REPORT of the 1993 National Survey of Science and Mathematics Education

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Chapter One
Introduction

A. Background and Purpose of the Study

In 1993, the National Science Foundation supported the third in a series of surveys through a grant to Horizon Research, Inc. (HRI). The first survey was conducted in 1977 as part of a major assessment of science and mathematics education consisting of a comprehensive review of the literature; case studies of 11 districts throughout the United States; and a national survey of teachers, principals, district, and state personnel. A second survey of teachers and principals was conducted in 1985–86 to identify trends since 1977.

The 1993 National Survey of Science and Mathematics Education was designed to provide up-to-date information and to identify trends in the areas of teacher background and experience, curriculum and instruction, and the availability and use of instructional resources. A total of 6,120 science and mathematics teachers from 1,252 schools across the United States were selected for this survey. Among the questions addressed by the survey:

- How well prepared are science and mathematics teachers in terms of both content and pedagogy?

- To what extent do teachers support reform notions embodied in the *National Council of Teachers of Mathematics' Standards* and the *National Science Education Standards*?

- What are teachers trying to accomplish in their science and mathematics instruction, and what activities do they use to meet these objectives?

- What are the barriers to effective and equitable science and mathematics education?

The design and implementation of the 1993 National Survey of Science and Mathematics Education involved developing a sampling strategy and selecting samples of schools and teachers; developing and field testing survey instruments; collecting data from sample members; and preparing data files and analyzing the data. These activities are described in the following sections. The final section of this chapter outlines the contents of the remainder of the report.

B. Sample Design and Sampling Error Considerations

The 1993 National Survey of Science and Mathematics Education is based on a national probability sample of science and mathematics program heads and teachers in grades 1–12 in the 50 states and the District of Columbia. The sample was designed to allow national estimates of science and mathematics course offerings and enrollment; teacher background preparation; textbook usage; instructional techniques; and availability and use of science and mathematics facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being drawn into the sample.

The sample design involved clustering and stratification prior to sample selection. The first stage units consisted of elementary and secondary schools. Science and mathematics teachers constituted the second stage units. The target sample sizes were 1,250 schools and 6,000 teachers, large enough to allow sub-domain estimates such as for particular regions or types of community.

The sampling frame for the school sample was constructed from the Quality Education Data, Inc. database, which includes school name and address and information about the school needed for stratification and sample selection. The sampling frame for the teacher sample was constructed from lists provided by sample schools, identifying current teachers and the specific science and mathematics subjects they were teaching in the spring of 1993.

Since biology is by far the most common science course at the high school level, selecting a random sample of science teachers would result in a much larger number of biology teachers than chemistry or physics teachers. Similarly, random selection of mathematics teachers might result in a smaller than desired sample of teachers of advanced mathematics courses. In order to ensure that the sample would include a sufficient number of advanced science and mathematics teachers for separate analyses, information on teaching assignments was used to create separate domains, e.g., for teachers of chemistry and physics, and sampling rates were adjusted by domain.

The study design included obtaining in-depth information from each teacher about curriculum and instruction in a single, randomly selected class. Most elementary teachers were reported by their principals to teach in self-contained classrooms, i.e. they are responsible for teaching all academic subjects to a single group of students. Each such sample teacher was randomly assigned to one of two groups—science or mathematics—and received a questionnaire specific to that subject. Most secondary teachers in the sample taught several classes of a single subject; some taught both science and mathematics. For each such teacher, one class was randomly selected. For example, a teacher who taught two classes of science and three classes of mathematics each day might have been asked to answer questions about his first or second science class or his first, second, or third mathematics class of the day.

Whenever a sample is anything other than a simple random sample of a population, the results must be weighted to take the sample design into account. In the 1993 Survey, the weight for each respondent was calculated as the inverse of the probability of selecting the individual into the sample multiplied by a non-response adjustment factor.[1] In the case of data about a randomly selected class, the teacher weight was adjusted to reflect the number of classes taught, and therefore, the probability of a particular class being selected. Detailed information about the sample design, weighting procedures, and non-response adjustments used in the 1993 National Survey of Science and Mathematics Education is included in Appendix A.

The results of any survey based on a sample of a population (rather than on the entire population) are subject to sampling variability. The sampling error (or standard error) provides a measure of the range within which a sample estimate can be expected to fall a certain proportion of the time. For example, it may be estimated that 9 percent of all grade 1–4 mathematics lessons involve the use of computers. If it is determined that the sampling error for this estimate was 1 percent, then according to the Central Limit Theorem, 95 percent of all possible samples of that same size selected in the same way would yield calculator usage estimates between 7 percent and 11 percent (that is, 9 percent ± 2 standard error units).

The decision to obtain information from a sample rather than from the entire population is made in the interest of reducing costs, both in terms of money and the burden on the population to be surveyed. The particular sample design chosen is the one which is expected to yield the most accurate information for the least cost. It is important to realize that, other things being equal, estimates based on small sample sizes are subject to larger standard errors than those based on large samples. Also, for the same sample design and sample size, the closer a percentage is to zero or 100, the smaller the standard error. The standard errors for the estimates presented in this report are included in parentheses in the tables. The narrative sections of the report generally point out only those differences which are substantial as well as statistically significant as the .05 level or beyond.

C. Instrument Development

Since a primary purpose of the 1993 National Survey of Science and Mathematics Education was to identify trends in science and mathematics education, the process of developing survey instruments began with the questionnaires that had been used in the earlier national surveys, in 1977 and 1985–86. The project Advisory Panel, comprised of experienced researchers in science and mathematics education, reviewed these questionnaires and made recommendations about retaining or deleting particular items. Additional items needed to provide important information about the current status of science and mathematics education were also considered.

Preliminary drafts of the questionnaires were sent to a number of professional organizations for review; these included the American Association for the Advancement of Science, the National Science Teachers Association, the National Council of Teachers of Mathematics, the

[1] The aim of non-response adjustments is to reduce possible bias by distributing the non-respondent weights among the respondents expected to be most similar to these non-respondents. In this study, adjustment was made by region and by urbanicity of the school.

National Education Association, the American Federation of Teachers, and the National Catholic Education Association.

The Education Information Advisory Committee (EIAC) also played an important role in the instrument development process. This committee was established by the Council of Chief State School Officers to reduce the burden of data collection efforts on local education agencies; most state commissioners of education will not approve a survey unless it is first endorsed by EIAC. Horizon Research, Inc. worked with members of the EIAC committee throughout the planning stages of this project to make sure that the disruption to school activities and the burden on schools and teachers would be kept to a minimum. EIAC officially endorsed the survey in May of 1992.

The survey instruments were revised based on feedback from the various reviewers, field tested, and revised again. The instrument development process was a lengthy one, constantly compromising between information needs and data collection constraints. There were several iterations of field testing and revision to help ensure that individual items were clear and unambiguous and that the survey as a whole would provide the necessary information with the least possible burden on participants. Copies of the survey questionnaires are included in Appendix B.

D. Data Collection

Once the Education Information Advisory Committee had approved the study design, instruments, and procedures, the data subcontractor (CODA) proceeded with the data collection. First, notification letters were mailed to the Chief State School Officers, identifying the schools in the state that had been selected for the survey. Similar letters were subsequently mailed to superintendents of districts including sampled public schools and diocesan offices of sampled Catholic schools. (Information about this pre-survey mailout is included in Appendix C.) Copies of the survey instruments and additional information about the study were provided when requested. Eleven schools were deleted from the study at this point, because the districts refused to allow the schools to participate.

Principals in the remaining schools were asked to provide demographic information about the students in the school; the names of the science and mathematics department heads or other individuals who would be able to provide information about the science and mathematics program in the school; and a list of all teachers responsible for teaching science and/or mathematics to one or more classes. The response rate at the school level was 89 percent.

An incentive system was developed to encourage school and teacher participation in the survey. Each school was given a credit of $25 towards the purchase of science and mathematics education materials; the amount was augmented by $10 for each responding teacher. At the completion of the data collection phase, schools were sent vouchers that they could use for purchasing NCTM publications, calculators, science activity books, kits, etc. from a catalogue developed for this study. Postcard reminders, phone calls, and additional mailings of survey materials were also used to encourage non-respondents to complete the questionnaires; the final questionnaire response rates were 88 percent for school program representatives and 84 percent for science and mathematics teachers. A more detailed description of the data collection procedures is included in Appendix D.

E. File Preparation and Analysis

Completed questionnaires were recorded in the data receipt system and routed to editing and coding. Manual edits were used to identify missing information and obvious out-of-range answers; to identify and, if possible resolve, multiple responses; and to make a number of consistency checks. When necessary, respondents were re-contacted and asked to clarify and/or complete responses to key items. After data entry, machine-edits were performed to check for out-of-range answers, adherence to skip patterns, and logical inconsistencies, and weights were added to the data files. All population estimates presented in this report were computed using weighted data.

F. Outline of This Report

This report of the 1993 National Survey of Science and Mathematics Education is organized into major topical areas. In most cases, results are presented for groups of teachers categorized by grade ranges—grades 1–4, 5–8, and 9–12. Trend results are typically reported for grades 1–3, 4–6, 7–9, and 10–12, the grade ranges used in the 1977 and 1985–86 surveys. The definitions of these categories and other reporting variables used in this report are included in Appendix E.

Chapter Two focuses on science and mathematics teacher backgrounds and beliefs. Basic demographic data are presented along with information about course background, perceptions of preparedness, and pedagogical beliefs. Chapter Three examines data on the professional status of teachers, including their perceptions of their autonomy in making curriculum and instructional decisions, and their opportunities for continued professional development.

Chapter Four presents information about the time spent on science and mathematics instruction in the elementary grades, and about science and mathematics course offerings at the secondary level. Chapter Five examines the instructional objectives of science and mathematics classes, and the instructional activities used to achieve these objectives, followed by a discussion of the availability and use of various types of instructional resources in Chapter Six. Finally, Chapter Seven presents data about a number of factors which are likely to affect science and mathematics instruction, including school-wide programs, practices, and problems.

