i.e., those that did not provide graduation lists), and (4) the weight adjustment using HEGIS/IPEDS data tape to produce ratio-type estimates of totals.

Sampling Error

Averages of the square roots of design effects were calculated separately for each combination of year of graduation/degree field/degree level and for 23 tabulation items. These averages were then employed in the production of generalized sampling errors. (Refer to technical docun :ntation. Table A-5.)

Nonsampling Error

Item nonresponse

The existing technical documentation does not provide information on item nonresponse.

Other sources

The existing technical documentation does not discuss sources of (or precautions taken against) nonsampling error. However, given that institutions were sampled from the HEGIS/IPEDS survey universe, it is assumed that many of the same error sources apply, most notably errors stemming from discrepancies between the Classification of Instructional Programs (CIP) codes and institutions' classification of programs.

Technical Document Reference

J. Tsapogas, *Characteristics of Recent Science and Engineering Graduates: 1990* (NSF 92-316), The National Science Foundation, 1992; and Institute for Survey Research, *Methodological Approach to the 1990 New Entrants Survey* (Contract No. SRS-87-19021), Division of Science Resource Studies, National Science Foundation, 1991.

579

Open Doors 1990–1991. Report on International Educational Exchange, The Annual Census of Foreign Students in the United States, Institute of International Education (IIE)

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Overview

Open Doors is an annual report resulting from the IIE's Annual Census of Foreign Students in the United States. The publication focuses on identifying trends and changes in foreign student flows to and from the United States in the context of student mobility worldwide. IIE was founded in 1919 to promote international peace and understanding through cultural and educational exchanges. At present, IIE is the largest and most active nonprofit organization in the field of international educational exchange.

The International Education Data Collection Committee was formed in the late 1970s to help individuals and institutions of higher education maintain and provide better data on educational exchanges. One major objective is advising and assisting IIE in the collection, analysis, and publication of data on international educational exchanges.

Data on foreign study worldwide are derived primarily from UNESCO's *Statistical Yearbook 1990.* Data on foreign students who come to study in the United States are derived from IIE's Annual Census of Foreign Students in the United States.

The Annual Census of Foreign Students in the United States requested campus officials to provide information on the total number of foreign students at their institutions and totals based on specific characteristics, such as world region, subregion, country of origin, field of study, academic level, full- and part-time status, and primary sources of financial support. In addition, the institutions reported on sex, marital status, and immigration status or visa type. Responding institutions were also asked to provide academic level breakdowns, if available.

Population Coverage

The 2,879 regionally accredited institutions of higher education in the United States made up the sample surveyed.

Sampling

Not applicable.

Data Collection Method

Data were obtained by IIE's research division through a survey conducted in fall 1990 and spring 1991 of campus officials in the 2,879 regionally accredited institutions of higher education in the United States.

Response Rate

Of the 2,879 institutions surveyed in 1990–91, 2,784 (97%) responded to the questionnaire. Since 1959, response rates have ranged from a low of 62% in 1974–75 to a high of nearly 100% in 1987–88. (Refer to Table 1.0 for a complete listing of response rates of the Annual Census of Foreign Students by each survey year from 1959–60 to 1990–91.)

Sample Weighting

Not applicable.

Sampling Error

Not applicable.

Nonsampling Error

Item nonresponse

Refer to technical documentation, Tables 1.1 and 1.2, for percentages of institutions reporting total foreign student numbers only (Step 1 responses), those reporting institutional data (Step 2 responses), and those reporting individual data (Step 3 responses).

Other sources

Additional sources of error are those that compromise the comparability of data across countries, most notably variations in the definition of "foreign student" from country to country. Some countries include permanent residents in their reports, while others do not. Major field of study codes may vary as well: IEE uses the Classification of Instructional Program (CIP) codes recognized by the National Center for Education Statistics (NCES), but the degree of conformity to this taxonomy may be expected to vary both within and across countries.

Technical Document Reference

Institute of International Education, *Open Doors 1990–1991: Report on International Educational Exchange*, 1991.

551

Science and Engineering Degrees: 1966 to 1990

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Overview

The bachelor's and master's degree data were obtained from universe institution surveys of the National Center for Education Statistics (NCES), U.S. Department of Education. Data on doctorates are from the Survey of Earned Doctorates, a universe survey of individual doctorate recipients that is sponsored by the National Science Foundation (NSF) plus four other Federal agencies and collected by the National Research Council.