Chapter Two

Teacher Background and Beliefs

A. Overview

While various reform efforts focus initially on different parts of the science and mathematics education system, e.g., curriculum, assessment, in-service teacher education, there is a consensus that having a well-prepared teaching force is essential for effective science and mathematics education. The 1993 National Survey of Science and Mathematics Education collected a variety of information about science and mathematics teachers, including their age, sex, race/ethnicity, number of years teaching, course background, and pedagogical beliefs. These data are presented in the following sections.

B. Teacher Characteristics

As can be seen in Table 2.1, the vast majority of science and mathematics teachers in grades 1–4 are female. In grades 5–8, approximately 70 percent of science and mathematics teachers are female, compared to about 40 percent in grades 9–12, including 34 percent of science teachers and 48 percent of mathematics teachers. It is interesting to note that the percentage of female middle and high school science and mathematics teachers has increased considerably in recent years. For example, in 1977, 46 percent of grade 7–9 mathematics teachers were female, increasing to 54 percent in 1985–86, and 63 percent in 1993. (See Table 2.2.)

Blacks, Hispanics, and other minority groups continue to be underrepresented in the science and mathematics teaching force; at a time when minorities constitute roughly 30 percent of the student enrollment, only from 6 to 11 percent of science and mathematics teachers, depending on subject and grade range, are members of minority groups.

Table 2.1
Characteristics of the Science and Mathematics Teaching Force

	Science			Mathematics		
	Grades 1–4	Grades 5–8	Grades 9–12	Grades 1–4	Grades 5–8	Grades 9–12
Sex						
Male	9 (1.3)	31 (3.3)	66 (3.2)	3 (1.2)	27 (2.7)	52 (2.8)
Female	91 (1.4)	69 (3.4)	34 (3.2)	97 (1.3)	73 (2.5)	48 (2.8)
Race						
White	88 (2.2)	89 (2.6)	95 (0.8)	90 (1.1)	90 (1.7)	92 (1.1)
Black	6 (1.8)	6 (1.4)	3 (0.4)	4 (0.7)	5 (0.7)	4 (0.8)
Hispanic	5 (1.2)	1 (0.7)	1 (0.3)	5 (1.8)	4 (1.2)	1 (0.5)
American Indian	0 (0.3)	0 (0.3)	1 (0.4)	0 (0.3)	0 (0.2)	0 (0.2)
Asian	0 (0.3)	3 (1.7)	1 (0.1)	1 (0.1)	1 (0.7)	2 (0.7)
Age						
< 31 Years	16 (2.3)	11 (1.4)	13 (1.1)	17 (2.2)	15 (3.4)	13 (1.8)
31–40 Years	26 (2.6)	28 (3.0)	23 (3.2)	27 (2.6)	21 (1.9)	23 (2.7)
41–50 Years	40 (2.9)	36 (3.4)	41 (3.4)	32 (2.3)	46 (2.9)	42 (2.3)
> 50 Years	18 (2.4)	25 (3.9)	23 (2.7)	23 (2.4)	18 (3.1)	22 (1.9)
Experience						
0–2 Years	13 (2.1)	12 (1.9)	11 (1.2)	12 (1.8)	12 (2.2)	10 (1.2)
3–5 Years	10 (1.5)	11 (1.6)	10 (1.1)	14 (1.3)	9 (1.4)	9 (1.2)
6–10 Years	15 (1.7)	19 (2.7)	14 (3.1)	17 (2.3)	22 (3.5)	20 (3.3)
11–20 Years	43 (2.7)	34 (3.1)	30 (1.9)	36 (2.3)	34 (2.8)	28 (1.6)
> 20 Years	19 (2.7)	25 (3.1)	35 (2.6)	22 (2.7)	22 (2.9)	33 (1.9)
Masters Degree						
Yes	34 (2.8)	42 (3.4)	57 (2.1)	35 (2.4)	41 (3.2)	53 (2.8)
No	66 (2.8)	58 (3.4)	43 (2.1)	65 (2.4)	59 (3.2)	47 (2.8)

Table 2.2
Females in the Science and Mathematics Teaching Force: 1977, 1985–86, 1993

	Percent of Teachers					
	1977*		1985–86		1993	
Science						
Grades 1–3	98	(1.0)	96	(1.0)	96	(0.8)
Grades 4–6	67	(3.3)	77	(2.8)	79	(3.4)
Grades 7–9	38	(2.5)	42	(3.0)	43	(3.1)
Grades 10–12	25	(2.1)	31	(2.5)	34	(2.3)
Mathematics						
Grades 1–3	94	(1.6)	96	(1.0)	98	(1.3)
Grades 4–6	78	(2.9)	80	(2.5)	84	(2.1)
Grades 7–9	46	(2.5)	54	(3.0)	63	(4.0)
Grades 10–12	32	(2.4)	46	(2.0)	46	(2.6)

* The 1977 survey included Kindergarten teachers; figures are for teachers of grades K–3 rather than 1–3.

As can be seen in Table 2.3, the science and mathematics teaching force is growing older; the average age of teachers has increased by approximately two years since 1985–86. While it is extremely difficult to monitor teacher supply—many people who prepare to become teachers do not actually do so and many others who leave the profession return at a later date—the fact that 1 in 5 science and mathematics teachers in each grade range is over age 50 (and smaller percentages are age 30 or younger) raises concerns about having an adequate supply of qualified teachers as these teachers reach retirement age.

Table 2.3
Average Age of the Science and Mathematics Teaching Force: 1985–86 and 1993

	Percent of Teachers							
	Science				Mathematics			
	1985–86		1993		1985–86		1993	
Grades 1–6	40.1	(0.4)	42.1	(0.6)	39.8	(0.4)	42.1	(0.6)
Grades 7–9	39.2	(0.8)	41.8	(0.6)	39.2	(0.6)	41.6	(0.9)
Grades 10–12	40.3	(0.4)	43.3	(0.5)	40.3	(0.5)	43.4	(0.5)

About 1 in 3 teachers in grades 1–4 has earned a degree beyond the bachelor's, increasing to roughly 40 percent in grades 5–8 and more than 50 percent in grades 9–12. It is interesting to note that the percentage of teachers with master's degrees rises steadily with years of teaching experience; for example, as can be seen in Table 2.4, only 8 percent of grade 1–12 science teachers with two or fewer years prior teaching experience have master's degrees, compared to 55 percent of those with more than 20 years prior teaching experience.

Table 2.4
Science and Mathematics Teachers with Degrees Beyond the Bachelor's, by Years Teaching

	Percent of Teachers			
	Science		Mathematics	
Prior Teaching Experience				
0–2 Years	8	(1.8)	12	(2.5)
3–5 Years	19	(3.5)	18	(4.0)
6–10 Years	36	(3.9)	41	(4.9)
11–20 Years	45	(4.0)	43	(3.8)
> 20 Years	55	(3.1)	53	(3.5)

C. Teacher Preparation

National standards call for the introduction of challenging science and mathematics content to all students beginning in the early grades. If teachers are to guide students in their exploration of science and mathematics concepts, they must themselves have a firm grasp of powerful science and mathematics concepts.

Because it would be extremely difficult to gauge the extent to which a large national sample of teachers understands science and mathematics concepts (and knows how to help their students learn these concepts), proxy measures such as major or number of courses taken in the field are typically used. Table 2.5 shows that very few grade 1–4 teachers had undergraduate majors in these fields. (Roughly 80 percent majored in elementary education.) While science and mathematics teachers in grades 5–8 were more likely than their grade 1–4 colleagues to have undergraduate majors in science, a majority still had majors in education.

Table 2.5
Teacher Undergraduate Majors in Science and Mathematics

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science Teachers						
Science	2	(0.5)	17	(2.0)	63	(2.1)
Science Education	0	(0.2)	2	(0.4)	6	(1.2)
Other Education	86	(2.9)	63	(3.2)	22	(3.7)
Other Fields	12	(2.1)	18	(3.3)	10	(2.1)
Mathematics Teachers						
Mathematics	1	(0.4)	7	(0.8)	41	(2.5)
Mathematics Education	0	(0.0)	3	(0.5)	18	(1.8)
Other Education	89	(2.2)	71	(2.3)	20	(2.1)
Other Fields	11	(1.9)	20	(2.1)	22	(3.4)

Grade 9–12 science teachers were much more likely to have majored in a science discipline (63 percent) than in science education (6 percent). The comparable figures for mathematics teachers were 41 percent mathematics majors and 18 percent mathematics education majors. While the percentages of teachers with major in field are greater for grades 9–12 than for the lower grades, still roughly 3 out of 10 high school science teachers and 4 out of 10 high school mathematics teachers did not major in their fields at either the undergraduate or graduate level. Moreover, while the vast majority of grade 9–12 science teachers had at least a minor in science or science education, nearly 1 in 5 grade 9–12 mathematics teachers did not have even a minor in the field. (See Table 2.6.)

Table 2.6
Teacher Majors and Minors in Science/Mathematics and Science/Mathematics Education

	Percent of Teachers					
	Science			Mathematics		
	Grades 1–4	Grades 5–8	Grades 9–12	Grades 1–4	Grades 5–8	Grades 9–12
Undergraduate major in science/mathematics	2 (0.5)	17 (2.0)	63 (2.1)	1 (0.4)	7 (0.8)	41 (2.5)
Undergraduate or graduate major in science/ science education (mathematics/ mathematics education)	3 (0.7)	21 (2.3)	72 (2.2)	1 (1.0)	11 (1.5)	63 (1.5)
Undergraduate or graduate major or minor in science/science education (mathematics/ mathematics education)	7 (1.6)	32 (2.9)	94 (1.2)	7 (1.9)	18 (2.1)	81 (2.1)

Tables 2.7, 2.8, and 2.9 tell a similar story, in this case using the number of semesters of college science coursework completed by science teachers in each grade range: elementary teachers have less extensive backgrounds in science than do their middle grade counterparts, who in turn have had less science coursework than their high school counterparts. For example, Table 2.7 shows the percentages of grade 1–4, 5–8, and 9–12 science teachers who have completed various numbers of semesters of college science coursework; the average number of courses completed ranges from 6.8 for grades 1–4 to 17.6 for grades 9–12.

Table 2.7
Number of Semesters* of College Coursework in Science

	Percent of Science Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
< 6 Semesters	50	(3.3)	28	(4.1)	1	(0.5)
6–10 Semesters	31	(2.6)	31	(3.4)	12	(1.6)
11–14 Semesters	11	(1.6)	16	(2.6)	20	(2.0)
15–20 Semesters	6	(1.4)	17	(3.0)	39	(2.1)
> 20 Semesters	1	(0.6)	8	(1.2)	28	(1.7)
Average number of semesters	6.8	(0.3)	10.3	(0.6)	17.6	(0.3)

* Since the highest number of semesters a teacher could indicate for each of the four categories—life science, chemistry, physics/physical science, and earth/space science—was "8," these figures underestimate the total for any teacher who completed more than eight courses in a particular category.

As can be seen in Table 2.8, 92 percent of grade 1–4 science teachers have had at least one college course in the life sciences. Most (85 percent) have had coursework in earth science, science education (82 percent), and physics/physical science (66 percent), while nearly one-half have had one or more college courses in chemistry. Similarly, most grade 5–8 science teachers have had coursework in the life sciences (94 percent), earth sciences (86 percent), science education (78 percent), physics/physical science (72 percent), and chemistry (61 percent).

Table 2.8
Number of Semesters Completed in Various Course Categories

	Percent of Science Teachers							
	No Semesters		1–2 Semesters		3–5 Semesters		6 or More Semesters	
Grades 1–4								
Life Sciences	8	(1.2)	52	(3.0)	29	(2.7)	11	(2.5)
Chemistry	53	(2.3)	37	(2.6)	8	(1.6)	2	(0.2)
Physics/Physical Science	34	(2.3)	53	(2.9)	11	(1.8)	1	(0.7)
Earth/Space Science	15	(1.6)	51	(2.9)	30	(2.0)	4	(1.3)
Science Education	18	(1.7)	58	(2.3)	17	(2.8)	7	(1.1)
Grades 5–8								
Life Sciences	6	(1.6)	32	(3.3)	34	(2.9)	28	(3.0)
Chemistry	39	(3.4)	36	(3.0)	17	(2.1)	8	(1.5)
Physics/Physical Science	28	(3.6)	45	(4.3)	19	(2.5)	8	(1.6)
Earth/Space Science	14	(2.2)	36	(3.9)	36	(3.8)	14	(2.4)
Science Education	22	(2.8)	50	(3.9)	18	(2.8)	10	(1.4)
Grades 9–12								
Life Sciences	6	(1.1)	13	(2.3)	16	(2.5)	65	(2.3)
Chemistry	4	(0.8)	22	(2.2)	34	(1.5)	40	(2.8)
Physics/Physical Science	8	(0.9)	35	(2.9)	28	(2.6)	29	(1.9)
Earth/Space Science	20	(2.3)	32	(2.4)	29	(1.3)	19	(1.4)
Science Education	20	(2.3)	31	(2.3)	24	(2.0)	26	(2.3)

Almost all high school science teachers have had at least one course in chemistry (96 percent), biology/life science (94 percent), and physics or physical science (92 percent). Somewhat fewer (80 percent in each case) have had coursework in earth/space science or science education. In terms of specific courses, the majority of high school science teachers have completed college coursework in general chemistry, introductory biology, general physics, botany, zoology, organic chemistry, anatomy/physiology, genetics, life science, and microbiology. (See Table 2.9.)

Table 2.9
Middle and High School Science Teachers Completing Various College Courses

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
Life Science	59	(3.2)	56	(2.6)
Introductory Biology	79	(2.6)	83	(1.7)
Botany, Plant Physiology	42	(3.6)	66	(3.6)
Cell Biology	22	(2.9)	49	(2.7)
Ecology	25	(3.2)	48	(2.5)
Genetics, Evolution	20	(2.2)	57	(3.2)
Microbiology	15	(2.3)	50	(2.8)
Anatomy/Physiology	31	(3.9)	62	(3.5)
Zoology, Animal Behavior	32	(2.9)	63	(3.7)
General Chemistry	56	(3.2)	96	(0.8)
Analytical Chemistry	7	(1.1)	45	(2.9)
Organic Chemistry	15	(2.0)	63	(4.8)
Physical Chemistry	10	(2.0)	29	(2.0)
Quantum Chemistry	1	(0.3)	11	(1.1)
Biochemistry	9	(1.8)	37	(3.2)
Physical Science	55	(3.5)	48	(2.8)
General Physics	34	(3.1)	80	(3.9)
Electricity and Magnetism	15	(2.6)	32	(2.4)
Heat and Thermodynamics	7	(2.0)	23	(1.6)
Mechanics	5	(1.5)	24	(1.4)
Modern or Quantum Physics	2	(0.9)	15	(1.6)
Nuclear Physics	2	(0.6)	12	(1.4)
Solid State Physics	3	(1.0)	5	(0.9)
Optics	4	(1.6)	14	(1.1)
Earth Science	66	(3.3)	47	(2.9)
Astronomy	26	(2.1)	36	(2.0)
Geology	42	(3.8)	48	(2.4)
Meteorology	13	(2.0)	22	(1.6)
Oceanography	12	(3.0)	20	(1.8)
Physical Geography	44	(3.7)	25	(2.9)
Environmental Science	36	(2.8)	42	(2.5)
History of Science	9	(1.5)	25	(1.9)
Science and Society	7	(1.2)	18	(1.8)
Electronics	4	(1.2)	12	(1.4)
Engineering	3	(1.5)	13	(2.2)
Integrated Science	8	(1.6)	5	(0.8)
Supervised Student Teaching in Science	56	(3.8)	75	(2.0)
Instructional Use of Computers/Other Technologies	41	(2.6)	44	(3.0)

The National Science Teachers Association (NSTA) has recommended that elementary teachers have at least one college course in each of three science areas—biological sciences, physical sciences, and earth sciences—as well as coursework in science education. As can be seen in Table 2.10, roughly half of the science teachers in the elementary and middle grades meet those standards, while another 12 to 14 percent meet the science coursework standard but lack a course in science education.

Table 2.10
Elementary Science Teachers Meeting
NSTA Course-Background Standards

	Percent of Teachers			
	Grades 1–4		Grades 5–8	
Coursework in each science discipline plus science education	51	(3.4)	54	(3.6)
Lack coursework in science education only	12	(1.6)	14	(3.0)
Lack coursework in one science discipline	28	(2.2)	25	(3.2)
Lack coursework in two science disciplines	9	(1.4)	7	(1.9)
Lack coursework in three science disciplines	1	(0.5)	0	(0.2)

NSTA course background standards for middle/junior high school science teachers include at least two courses in each of the three science areas, as well as coursework in science education. Table 2.11 shows that the majority of grade 7–9 science teachers (57 percent) meet the NSTA standards, compared to 42 percent of those in grades 5–8. The differences between "middle grade" and "junior high school" teachers are most evident at the lower end of the scale, where 28 percent of grade 5–8 teachers, but only 8 percent of grade 7–9 science teachers lack the recommended coursework in two or three of the science areas.

Table 2.11
Middle and Junior High School Science Teachers Meeting
NSTA Course-Background Standards

	Percent of Teachers			
	Grades 5–8		Grades 7–9	
Two or more semesters in each science discipline plus science education	42	(3.5)	57	(3.1)
Lack science education only	7	(2.1)	9	(1.3)
Inadequate coursework in one science discipline	24	(2.7)	26	(2.7)
Inadequate coursework in two science disciplines	20	(3.5)	7	(2.0)
Inadequate coursework in all three science disciplines	8	(1.4)	1	(0.4)

At the high school level, NSTA's recommendations are very detailed and extensive, including lists of specific courses that teachers of each discipline should have completed. Because very few teachers, even those with considerable coursework in the field, meet the specific NSTA requirements, analyses of data from the 1993 National Survey of Science and Mathematics Education used a more general measure in defining "well-prepared"—six or more courses in field.

As can be seen in Table 2.12, there is considerable variation in extent of teacher preparation for the various science subjects taught at the secondary level. For example, 94 percent of high school biology classes are taught by teachers who have taken six or more biology courses, but only 45 percent of grade 7–12 earth science classes are taught by teachers who have had six or more earth science courses. Note also that while almost all high school biology, chemistry, and physics classes are taught by teachers with in-depth preparation either in that discipline or in another science discipline, substantial percentages of secondary life science, earth science, and physical science classes are taught by teachers who have not had in-depth preparation in any science discipline.

Table 2.12
Science Classes Taught by Teachers with Six or More College Courses in Field, in Another Science Field, and Lacking In-Depth Preparation in Any Science

	Percent of Classes					
	Six or More Courses In Field		Not In-Depth in Field, But Six or More in Another Science		Not In-Depth in Any Science	
Grades 7–12						
Life Science/Biology	82	(5.6)	3	(1.2)	14	(5.7)
Earth Science	45	(5.3)	34	(8.2)	21	(8.2)
Physical Science	75	(4.2)	11	(2.5)	14	(3.9)
Grades 9–12						
Biology	94	(1.9)	3	(1.6)	3	(1.1)
Chemistry	82	(3.4)	18	(3.6)	1	(0.4)
Physics	74	(6.0)	22	(5.7)	4	(2.9)

Most prospective secondary school science teachers are prepared to teach one discipline, typically either biology, chemistry, or physics. The reality, however, is that many science teachers will be assigned to teach courses in more than one discipline, resulting in extensive out-of-field teaching. As can be seen in Table 2.13, this situation is particularly prevalent in rural schools, where more than 1 in 3 teachers teach courses in two science disciplines and 1 in 8 teaches courses in three or more science disciplines.