The data in this report cover earned degrees conferred in the aggregate United States, which comprises the 50 states, District of Columbia, and outlying areas (American Samoa, the former Canal Zone, Northern Marianas Island, Puerto Rico, Guam, the Virgin Islands, and the Trust Territory of the Pacific Islands). Because of this broad coverage, the data may differ from numbers published by NCES, which relate only to the 50 states, the District of Columbia, and their field groupings. Degree data are compiled for a 12-month period, July through June of the following year. For convenience, degrees in a given July-through-June period are referred to by the year in which the period ended, e.g., 1990 means the 12-month period ending June 1990.

It is difficult to establish a completely consistent series of degree data over a long period of time because of changes in definitions, instructions, and field classifications, including the introduction of new specialties. The data for earlier years are presented as consistently as possible with the classifications used in the current Classification of Instructional Programs (CIP) taxonomy.

This publication focuses on degrees in science and engineering fields, and, where appropriate, the data have been reclassified according to NSF field categories. It should be noted that data on engineering technology degrees and degrees in the health/medical sciences are not included in the science and engineering totals here.

Survey of Earned Doctorates Awarded in the United States (SED), 1990

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Overview

The Survey of Earned Doctorates (SED) has collected basic statistics from the universe of doctoral recipients in the United States since the 1920s. Beginning in 1958, SED has been supported by five Federal agencies: the National Academy of Sciences/National Research Council, under contract to the National Science Foundation; U.S. Department of Education, The National Center for Education Statistics; the National Endowment for the Humanities; the Department of Agriculture; and the National Institutes of Health.

Administered annually, SED is designed to produce national-level data. The 1990 questionnaire contains 25 items that obtain information on sex, race/ethnicity, marital status, citizenship, disabilities, dependents, specialty field of doctorate, educational institutions attended, time spent in completion of doctorate, financial support, educational debt, postgraduation plans, and educational attainment of parents.

Population Coverage

The survey universe is a complete census of all regionally accredited universities in the United States and its territories that confer research doctorates. In 1990, there were 366 such institutions.

Within institutions, surveys are administered to all persons who have completed the requirements for a research doctorate—i.e., Ph.D., Ed.D., or D.Sc. The survey excludes persons who received nonresearch doctorates and first-professional degrees, such as the J.D. or M.D.

Sampling

Not applicable.

Data Collection Method

Survey forms are mailed to graduate school deans each May for distribution to individuals who will receive their doctorates between July 1 and June 30 of the next year. The data for a given year include the research doctorates awarded in the 12-month period ending on June 30 of that year. Data are collected, edited, and published by NAS.

583

Response Rate

Approximately 93% or more of the annual cohorts of doctoral recipients respond to the survey. Response rates are further delineated by science and/or engineering (S&E) field. In 1990, these varied from 91% to 97% across science and engineering fields. (Refer to technical documentation, Table E.)

Sample Weighting

Not applicable.

Sampling Error

Because the SED is a universe survey of all recipients of research doctorates, the issue of sampling error does not arise.

Nonsampling Error

A major source of nonsampling error relates to the classification of doctorates by field of specialization. When the results of the 1989 SED are compared with those from the Integrated Postsecondary Education Data System (IPEDS) Completions Survey (CS), there are some discrepancies in the number of doctorates by S&E field categories: earth/atmospheric/oceanographic sciences (740 reported in SED versus 559 reported in CS) and biological sciences (4,115 reported in SED versus 3,560 reported in CS).

For the earth/atmospheric/oceanographic science category, this difference stems primarily from the different field taxonomies used in the two surveys. The field taxonomy used in SED contains 20 specialties, while the taxonomy used in the IPEDS surveys contains only seven specialties.

Within the biological science category, differences in the numbers of S&E doctorates reported by the two surveys may be attributed, at least in part, to a design effect. Specifically, SED samples individuals, and CS samples universities. In CS, field of degree is provided by the university and reflects the institution's internal organization, such as department names. For example, 985 respondents to the 1989 SED classified their field as health science, while IPEDS institutions reported 1,385 doctorates in health science. It is likely that many of the degrees classified as health science fields in the CS survey are classified under biological science by SED respondents.

In general, major differences in the number of science and engineering doctorates reported by SED and CS occur when the field of study is interdisciplinary (e.g., biochemistry) or a new or growing field (e.g., immunology) or where the taxonomy is more specialized in one survey than in the other (e.g., earth/atmospheric/oceanographic sciences).