Table 2.13
Science Teachers Teaching Courses in One, Two, or Three or More Science Subjects, by Community Type

	Percent of Teachers							
	Total		Urban		Suburban		Rural	
Number of Subjects Taught								
One Subject	71	(3.7)	79	(3.1)	76	(3.8)	51	(11.7)
Two Subjects	26	(3.3)	20	(2.9)	23	(3.9)	37	(10.4)
Three or More Subjects	4	(1.0)	2	(0.8)	1	(0.4)	12	(3.5)

Turning to mathematics, the 1993 National Survey of Science and Mathematics Education found that, as is the case in science, mathematics teachers in the higher grades tend to have much stronger course background in mathematics than do their colleagues in the lower grades. For example, as can be seen in Table 2.14, 83 percent of grade 9–12 mathematics teachers have had at least eight semesters of coursework in mathematics, compared to 8 percent of those teaching in grades 1–4. It is interesting to note that while only 20 percent of grade 5–8 mathematics teachers have had eight or more semesters of college mathematics, 32 percent of grade 5–8 mathematics *classes* are taught by these teachers, a reflection of the fact that teachers in grades 7 and 8 are generally both better prepared than teachers in grades 5 and 6 and are more likely to teach multiple mathematics classes each day.

Table 2.14
Number of Semesters* of College Coursework in Mathematics

	Percent of Mathematics Teachers			Percent of Mathematics Classes		
	Grades 1–4	Grades 5–8	Grades 9–12	Grades 1–4	Grades 5–8	Grades 9–12
< 4 Semesters	80 (1.9)	62 (3.5)	4 (0.9)	80 (1.7)	48 (3.3)	3 (0.9)
4–7 Semesters	13 (1.4)	19 (2.3)	12 (1.6)	13 (1.3)	20 (1.9)	10 (1.2)
8–11 Semesters	6 (1.5)	13 (1.9)	45 (3.2)	6 (1.4)	20 (2.4)	46 (3.1)
> 11 Semesters	2 (0.6)	7 (0.8)	38 (2.4)	1 (0.6)	12 (1.6)	41 (2.8)

* Since the highest number of semesters a teacher could indicate for "calculus" and for "all other mathematics courses" was "8," these figures underestimate the total for any teacher who completed more than eight courses in a particular category.

As can be seen in Table 2.15, the vast majority of grade 1–4 teachers have had college coursework in mathematics education and mathematics for elementary school teachers. Far fewer have had college coursework in geometry or probability and statistics, areas that the National Council of Teacher of Mathematics (NCTM) *Curriculum and Evaluation Standards* suggest should be addressed beginning in the primary grades.

Table 2.15
Grade 1–4 Mathematics Teachers
Completing Various College Courses

	Percent of Teachers	
Mathematics education	99	(0.4)
Mathematics for elementary school teachers	98	(1.2)
College algebra/trigonometry/elementary functions	42	(2.3)
Geometry for elementary/middle school teachers	30	(2.2)
Probability and statistics	27	(3.0)
Applications of mathematics/problem solving	24	(1.8)
Calculus	12	(1.8)

Table 2.16 shows the percentages of grade 5–8 and 9–12 mathematics teachers who have completed each of a number of college courses in mathematics and related fields. At the middle/junior high school level, the National Council of Teachers of Mathematics has recommended that mathematics teachers have college coursework in abstract algebra; geometry; calculus; probability and statistics; and applications of mathematics/problem solving. Percentages of grade 5–8 teachers having completed these courses range from 22 percent for abstract algebra to 44 percent for probability and statistics.

In contrast, the 1993 Survey found that high school mathematics teachers have relatively strong content backgrounds. The majority have had college coursework in calculus (95 percent); college algebra (89 percent); geometry (84 percent); probability and statistics (81 percent); linear algebra (78 percent); abstract algebra (75 percent); advanced calculus (72 percent); differential equations (62 percent); and other upper division mathematics (57 percent). The only two NCTM-recommended areas where fewer than half of the high school mathematics teachers had coursework were applications of mathematics/problem-solving (45 percent) and history of mathematics (42 percent).

Table 2.16
Middle and High School Mathematics Teachers Completing Various College Courses

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
Mathematics for middle school teachers	41	(3.6)	30	(1.9)
Geometry for elementary/middle school teachers	35	(3.2)	24	(1.7)
Any computer programming/computer science	43	(2.3)	69	(2.4)
Methods of teaching mathematics	91	(2.1)	84	(2.7)
College algebra/trigonometry/elementary functions	57	(3.7)	89	(1.0)
Calculus	32	(2.2)	95	(1.3)
Advanced calculus	17	(2.1)	72	(2.9)
Differential equations	12	(1.3)	62	(3.3)
Geometry	39	(3.0)	84	(2.6)
Probability and statistics	44	(3.1)	81	(2.7)
Abstract algebra/number theory	22	(2.2)	75	(2.9)
Linear algebra	20	(2.0)	78	(2.6)
Applications of mathematics/problem solving	28	(2.5)	45	(2.7)
History of mathematics	13	(1.6)	42	(2.6)
Discrete mathematics	6	(1.2)	26	(2.0)
Other upper division mathematics	18	(1.9)	57	(3.3)
Biological sciences	72	(2.9)	55	(2.9)
Chemistry	37	(2.4)	51	(2.8)
Physics	27	(1.9)	59	(3.0)
Physical science	48	(3.6)	31	(2.6)
Earth/space science	45	(2.4)	28	(2.8)
Engineering	3	(0.9)	10	(0.8)
Computer programming	30	(2.4)	65	(2.5)
Other computer science	24	(2.6)	33	(2.6)
Supervised student teaching in mathematics	41	(3.3)	65	(2.9)
Instructional use of computers/other technologies	32	(2.7)	43	(2.3)

As can be seen in Table 2.17, 34 percent of grade 5–8 mathematics teachers have not had *any* of the five recommended mathematics courses; only 7 percent have had all five. Nearly one-third of all high school mathematics teachers had completed at least 9 of the 10 recommended courses; another 43 percent had completed 6, 7, or 8 of these courses.

Table 2.17
Mathematics Teachers Completing
NCTM-Recommended College Mathematics Courses

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
Recommended for Middle/Junior High School Teachers				
No Courses	34	(2.8)	1	(0.3)
1–2 Courses	37	(2.6)	14	(2.7)
3–4 Courses	21	(2.4)	53	(2.6)
5 Courses	7	(1.3)	33	(2.3)
Recommended for High School Teachers				
0–1 Courses	50	(3.7)	2	(0.4)
2–5 Courses	33	(3.8)	25	(3.8)
6–8 Courses	12	(1.4)	43	(2.9)
9–10 Courses	4	(0.7)	31	(2.1)

There is evidence, however, that students who take lower level mathematics classes are not as likely to get the benefits of having well-prepared teachers. For example, Table 2.18 shows the percentage of high school mathematics teachers who do and do not teach advanced mathematics classes (Algebra II or higher) who have completed each of a number of college mathematics classes. Note that much larger percentages of teachers who are assigned to advanced classes have taken coursework in a number of these areas. For example, 62 percent of high school teachers assigned to lower-level mathematics courses only have had coursework in abstract algebra, compared to 85 percent of those who teach one or more advanced mathematics courses.

Table 2.18
Grade 9–12 Mathematics Teachers Who Have Completed Various College Courses, by Teaching Assignment

	Percent of Teachers			
	Teaching No Advanced Courses		Teaching One or More Advanced Courses	
Calculus	91	(1.8)	97	(1.4)
Advanced Calculus	66	(3.6)	77	(4.7)
Differential Equations	54	(4.7)	69	(4.3)
Geometry	84	(2.0)	83	(4.6)
Probability and Statistics	73	(4.9)	87	(2.1)
Abstract Algebra/Number Theory	62	(4.4)	85	(2.0)
Linear Algebra	70	(4.8)	85	(2.7)
Applications of Mathematics/Problem Solving	46	(4.7)	45	(3.1)
History of Mathematics	34	(4.1)	48	(3.0)
Discrete Mathematics	21	(2.4)	31	(2.9)
Other upper division mathematics	45	(3.9)	68	(4.6)
Computer Programming	57	(4.5)	71	(2.2)
Instructional use of computers/other technologies	39	(3.4)	46	(3.5)

D. Teacher Pedagogical Beliefs

The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989 and *Professional Standards for Teaching Mathematics* in 1991. As one measure of the influence of the NCTM *Standards*, mathematics teachers in the 1993 National Survey of Science and Mathematics Education were asked the extent of their familiarity with each of these documents. As can be seen in Table 2.19, mathematics teachers in the higher grades are much more likely than their counterparts in the lower grades to report that they are familiar with the two standards documents. Roughly 1 in 5 elementary mathematics teachers, 1 in 4 middle grade mathematics teachers, and 1 in 2 high school mathematics teachers indicated they were "well aware" of the *Curriculum and Evaluation Standards*. Not surprisingly, teachers in each grade range are less likely to be familiar with the more recently released *Professional Standards for Teaching Mathematics*.

Table 2.19
Mathematics Teachers' Familiarity with the NCTM *Standards*

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Curriculum and Evaluation Standards						
Well aware of the NCTM *Standards*	18	(1.6)	28	(2.2)	56	(2.6)
Heard of the NCTM *Standards*, but don't know much about them	39	(1.8)	41	(3.0)	33	(2.7)
Not aware of the NCTM *Standards*	30	(2.9)	22	(2.6)	8	(1.4)
Not sure	13	(1.2)	9	(2.1)	3	(0.3)
Professional Standards for Teaching						
Well aware of the NCTM *Teaching Standards*	12	(1.3)	19	(1.7)	40	(2.0)
Heard of the NCTM *Teaching Standards*, but don't know much about them	38	(2.0)	48	(3.0)	44	(2.7)
Not aware of the NCTM *Teaching Standards*	38	(2.8)	25	(2.9)	13	(1.8)
Not Sure	13	(1.3)	8	(1.4)	3	(0.4)

Those teachers who indicated they were "well aware" of each set of standards were asked to indicate the depth of their knowledge. As can be seen in Table 2.20, roughly 90 percent of the teachers in each grade range who said they were well aware of a particular set of standards indicated they were well informed about them for the grades they teach, and one-half or more said they were prepared to explain the *Standards* to their colleagues.

Table 2.20
Mathematics Teachers Reported Understanding of the NCTM *Standards*

	Percent of Teachers Agreeing*					
	Grades 1–4		Grades 5–8		Grades 9–12	
Curriculum and Evaluation Standards						
I am well informed about the NCTM *Standards* for the grades I teach	87	(1.6)	88	(2.4)	91	(2.6)
I am prepared to explain the NCTM *Standards* to my colleagues	50	(1.3)	53	(1.7)	58	(2.9)
Professional Standards for Teaching						
I am well informed about the NCTM *Teaching Standards* for the grades I teach	90	(1.2)	91	(1.8)	89	(1.9)
I am prepared to explain the NCTM *Teaching Standards* to my colleagues	57	(1.1)	49	(1.3)	55	(1.7)

* Only teachers who indicated they were "well aware" of each set of standards were asked to respond to these items. These percentages include teachers who responded "strongly agree" or "agree."

Of course, whether or not they are knowledgeable about the documents, mathematics teachers may or may not agree with the principles underlying the *Standards* or the recommendations that flow from them. The NCTM *Standards* and the *National Science Education Standards* stress the need to involve all students in learning important and powerful science and mathematics concepts from the earliest grades; deemphasizing, for example, arithmetic computation in favor of having students develop reasoning and problem-solving abilities. Tracking and other school and district policies that prevent some students from having the opportunity to learn challenging science and mathematics content are to be discontinued.

Moreover, reform advocates stress that all students need to be actively engaged in learning science and mathematics—studying science phenomena through hands-on, inquiry-based explorations; using manipulatives to investigate mathematics concepts; using calculators, computers, and other technologies to explore science and mathematics concepts; and working with their peers in cooperative learning groups. The teacher should be a guide rather than simply a dispenser of information, and should use a variety of strategies to assess student learning, rather than relying primarily on paper and pencil, multiple-choice tests.

To get an idea of teachers' beliefs as they relate to reforms suggested by the NCTM *Standards* and the *National Science Education Standards*, teachers were asked if they agreed with a number of statements about science and mathematics education. The results show that while most science and mathematics teachers believe that "virtually all students can learn to think scientifically (mathematically)," sizable proportions believe that such learning is best accomplished by placing students in classes with students of similar abilities. Support for homogeneous grouping is stronger in mathematics than in science; for example, 41 percent of grade 1–4 teachers indicated that students learn mathematics best in classes with students of similar abilities compared to 23 percent for science. And in both subjects high school teachers are more likely than middle grade teachers, who in turn are more likely than elementary grade teachers, to endorse such grouping. (See Tables 2.21 and 2.22.)

While most middle and high school science teachers believe that science is learned best in the context of a personal or social application, and that laboratory-based science classes are more effective than non-laboratory classes, there is resistance to the reform notion of teaching science concepts first and only then having students learn the terminology associated with those concepts. Almost one-third of the teachers in grades 1–4, increasing to more than half of all high school science teachers, indicated that "it is important for students to learn basic scientific terms and formulas before learning underlying concepts and principles."

Mathematics teachers are supportive of the importance of teaching in the context of personal and social applications, but they voiced considerable resistance to another of the tenets of current reform ideas. While the NCTM *Curriculum and Evaluation Standards* argue for the earlier introduction of algebraic concepts, the majority of elementary, middle, and high school mathematics teachers indicated their belief that "students must master arithmetic computations before going on to algebra." Support for the frequent use of calculators, another emphasis of the NCTM *Standards*, was quite high among high school mathematics teachers, with 73 percent indicating that "students should be able to use calculators most of the time"; mathematics teachers in the lower grades were less likely to support such extensive use of calculators.

In another attempt to gauge teacher support for reform recommendations, science and mathematics teachers were provided with a list of instructional "strategies" and asked how important they believed each was for effective science/mathematics instruction. Again, it is clear that science and mathematics teachers support some of the current reform notions, but are less convinced about others.

Table 2.21
Science Teachers' Opinions on Curriculum and Instruction Issues

	Percent of Teachers Agreeing*					
	Grades 1–4		Grades 5–8		Grades 9–12	
Students learn best when they study science in the context of a personal or social application	94	(1.4)	92	(2.2)	86	(4.5)
Virtually all students can learn to think scientifically	80	(2.4)	84	(3.3)	76	(2.6)
Laboratory-based science classes are more effective than non-laboratory classes	78	(2.1)	87	(1.5)	90	(1.2)
The testing program in my state/district dictates what science I teach	38	(2.5)	40	(3.4)	30	(3.8)
It is important for students to learn basic scientific terms and formulas before learning underlying concepts and principles	31	(2.2)	44	(3.7)	55	(2.6)
Students learn science best in classes with students of similar abilities	23	(2.3)	33	(3.3)	68	(2.0)
Activity-based experiences aren't worth the time and expense for what students learn	4	(0.7)	5	(1.4)	6	(1.3)

* Includes teachers indicating "strongly agree" and "agree" to each statement.

Table 2.22
Mathematics Teachers' Opinions on Curriculum and Instruction Issues

	Percent of Teachers Agreeing*					
	Grades 1–4		Grades 5–8		Grades 9–12	
Students learn best when they study mathematics in the context of a personal or social application	94	(1.3)	91	(1.7)	84	(1.7)
Virtually all students can learn to think mathematically	76	(2.0)	76	(2.6)	72	(2.3)
Students learn mathematics best in classes with students of similar abilities	41	(1.9)	62	(3.8)	76	(2.9)
Students need to master arithmetic computation before going on to algebra	70	(2.2)	77	(3.1)	81	(1.7)
The testing program in my state/district dictates what mathematics I teach	60	(3.0)	52	(3.3)	40	(2.6)
Students should be able to use calculators most of the time	24	(1.9)	39	(3.1)	73	(1.7)
Activity-based experiences aren't worth the time and expense for what students learn	5	(1.3)	8	(2.2)	9	(1.0)

* Includes teachers indicating "strongly agree" and "agree" to each statement.

Table 2.23 shows the percent of mathematics teachers rating each strategy a five on a five-point scale ("definitely should be a part of mathematics instruction") at the grade level they teach. Table 2.24 shows the analogous data combining ratings of four and five. Note that pedagogical beliefs among mathematics teachers vary considerably by grade taught. For example, as can be seen in Table 2.23, more than 80 percent of grade 1–4 mathematics teachers, but only 1 in 2 in grades 5–8 and 1 in 4 in grades 9–12 consider the use of hands-on/manipulative activities to be essential for effective mathematics instruction. Teachers in the higher grades are similarly less likely to consider essential such strategies as concrete experiences before abstract treatments; applications of mathematics in daily life; having students work in cooperative learning groups; use of computers; and taking students' prior conceptions about a topic into account when planning curriculum and instruction. In contrast, high school teachers are more likely than their colleagues in the elementary grades to consider the use of calculators essential for effective mathematics instruction.

Table 2.23
Mathematics Teachers Indicating that Various Strategies Definitely Should be a Part of Mathematics Instruction

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Hands-on/manipulative activities	82	(2.2)	49	(3.2)	26	(2.2)
Concrete experience before abstract treatments	81	(2.0)	55	(2.7)	33	(2.5)
Applications of mathematics in daily life	81	(1.6)	75	(3.1)	50	(2.8)
Emphasis on solving real problems	80	(1.9)	78	(2.6)	57	(2.9)
Every student studying mathematics each year	76	(2.7)	69	(3.5)	38	(2.5)
Emphasis on mathematical reasoning	69	(2.0)	64	(2.6)	58	(3.0)
Emphasis on connections among concepts	68	(1.7)	62	(2.4)	52	(2.2)
Students working in cooperative learning groups	58	(1.8)	41	(2.8)	27	(2.2)
Use of computers	52	(2.9)	39	(3.3)	34	(2.3)
Emphasis on arithmetic computation	49	(2.4)	36	(2.4)	22	(1.8)
Coordination of mathematics with science	34	(2.1)	27	(3.4)	22	(2.6)
Taking student preconceptions about a topic into account when planning curriculum/instruction	34	(2.9)	26	(2.8)	18	(2.5)
Use of calculators	33	(3.2)	37	(3.7)	50	(2.5)
Inclusion of performance-based assessment	33	(1.9)	29	(2.9)	18	(1.6)
Deeper coverage of fewer mathematics ideas	33	(3.6)	31	(3.4)	16	(2.6)
Emphasis on writing about mathematics	32	(2.0)	23	(2.6)	20	(2.8)
Integration of mathematics subjects (e.g., algebra, probability, geometry, etc.) all taught together each year	26	(1.7)	25	(3.2)	20	(2.8)
Coordination of mathematics with vocational/technology education	25	(2.5)	23	(2.8)	19	(1.7)

Table 2.24
Mathematics Teachers Indicating that Various Strategies Are an Important Part of Mathematics Instruction*