Item nonresponse

Rates of item nonresponse ranged from 0% (sex, state, institution) to 9% (baccalaureate field). (Refer to technical documentation, Table F.)

For nonrespondents, partial data on degree, field, and sex are obtained from commencement programs. No imputations are performed to adjust for missing data.

Other sources

The SED taxonomy of degree fields is based on the Federal Government taxonomy, Classification of Instructional Programs (CIP). CIP codes have been revised periodically (in 1985 and again in 1991–92) to reflect changes in degree programs. This NSF grouping may differ from the groupings used by other organizations to report SED results.

Technical Document Reference

S.T. Hill, *Science and Engineering Doctorates: 1960–90* (NSF 91-310). The National Science Foundation, 1991.

Survey of Graduate Science and Engineering Students and Postdoctorates (GSESP), Fall 1989

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Overview

The Survey of Graduate Science and Engineering Students and Postdoctorates (GSESP) has been conducted annually by the National Science Foundation (NSF) since 1975. GSESP provides national estimates of graduate enrollment and postdoctorate employment in all academic institutions in the United States that grant doctorate and/or master's degrees in science and engineering (S&E) fields.

NSF has collected data on graduate S&E enrollment and postdoctorates since 1966. From the fall of 1966 through the fall of 1971, data were collected from a limited number of doctorate-granting institutions through the NSF Graduate Traineeship Program, which requested data only on those S&E fields requested by NSF. Between 1972 and 1975, the survey scope was gradually expanded to include additional S&E fields as well as all institutions granting S&E degrees at either the master's or doctoral level. Because of this expansion of coverage, data obtained prior to 1975 are not strictly comparable with data obtained in 1975 and later.

The primary survey instrument was the Departmental or Program Data Sheet (NSF form 812). Additionally, each survey packet included (1) a flier explaining NSF's academic S&E surveys; (2) a List of Departments or Programs (NSF Form 811) generated individually for each institution surveyed, based on the departments known to exist in the previous survey cycle; (3) a crosswalk showing the National Center for Education Statistics (NCES) instructional program codes corresponding to each S&E field defined by NSF; (4) a flow chart for use by institutions using computerized records to compile their submissions; and (5) a postcard for the institutions to indicate changes in the coordinator's name, address, or telephone number.

Population Coverage

The survey universe is a complete census of all institutions in the United States with departments or programs offering courses of study at the postbaccalaureate level in any science and engineering field. Medical schools and other specialized institutions offering first-professional doctoral degrees in health-related fields are also included.

586

Within each institution, all science and engineering departments and programs are surveyed. The 1989 survey universe consisted of 728 responding departments and/or programs at 609 institutions, 334 of which grant doctoral degrees and 275 of which grant master's degrees.

During the fall 1988 survey cycle, the criteria for inclusion of departments in the survey universe were tightened: those departments that were not primarily oriented toward the granting of research degrees were no longer considered to fall within the definition of science and engineering. As a result, a number of departments—primarily those in the social sciences—that were primarily engaged in training teachers or practitioners rather than researchers were deleted from the database. This review process was continued during the fall 1989 survey cycle and expanded to ensure trend consistency for the entire 1975–89 period. Consequently, total enrollments and social science enrollments for all years were reduced. (Refer to technical documentation, Table I-9, for the net effect of adjustments over the years.)

Sampling

The primary sampling unit is the department. The survey is a complete census of all science and engineering departments in institutions that grant master's and doctoral degrees in the United States.

Data Collection Method

Survey packages were mailed to institutional coordinators by October 31, 1989. The acknowledgement postcard requested information on the sources of the data reported, whether they were maintained at a central location or collected from the individual departments and whether they were derived from a computerized database or hand tabulated. Of the 728 responding units surveyed, coordinators at 620 units, or 85% of respondents, provided this information.

Institutional coordinators were asked to review the departmental listing provided on Form 811 and to indicate any changes in their departmental structure. The revised 811s were returned to NSF and used as a checklist in tracking departmental responses. Form 812 was completed for each department, either centrally or at the department level, and returned for tabulation.

Response Rate

Of the 728 responding entities, 708 (97%) were able to provide at least partial data. The response rate was slightly higher at the doctoral level than at the master's level (99% versus 95%).