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Emphasis on solving real problems	99	(0.7)	99	(0.9)	98	(0.4)
Applications of mathematics in daily life	99	(0.4)	99	(1.0)	95	(1.0)
Emphasis on mathematical reasoning	98	(0.5)	98	(1.0)	98	(0.3)
Emphasis on connections among concepts	98	(0.8)	98	(1.0)	97	(0.5)
Hands-on/manipulative activities	98	(1.0)	89	(2.2)	78	(2.1)
Every student studying mathematics each year	97	(1.1)	96	(1.2)	81	(2.7)
Concrete experience before abstract treatments	97	(1.3)	92	(1.6)	85	(1.6)
Students working in cooperative learning groups	92	(1.5)	82	(3.0)	78	(1.6)
Emphasis on arithmetic computation	90	(1.7)	89	(1.6)	64	(2.5)
Use of computers	87	(1.7)	87	(2.3)	81	(2.7)
Inclusion of performance-based assessment	82	(2.2)	78	(2.3)	71	(2.3)
Coordination of mathematics with science	81	(2.2)	75	(2.4)	80	(1.6)
Taking student preconceptions about a topic into account when planning curriculum/instruction	79	(2.1)	80	(2.2)	67	(2.3)
Deeper coverage of fewer mathematics ideas	72	(2.4)	75	(3.1)	55	(2.9)
Use of calculators	71	(2.1)	80	(3.8)	89	(1.0)
Emphasis on writing about mathematics	71	(2.0)	64	(4.0)	60	(2.0)
Integration of mathematics subjects (e.g., algebra, probability, geometry, etc.) all taught together each year	64	(1.7)	65	(2.9)	56	(2.8)
Coordination of mathematics with vocational/technology education	62	(2.7)	73	(2.5)	75	(2.1)

* Teachers were given a five-point scale for each strategy, with 1 labeled "definitely should not be a part of science instruction"; 3, "makes no difference"; and 5, "definitely should be a part of science instruction." These numbers represent the total circling 4 or 5.

Science teacher ratings of the importance of each of a number of strategies for effective science teaching are shown in Tables 2.25 ("definitely should be included") and 2.26 ("definitely should" or "should be included"). Roughly 3 out of 4 science teachers in grades 1–4, 5–8, and 9–12 indicated that hands-on activities should definitely be a part of science instruction; nearly that many consider teaching of applications of science in daily life to be essential. Support for concrete experience before abstract treatments is much lower, especially in grades 9–12, as is having students work in cooperative learning groups. Even fewer high school science teachers (about 1 in 5) consider it essential to take student conceptions about natural phenomena into account when planning curriculum and instruction; to have deeper coverage of fewer science concepts; or to revisit science topics, each time in greater depth.

Table 2.25
Science Teachers Indicating that Various Strategies Definitely Should be a Part of Science Instruction

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Hands-on/laboratory activities	78	(2.3)	78	(2.8)	76	(2.1)
Applications of science in daily life	73	(2.5)	69	(4.3)	60	(3.6)
Concrete experience before abstract treatments	70	(2.6)	51	(4.4)	35	(3.1)
Every student studying science every year	63	(2.0)	61	(2.9)	37	(2.6)
Students working in cooperative learning groups	57	(2.5)	50	(3.0)	30	(2.0)
Emphasis on connections among concepts	52	(2.7)	54	(4.4)	53	(2.5)
Coordination of sciences with mathematics	47	(2.8)	43	(3.5)	47	(3.8)
Coordination of sciences with language arts	46	(2.7)	35	(3.7)	20	(3.0)
Coordination of sciences with social science	43	(2.9)	34	(3.6)	19	(3.8)
Taking student conceptions about a natural phenomenon into account when planning curriculum/instruction	39	(2.2)	34	(4.0)	22	(1.4)
Coordination of sciences with vocational/technology education	37	(2.5)	33	(4.2)	29	(1.7)
Use of computers	30	(3.6)	37	(4.3)	36	(2.3)
Coordination of science disciplines	30	(3.4)	37	(3.3)	35	(2.7)
Revisiting science topics, each time in greater depth	29	(2.6)	21	(2.4)	19	(1.6)
Deeper coverage of fewer science concepts	28	(2.8)	30	(3.1)	20	(1.6)
Applications of scientific methods in addressing societal issues	28	(2.3)	33	(3.3)	35	(3.1)
Inclusion of performance-based assessment	22	(2.4)	26	(3.5)	18	(1.8)

Table 2.26
Science Teachers Indicating that Various Strategies Are an Important Part of Science Instruction*

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Applications of science in daily life	99	(0.9)	99	(0.6)	98	(0.4)
Hands-on/laboratory activities	99	(0.9)	99	(0.6)	97	(0.9)
Emphasis on connections among concepts	97	(1.1)	99	(0.4)	97	(0.8)
Every student studying science every year	96	(1.1)	93	(2.1)	76	(1.8)
Concrete experience before abstract treatments	93	(1.9)	91	(1.9)	84	(1.7)
Coordination of sciences with mathematics	92	(1.9)	90	(1.9)	92	(1.2)
Coordination of sciences with language arts	92	(1.2)	83	(2.5)	69	(1.7)
Students working in cooperative learning groups	91	(2.1)	93	(1.5)	81	(1.7)
Coordination of sciences with social science	91	(1.7)	80	(3.8)	68	(1.4)
Taking student conceptions about a natural phenomenon into account when planning curriculum/instruction	87	(2.0)	83	(2.7)	76	(4.5)
Coordination of science disciplines	81	(1.8)	87	(3.2)	89	(1.4)
Revisiting science topics, each time in greater depth	78	(2.5)	86	(2.1)	78	(1.7)
Use of computers	77	(3.0)	81	(2.7)	82	(1.5)
Applications of scientific methods in addressing societal issues	72	(2.2)	87	(2.0)	85	(2.0)
Coordination of sciences with vocational/technology education	69	(2.3)	83	(3.2)	79	(1.5)
Deeper coverage of fewer science concepts	69	(3.0)	68	(3.7)	59	(2.2)
Inclusion of performance-based assessment	67	(2.8)	73	(3.2)	72	(3.4)

* Teachers were given a five-point scale for each strategy, with 1 labeled "definitely should not be a part of science instruction"; 3, "makes no difference"; and 5, "definitely should be a part of science instruction." These numbers represent the total circling 4 or 5.

E. Teacher Perceptions of Their Preparation

Knowing the extent of teachers' course backgrounds provides useful information about the preparation of the nation's science and mathematics teaching force. Of equal importance are teachers' perceptions of their preparation—how well prepared teachers feel they are to teach the various content areas and to use the various instructional strategies recommended for science and mathematics education.

Elementary teachers are typically assigned to teach science, mathematics, and other academic subjects to one group of students, but it is clear that they do not feel equally qualified to teach these subjects. Table 2.27 shows the percent of self-contained elementary teachers perceiving themselves to be "very well qualified" to teach reading/language arts, social studies, mathematics, and science at three different points in time—1977, 1985–86, and 1993. In 1993, 76 percent of elementary teachers assigned to teach all four subjects indicated they felt very well qualified to teach reading/language arts, compared to roughly 60 percent for both mathematics and social studies, but only 26 percent for life science.

Table 2.27
Self-Contained Grade 1–6 Teachers Feeling Very Well Qualified to Teach Each Subject: 1977, 1985–86, and 1993

	Percent of Teachers					
	1977*		1985–86		1993	
Reading/Language Arts	63	(1.7)	86	(1.0)	76	(1.9)
Mathematics	49	(1.8)	69	(1.3)	60	(2.4)
Social Studies	39	(1.7)	51	(1.4)	61	(1.7)
Life Sciences	--	--	27	(1.2)	26	(2.0)
Science	22	(1.5)	--	--	--	--

* 1977 figures include Kindergarten teachers.

Tables 2.28, 2.29, and 2.30 provide more detailed data on grade 1–4, 5–8, and 9–12 teachers' perceptions of their qualifications to teach each of a number of subjects in their particular grade levels; response options were "not well qualified," "adequately qualified," and "very well qualified." Note that relatively few elementary and middle grade teachers indicated they feel well prepared to teach chemistry and physics, perhaps because they were thinking about the traditional high school treatment of these subjects rather than how one might approach them with younger students; many more elementary and middle grade science teachers perceive themselves as well prepared to teach the life and earth sciences.

Table 2.28
Grade 1–4 Science Teachers' Ratings of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Life Sciences	8	(1.5)	65	(2.7)	27	(2.5)
Chemistry	64	(2.5)	30	(2.4)	6	(1.1)
Physics	69	(1.9)	25	(2.0)	5	(1.1)
Earth Sciences	8	(1.6)	61	(2.9)	31	(2.9)
Technology	52	(3.5)	41	(3.5)	7	(1.3)
Integrated Science, drawing from various science disciplines	30	(3.3)	56	(2.9)	14	(1.8)
Mathematics	1	(0.4)	36	(3.1)	63	(2.7)

Table 2.29
Grade 5–8 Science Teachers' Ratings of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Life Sciences	7	(1.5)	52	(2.5)	42	(2.8)
Chemistry	47	(4.1)	39	(3.6)	14	(1.8)
Physics	52	(4.2)	36	(3.7)	12	(2.3)
Earth Sciences	9	(2.7)	56	(3.3)	35	(2.9)
Technology	46	(3.8)	44	(3.8)	10	(2.2)
Integrated Science, drawing from various science disciplines	24	(4.2)	53	(3.8)	23	(2.9)
Mathematics	7	(0.9)	44	(3.1)	49	(3.0)

Table 2.30
Grade 9–12 Science Teachers' Ratings of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Life Sciences	18	(1.5)	22	(2.9)	60	(3.4)
Chemistry	24	(1.6)	40	(3.2)	36	(2.4)
Physics	48	(2.2)	30	(1.8)	22	(1.6)
Earth Sciences	26	(1.9)	43	(2.7)	31	(3.6)
Technology	42	(2.5)	46	(2.7)	12	(1.4)
Integrated Science, drawing from various science disciplines	15	(1.0)	59	(3.3)	27	(2.8)
Mathematics	29	(2.1)	44	(2.9)	27	(3.3)

While current notions of science education reform recommend teaching about technology as part of science instruction, only about half of the teachers in each grade range feel at least adequately qualified to do so. Larger percentages of teachers feel at least adequately qualified to teach integrated science, ranging from 70 percent in grades 1–4 to 85 percent in grades 9–12.

Mathematics teachers were also given a list of 14 mathematics topics recommended by the NCTM *Curriculum and Evaluation Standards* for one or more of the grade ranges 1–4, 5–8, and 9–12 and asked to indicate how well qualified they felt to teach each one at the grade level they teach. As can be seen in Table 2.31, the only topics which a majority of grade 1–4 mathematics teachers feel very well qualified to teach are number sense and numeration (66 percent); patterns and relationships (58 percent); measurement (54 percent); and estimation (50 percent). Only 1 in 10 grade 1–4 teachers feels very well qualified to teach probability and statistics, topics that are recommended by the NCTM *Standards* for grades 1–4.

Table 2.31
Grade 1–4 Mathematics Teachers' Ratings of Their Qualifications to Teach Each of a Number of Topics

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Estimation	3	(0.8)	47	(2.6)	50	(2.7)
Number sense and numeration	1	(0.4)	33	(2.3)	66	(2.6)
Number systems and number theory	9	(1.5)	47	(2.4)	44	(2.3)
Measurement	3	(0.7)	44	(2.7)	54	(2.6)
Fractions and decimals	6	(1.0)	47	(1.7)	47	(2.1)
Geometry and spatial sense	9	(1.6)	49	(2.4)	42	(2.3)
Functions	14	(1.5)	50	(2.0)	36	(2.1)
Patterns and relationships	3	(0.8)	39	(3.1)	58	(3.1)
Algebra	42	(1.4)	41	(2.5)	17	(2.0)
Trigonometry	70	(1.9)	24	(2.1)	5	(1.3)
Probability and statistics	50	(1.7)	39	(2.2)	11	(1.6)
Discrete mathematics	64	(1.8)	31	(1.8)	5	(0.8)
Conceptual underpinnings of calculus	80	(2.1)	17	(1.9)	2	(0.5)
Mathematical structure	55	(2.1)	38	(2.2)	7	(1.8)

In grades 5–8 (see Table 2.32), a majority of mathematics teachers feels very well qualified to teach each of seven topics: fractions and decimals (81 percent); number sense and numeration (71 percent); estimation (64 percent); measurement (60 percent); number systems and number theory (58 percent); patterns and relationships (52 percent); and geometry and spatial sense (50 percent). Nearly that many feel very well qualified to teach functions (49 percent) and algebra (44 percent), but only 28 percent feel well qualified to teach probability and statistics.

Table 2.32
Grade 5–8 Mathematics Teachers' Ratings of Their Qualifications to Teach Each of a Number of Topics

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Estimation	3	(1.1)	33	(3.4)	64	(3.3)
Number sense and numeration	2	(0.7)	27	(3.0)	71	(3.0)
Number systems and number theory	5	(1.4)	37	(3.0)	58	(2.8)
Measurement	2	(0.8)	38	(3.3)	60	(3.2)
Fractions and decimals	0	(0.1)	19	(2.8)	81	(3.0)
Geometry and spatial sense	7	(2.0)	43	(3.5)	50	(3.0)
Functions	11	(2.0)	40	(2.8)	49	(2.5)
Patterns and relationships	2	(0.7)	46	(3.4)	52	(3.3)
Algebra	18	(2.5)	38	(2.4)	44	(3.1)
Trigonometry	59	(2.6)	28	(2.5)	13	(1.6)
Probability and statistics	27	(4.0)	46	(3.2)	28	(3.0)
Discrete mathematics	57	(4.0)	33	(3.2)	10	(2.0)
Conceptual underpinnings of calculus	73	(2.1)	24	(1.7)	4	(0.8)
Mathematical structure	46	(2.5)	41	(3.0)	14	(2.1)

As can be seen in Table 2.33, a majority of mathematics teachers in grades 9–12 feels very well qualified to teach each of 10 out of the 14 topics listed, ranging from 95 percent for algebra to 60 percent for trigonometry. In contrast, only about 3 out of 10 high school mathematics teachers feel well qualified to teach probability and statistics; mathematical structure; and the conceptual underpinnings of calculus; and only 2 out of 10 feel well qualified to teach discrete mathematics at the high school level.

Table 2.33
Grade 9–12 Mathematics Teachers' Ratings of Their Qualifications to Teach Each of a Number of Topics

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Estimation	2	(0.6)	27	(2.0)	72	(2.2)
Number sense and numeration	1	(0.2)	21	(2.2)	78	(2.3)
Number systems and number theory	2	(0.5)	30	(2.8)	67	(2.9)
Measurement	1	(0.5)	20	(2.1)	79	(2.2)
Fractions and decimals	0	(0.0)	7	(1.6)	93	(1.6)
Geometry and spatial sense	3	(0.7)	27	(3.3)	69	(3.3)
Functions	2	(0.5)	23	(2.1)	75	(2.2)
Patterns and relationships	1	(0.4)	28	(2.8)	71	(2.8)
Algebra	0	(0.2)	5	(0.8)	95	(0.8)
Trigonometry	10	(2.6)	30	(2.4)	60	(2.7)
Probability and statistics	14	(1.7)	54	(2.3)	33	(2.3)
Discrete mathematics	26	(1.8)	55	(2.3)	20	(1.7)
Conceptual underpinnings of calculus	33	(2.8)	38	(2.4)	29	(1.8)
Mathematical structure	19	(2.7)	51	(2.4)	30	(2.0)

Earlier, it was noted that teachers of advanced high school mathematics classes had stronger mathematics backgrounds than did teachers who were not assigned to advanced classes. It is not surprising, therefore, that teachers of advanced classes are more likely to perceive themselves as well qualified to teach various mathematics topics. As can be seen in Table 2.34, the difference is particularly large for mathematical structure; 41 percent of teachers assigned to one or more advanced high school mathematics classes, but only 18 percent of those who don't teach advanced classes, feel well qualified to teach this topic.

Table 2.34
Grade 9–12 Mathematics Teachers Considering Themselves Well Qualified to Teach Each Mathematics Topic, by Teaching Assignment

	Percent of Teachers			
	Teaching No Advanced Courses		Teaching One or More Advanced Courses	
Algebra	90	(1.7)	99	(0.7)
Fractions and decimals	90	(2.7)	95	(1.4)
Measurement	80	(2.9)	78	(3.1)
Number sense and numeration	72	(3.7)	82	(2.4)
Estimation	70	(3.5)	74	(3.0)
Functions	64	(3.7)	86	(2.5)
Patterns and relationships	63	(4.3)	77	(2.5)
Geometry and spatial sense	62	(4.4)	77	(4.1)
Number systems and number theory	59	(4.5)	74	(3.3)
Trigonometry	40	(3.4)	78	(2.4)
Probability and statistics	33	(3.0)	31	(2.9)
Mathematical structure	18	(2.1)	41	(2.8)
Discrete mathematics	17	(2.4)	22	(2.1)
Conceptual underpinning of calculus	14	(2.1)	43	(3.1)

Teachers in both the 1985–86 and 1993 national surveys were asked about their enjoyment of science/mathematics teaching and whether or not they consider themselves to be "master" teachers of these subjects. As can be seen in Table 2.35, in 1993, 86 percent of grade 1–6 science teachers and more than 95 percent of grade 1–6 mathematics, and grade 7–9 and 10–12 science and mathematics teachers reported that they enjoy teaching these subjects. Smaller numbers, but still sizeable percentages at the secondary level consider themselves to be "master" science and mathematics teachers, including nearly 70 percent of grade 7–9 science and mathematics teachers and roughly 75 percent of those in grades 10–12. While elementary science teachers continue to be far less likely than other science and mathematics teachers to perceive of themselves as "master" teachers of their subject, the percentage of grade 1–6 science teachers considering themselves to be "master" science teachers has increased from 14 to 25 percent since 1985–86.

Table 2.35
Teachers' Opinions About Their Science and Mathematics Teaching: 1985–86 and 1993

	Percent of Teachers Agreeing*											
	1985–86						1993					
	Grades 1–6		Grades 7–9		Grades 10–12		Grades 1–6		Grades 7–9		Grades 10–12	
Consider themselves "master" teacher of subject												
Science	14	(1.4)	49	(3.0)	63	(2.6)	25	(1.7)	69	(3.1)	74	(1.8)
Mathematics	44	(2.0)	60	(3.0)	68	(1.9)	49	(2.2)	69	(2.2)	77	(2.0)
Enjoy teaching subject												
Science	83	(1.5)	96	(1.2)	96	(1.1)	86	(1.5)	97	(0.7)	98	(0.4)
Mathematics	93	(0.9)	98	(1.0)	97	(0.7)	96	(0.7)	98	(0.8)	98	(1.1)

* Includes teachers indicating "strongly agree" and "agree" to each statement.

Both science and mathematics teachers were also asked how well prepared they felt for each of a number of tasks they might be expected to accomplish as part of their teaching responsibilities. Table 2.36 shows the percent of grades 1–4, 5–8, and 9–12 mathematics teachers indicating they were either "fairly well prepared" or "very well prepared"; for each task; analogous results for science teachers are presented in Table 2.37.

Note that while greater use of technology is advocated as part of science and mathematics education reform, only from 30 to 40 percent of science teachers and from 43 to 51 percent of mathematics teachers in the various grade ranges feel at least fairly well prepared to use computers as an integral part of instruction. (It is interesting to note that middle and high school mathematics teachers are more confident of their ability to use calculators as an integral part of instruction.)