At the department level, 9,800 departments responded, representing 95% of the 10,318 departments surveyed. This total includes 8,908 departments, or 86.3% of the total, that provided complete responses and 891 departments, or 8.6%, for which partial imputation was necessary.

Over the years, response rates for the survey have ranged from a high of 98.6% in 1976 to a low of 82.8% in 1982. For a complete listing of response rates by year, refer to technical documentation, Table I-4. Imputation rates (for nonresponse) are also delineated by S&E area and enrollment status. (Refer to technical documentation, Tables I-5 through I-8.)

Sample Weighting

Sample weighting for nonresponding units affects the estimates of change. Although sample weighting procedures are not explicitly reported, a weighted average of all similar departments (based on the previous and current year) is used to arrive at a rate of change from one year to the next.

Sampling Error

Because the 1989 GSESP is a complete census survey, standard error is inapplicable.

Nonsampling Error

Item nonresponse

Imputations for item nonresponse generally use the nonrespondent institution's prior year data.

Other sources

A major source of potential nonsampling error involves changes over the years to the survey questionnaire. To allow for the analysis of trends, data for items not included in a given survey year have been interpolated from the previous year and the following year's responses. For example, the 1978 abbreviated survey form did not request any information on sex; figures in the trends tables represent estimates based on 1977 and 1979 data.

A second potential source of nonsampling error is the issue of correspondence between NSF discipline codes and the NCES Classification of Instructional Programs. Refer to technical documentation for a complete crosswalk between the two taxonomies.

Technical Document Reference

J.G. Huckenpohler, *Academic Science and Engineering: Graduate Enrollment and Support, Fall 1989* (NSF 90-324), The National Science Foundation, 1990; and J.G. Huckenpohler, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990* (NSF 91-320), The National Science Foundation, 1991.

Survey of Recent College Graduates (RCG), 1987

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Overview

The Survey of Recent College Graduates (RCG) is conducted under the auspices of the National Center for Education Statistics (NCES). The first RCG survey was conducted in 1976 in response to a congressional mandate; five subsequent surveys have been conducted (1978, 1981, 1985, 1987, and 1991). Only the 1987 survey (RCG–87) collected transcript data in addition to graduate questionnaire data.

All RCG surveys have involved college graduates one year after graduation. Traditionally, the survey has concentrated on graduates entering the teaching profession and, consequently, has oversampled from this subgroup. However, since 1985 the survey also serves as a source of information on college outcomes in general.

RCG-87 included two major components: (1) a graduate questionnaire survey and (2) a transcript survey. The first part consisted of a national questionnaire survey of a sample of some 20,000 persons who were awarded a bachelor's or master's degree between July 1, 1985, and June 30, 1986. The second component examined the postsecondary education transcripts of the bachelor's degree recipients who received the graduate questionnaire. Data are available in four areas: student, transcript, term, and course.

Population Coverage

RCG-87 obtained data from a nationally representative sample of college graduates from bachelor's degree-granting institutions. The initial institutional sample consisted of 400 institutions drawn from the 1983–84 Survey of Earned Degrees, HEGIS XIX universe. This universe comprised the 1,867 institutions that granted bachelor's or master's degrees between July 1, 1983, and June 30, 1984.

The sample for the transcript study consisted of all postsecondary transcripts of those bachelor's degree recipients in the graduate questionnaire sample. The target population for the RCG-87 graduate questionnaire survey consisted of some 22,000 graduates who received a bachelor's or master's degree from an American college or university between July 1, 1985, and June 30, 1986. Graduates were eligible for inclusion in the transcript survey if they were alive, noninstitutionalized, and residing in the United States during the week of April 27, 1987.

Sampling

The sample was selected with a two-stage cluster sample design, with institutions offering the degrees of interest as first-stage units and graduates of these institutions as the second-stage units.

Institutions

The institutional sample consisted of some 400 degree-granting institutions drawn from the 1983–84 Survey of Earned Degrees, HEGIS XIX. This sampling frame comprised the 1,867 institutions that granted bachelor's or master's degrees between July 1, 1983, and June 30, 1984. Institutions were stratified according to control (public or private) and program status (educational versus noneducational). The probability of an institution's selection was proportional to size, where size was defined as the number of bachelor's and master's degrees awarded.

Sampled institutions were contacted and asked to provide a list of their graduates sorted by major field of study. A total of 375 of the 396 eligible institutions (95%) participated in the survey by providing lists of their graduates during the time frame of July 1, 1983, to June 30, 1984.

Graduates

Based on the institutional lists, graduates were selected and stratified by six major fields of study. The sampling interval was adjusted to oversample five major fields of study (education, mathematics, computer science, physical science, and the humanities).

Simple random samples of graduates were selected from each defined stratum in an institution, provided that the overall subgroup size was sufficiently large to meet minimum precision requirements for analysis. To minimize design effects and still achieve the desired subgroup sample sizes, the overall selection probabilities assigned to graduates in the same subgroup were made equal whenever possible.

Prior to data collection from graduates, the sampling rate for graduates was adjusted to take into consideration institutional nonresponse.

Data Collection Method

Postcards were mailed to all sample members to inform them of the study, to obtain their current name and address, and to request permission to use their transcript. Transcripts were then requested from all eligible (i.e., bachelor's degree-granting) institutions as well as any previously attended institution (i.e., transfer institution) identified on the sample member's transcript.

Response Rate

Institutions

Of the initial 400 institutions identified, all but four were found to be within the sample frame. Of the 396 in-scope institutions, 375 (95%) provided lists of their graduates. Of these, 2 institutions were ineligible because they granted only master's degrees. Five institutions refused to provide transcripts, and 7 did not respond to the request. The final sample consisted of 361 bachelor's degree institutions. This constitutes 97% of the in-scope institutions and 91% of the original sample of institutions.

Students

Of the 19,827 bachelor's degree recipients in the sample, 1,002 were determined to be ineligible. Of the remaining 18,825 eligible sample members, 525 refused to release their transcripts, 500 attended an institution that refused to provide transcripts, and 823 were associated with institutions that did not respond to the request for transcripts. Transcripts were obtained for 16,977 graduates, an unweighted response rate of approximately 90%.

The response rate for transcripts from transfer institutions was 75%. The number of transcripts per graduate (i.e., degree-institution plus transfers) ranged from one to five. Forty percent of graduates had more than one transcript. (Refer to the technical documentation, Table 3, for exact counts.)

Sample Weighting

Sample weights for the transcript data were based upon the procedures to calculate weights for the graduate questionnaire survey, with the major difference occurring in the treatment of unit nonresponse. (Refer to technical documentation for details of the weighting procedure.) In general, sample weights for the graduate questionnaire survey were calculated as the inverse of the probabilities of selection at each stage of the design.

At the second stage, simple random samples of graduates were selected from each discipline stratum using sampling rates that would attain the desired stratum sample sizes and equalize the overall selection probabilities assigned to graduates in the same discipline stratum whenever possible. Thus, the desired sampling rate for graduates in a given discipline stratum was the probability of that institution's selection multiplied by the within-institution sampling rate applied to students in a given stratum at a given institution. The vast majority of graduates were selected with the desired sampling rates; adjusted sampling rates were used for exceptions. Additional weighting was conducted to further adjust for unit nonresponse.

Differential weighting of sample members occurred under two conditions: (1) disproportionate sample allocations to disciplines of interest and (2) differential nonresponse adjustments among the poststrata. Typically, unequal weights cause some increase in sampling errors by introducing a design effect into the error term. In RCG-87, this issue was addressed by implementing a "smoothing" adjustment procedure for disproportionally large or small weights so that they summed to the total of the untruncated weights.

Sampling Error

A Taylor approximation procedure was used to estimate the sampling standard errors. This procedure takes into account the complexities of the sample design at each level or stage, resulting in significantly larger sampling errors than those that would have been calculated using formulas based on the assumption of simple random sampling. For a listing of the standard errors, refer to the forthcoming NCES publication, "Recent College Graduate Transcript Study: Estimates of 1985–86 Bachelor's Degree Recipients' Course Taking Behavior."

Nonsampling Error

A possible source of nonsampling error may be the nonresponse bias produced by those graduates who refused to permit access to their transcripts. Moreover, the initial contact to graduates, via the postcard mailings, may have been biased toward less mobile sample members—because those who had few, if any, address changes were easier to trace.

Item nonresponse

Of the 16,977 sample members for whom transcript data were obtained, 85% had complete data (i.e., all transcripts requested were obtained). Counts of missing or "blank" data are available for selected variables. (Refer to technical documentation.) No imputations for item nonresponse were performed.

Other sources

The assumption is made that transcript data were accurate. Data entry errors were minimized by a data entry program that provided on-line screening for out-of-range values.

Technical Document Reference

The National Center for Education Statistics, *Recent College Graduate Transcript Study: Estimates of 1985–86 Bachelor's Degree Recipients' Course-taking Behavior*, U.S. Department of Education, in progress.

The United Nations Educational, Scientific, and Cultural Organization (UNESCO), *Statistical Yearbook 1991*

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Overview

Approximately 200 countries and territories reply to United Nations Educational, Scientific, and Cultural Organization (UNESCO) questionnaires. Each member state is requested to report periodically to the Organization on its laws, regulations, and statistics relating to its educational, scientific, and cultural life and activities in accordance with Article VIII of the constitution of UNESCO. Data are gathered mainly from official replies to UNESCO questionnaires and special surveys but also from official reports and publications, supplemented by information available to the Secretariat from other national and international sources.

A discussion of the construction of UNESCO surveys and data gathering procedures is beyond the scope of this summary.

Population Coverage

Data relate in general to territorial units within de facto boundaries, as of October 1990. Inclusion relies, in part, on the availability of official statistics relating to such territories.

Sampling

Not applicable.

Data Collection Method

The data on education presented in the *UNESCO Statistical Yearbook* are collected as part of the organization's ongoing program of collecting national-level aggregate data from all member states on population. economy, health, etc. Each year, a questionnaire sent to all member states is filled out by the government agencies in charge of gathering the national data in each state.

The data on foreign students were gathered from the questionnaire responses to the number of foreign students enrolled in the reporting country according to country of origin of the students. The 50 host countries reported in the UNESCO yearbook accounted for about 95% of all students studying outside their countries. Because this study is not a survey, many of the following categories do not apply.

Response Rate

Not applicable.

Sample Weighting

Not applicable.

Sampling Error

Not applicable.

Nonsampling Error

Item nonresponse

Refer to text.

Other sources

Other sources of nonsampling error vary by survey and/or data type. Errors typically concern the comparability of data across countries, such as variations in the definitions and/or classification of major variables. For example, countries differ on their definition and classification of "foreign student"; some include permanent residents in this category, whereas others do not.

Technical Document Reference

UNESCO, *Statistical Yearbook 1991.*

Acronyms and Abbreviations

AAAS American Association for the Advancement of Science

AAPT American Association of Physics Teachers

AAUW American Association of University Women

BICSE Board on International Comparative Studies in Education

CCSSO Council of Chief State School Officers

CIRP Cooperative Institutional Research Program

E.D. U.S. Department of Education

EHR Directorate for Education and Human Resources, National Science Foundation

ETS Educational Testing Service

FCCSET Federal Coordinating Council for Science. Engineering and Technology

FIMS First IEA International Mathematics Study

FISS First IEA International Science Study

FY Fiscal year

GRE Graduate Record Examination

HBCUs Historically black colleges and universities

HS&B High School and Beyond Study

IAEP International Assessment of Educational Progress

IEA International Association for the Evaluation of Educational Achievement

IIE Institute of International Education

LSAY Longitudinal Study of American Youth

MPR Management Planning Research Associates, Inc.

NAEP National Assessment of Educational Progress

NAS National Academy of Sciences

NCEE National Commission on Excellence in Education

NCES National Center for Education Statistics

NCTM National Council of Teachers of Mathematics

NEA National Education Association

NELS National Education Longitudinal Study

NLS National Longitudinal Study

NRC National Research Council

NSF National Science Foundation

NSOPF National Survey of Postsecondary Faculty

NSSME National Survey of Science and Mathematics Education

NSTA National Science Teachers Association

OECD Organization for Economic Co-operation and Development

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

OSTP Office of Science and Technology Policy

OTA Office of Technology Assessment

OTL Opportunity to learn

RCG Survey of Recent College Graduates

RED Division of Research, Evaluation and Dissemination, NSF

S&E Science, mathematics, and engineering

SASS Schools and Staffing Survey

SAT Scholastic Aptitude Test

SES Socioeconomic status

SIMS Second IEA International Mathematics Study

SISS Second IEA International Science Study

SRS Division of Science Resources Studies, NSF

SS&C Project on Scope, Sequence, and Coordination

UNESCO United Nations Educational, Scientific, and Cultural Organization

Index

Page locators followed by "n" or a subscript numeral indicate footnotes; tables. figures, and appendixes are excluded from index filing.

A

B

C

D

E

509

I

J

L

M

N

O

P

R

S

T

U

W

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608