The 1993 National Survey of Science and Mathematics Education also provided evidence that teachers do not feel well prepared to teach the diversity of students in our nation's schools. On the positive side, the vast majority of science and mathematics teachers reported feeling at least fairly well prepared to encourage the participation of females (ranging from 90 to 95 percent, depending on subject and grade range), to encourage the participation of minorities (80 to 87 percent), and to teach students from a variety of cultural backgrounds (62 to 73 percent). However, only from 23 to 33 percent feel well prepared to teach students who have limited English proficiency. Similarly, while the great majority of teachers can be expected to have students with one or more learning disabilities in their classes sometime in their career, relatively few teachers, especially at the high school, feel qualified to teach these students.

Table 2.36
Mathematics Teachers Considering Themselves Well Prepared* for Each of a Number of Tasks

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Encourage participation of females in mathematics	95	(1.6)	95	(1.1)	92	(1.5)
Present the applications of mathematics concepts	93	(1.6)	93	(2.0)	87	(2.7)
Manage a class of students who are using manipulatives	90	(1.5)	79	(2.5)	62	(2.8)
Teach groups that are heterogeneous in ability	89	(1.8)	85	(2.5)	71	(2.3)
Use cooperative learning groups	87	(1.7)	82	(2.6)	66	(2.9)
Encourage participation of minorities in mathematics	84	(2.9)	84	(2.6)	83	(1.6)
Take into account students' prior conceptions about mathematics when planning curriculum and instruction	81	(2.6)	76	(3.3)	66	(2.3)
Use the textbook as a resource rather than as the primary instructional tool	79	(1.1)	67	(3.8)	62	(3.0)
Integrate mathematics with other subject areas	78	(2.8)	70	(2.9)	50	(2.9)
Use a variety of assessment strategies	77	(2.5)	73	(3.2)	67	(2.1)
Teach students from a variety of cultural backgrounds	70	(2.5)	73	(2.7)	63	(3.0)
Involve parents in the mathematics education of their children	67	(2.6)	57	(2.6)	49	(2.3)
Use performance-based assessment	61	(2.8)	63	(2.6)	58	(2.4)
Use computers as an integral part of mathematics instruction	51	(2.7)	48	(3.7)	43	(2.2)
Use calculators as an integral part of mathematics instruction	55	(2.8)	71	(2.2)	81	(2.4)
Teach students who have learning disabilities	52	(3.6)	43	(3.6)	28	(2.8)
Teach students who have limited English proficiency	28	(3.1)	33	(3.3)	25	(2.4)

* Includes teachers responding "very well prepared" and "fairly well prepared."

In both science and mathematics, high school teachers are less likely than their elementary and middle grade counterparts to feel well prepared to use cooperative learning groups as an instructional strategy. In science, elementary teachers are less likely than middle and high school teachers to feel prepared to present applications of science topics and to manage a class of students using hands-on materials. In contrast, in mathematics, it is the high school teachers who are less likely to feel prepared to use manipulatives; most teachers in all three grade ranges feel well prepared to present applications of mathematics concepts.

Table 2.37
Science Teachers Considering Themselves Well Prepared* for Each of a Number of Tasks

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Encourage participation of females in science	92	(2.0)	94	(1.7)	90	(3.0)
Teach groups that are heterogeneous in ability	89	(2.3)	90	(1.9)	71	(2.9)
Encourage participation of minorities in science	87	(2.3)	86	(2.4)	80	(3.3)
Use cooperative learning groups	83	(2.2)	83	(2.5)	64	(3.4)
Manage a class of students who are using hands-on/ laboratory activities	78	(2.6)	83	(2.1)	91	(3.1)
Use the textbook as a resource rather than as the primary instructional tool	77	(3.1)	70	(3.0)	80	(3.0)
Integrate science with other subject areas	76	(2.3)	67	(3.0)	62	(2.5)
Present the applications of science concepts	74	(2.3)	80	(3.5)	92	(3.1)
Teach students from a variety of cultural backgrounds	73	(2.7)	69	(3.7)	62	(2.3)
Use a variety of assessment strategies	70	(3.0)	78	(3.2)	85	(1.5)
Take into account students' prior conceptions about natural phenomena when planning curriculum and instruction	70	(2.2)	63	(3.8)	62	(3.0)
Use performance-based assessment	60	(2.9)	65	(3.3)	64	(2.7)
Involve parents in the science education of their children	57	(3.6)	56	(3.1)	43	(3.0)
Teach students who have learning disabilities	50	(3.5)	46	(3.1)	27	(1.8)
Teach students who have limited English proficiency	32	(2.7)	25	(3.4)	23	(2.1)
Use computers as an integral part of science instruction	30	(3.4)	31	(2.7)	40	(2.4)

* Includes teachers responding "very well prepared" and "fairly well prepared."

F. Teacher Familiarity with NSF-Supported Curricula

The National Science Foundation (NSF) has provided support for the development of curriculum and instructional materials since the late 1950s. In an attempt to gauge the extent to which these efforts have impacted on science and mathematics education, the 1993 National Survey asked teachers about each of a number of projects in a list supplied by NSF program staff. Response options were: "Have never heard of," "have heard of but not seen," "have seen but not used," and "have used in teaching." Table 2.38 shows the percent of science teachers who had heard of each of the projects, whether or not they had actually seen or used them; analogous results for mathematics are shown in Table 2.39.

In grade 1–4 science, by far the most widely known project in the list was the National Geographic Kids Network (68 percent), followed by several projects in the 35 to 45 percent awareness range, including Biological Science: An Ecological Approach (a high school program, but one that has been around for several decades); SuperScience Magazine, Quantum Magazine for Students (again aimed at a high school audience), and Grow Lab.

Grade 5–8 science teachers were also most likely to have heard of the National Geographic Kids Network (68 percent), followed by Biological Science: An Ecological Approach (57 percent); Second Voyage of the Mimi (49 percent); and Quantum Magazine for Students (43 percent).

At the high school level, science teachers were most likely to know about Biological Science: An Ecological Approach (77 percent); Science For Life and Living (61 percent); ChemCom: Chemistry in the Community (58 percent); National Geographic Kids Network (45 percent); and Second Voyage of the Mimi (40 percent).

Table 2.38
Science Teachers Having Heard of Selected NSF-Supported Curricula

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
National Geographic Kids Network	68	(3.0)	68	(2.8)	45	(2.5)
Biological Science: An Ecological Approach	45	(2.4)	57	(2.7)	77	(1.7)
Quantum Magazine for Students	38	(2.5)	43	(3.2)	37	(1.9)
SuperScience Magazine	38	(2.2)	42	(4.1)	19	(1.5)
Grow Lab, National Gardening Association	35	(2.4)	35	(4.3)	22	(1.3)
Second Voyage of the Mimi (Mayan Expedition)	29	(3.1)	49	(3.7)	40	(2.5)
ScienceVision	26	(3.0)	28	(3.2)	28	(1.5)
Middle School Life Science	24	(2.5)	34	(3.9)	34	(1.9)
Science for Life and Living: Integrating Science, Technology, and Health (BSCS)	24	(2.5)	33	(2.9)	61	(4.3)
Full Option Science System (FOSS Science Kits)	23	(2.2)	31	(3.6)	17	(1.5)
Bottle Biology	22	(2.1)	23	(2.9)	25	(1.8)
Chemical Education for Public Understanding Program (CEPUP)	10	(1.6)	22	(3.9)	26	(1.7)
ChemCom: Chemistry in the Community	10	(1.4)	19	(2.7)	58	(2.9)
Texas Learning Technology Group (TLTG) Physical Science/Math for Science	10	(1.5)	12	(2.2)	13	(1.3)
Wisconsin Fast Plants	7	(1.2)	13	(2.5)	25	(1.7)
Mechanical Universe, High School Adaptation	6	(1.2)	6	(1.5)	27	(1.8)

Awareness of the NSF-supported mathematics materials was generally lower than in science. In grades 1–4, the most widely known materials were Elementary Mathematician (38 percent); Logo Geometry (33 percent); Geometry and Measurement, K–6 (29 percent); and Futures with Jaime Escalante (24 percent).

The same four projects were the most widely known among grade 5–8 mathematics teachers, with percentages having heard of the various materials ranging from 31 to 43 percent. A fifth project, the Middle Grades Mathematics Project, was known by 29 percent of mathematics teachers in these grades.

At the high school level, slightly more than half of mathematics teachers had heard of each of three projects: Geometer's Sketchpad (54 percent); Futures with Jaime Escalante (51 percent); and Logo Geometry (51 percent). Three other projects were known by roughly one-third of high school mathematics teachers, including Computer-Intensive Algebra (35 percent); the High School Mathematics and Its Applications Project (29 percent); and Getting Ready for Algebra (28 percent).

Table 2.39
Mathematics Teachers Having Heard of Selected NSF-Supported Curricula

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Elementary Mathematician	38	(3.3)	32	(3.6)	16	(1.2)
Logo Geometry	33	(2.2)	43	(2.5)	51	(2.7)
Geometry and Measurement, K–6	29	(2.5)	31	(2.8)	21	(1.8)
Futures with Jaime Escalante	24	(2.7)	36	(3.4)	51	(2.8)
Math and the Mind's Eye	18	(3.2)	24	(2.5)	23	(1.7)
Journeys in Mathematics	16	(1.7)	23	(3.1)	19	(1.6)
Calculus and Mathematics Project-Los Angeles (CAMP-LA)	16	(1.7)	20	(3.5)	25	(1.5)
Getting Ready for Algebra	14	(1.9)	26	(2.2)	28	(1.9)
Project Mathematics!	14	(2.0)	22	(2.6)	20	(1.9)
Computer-Intensive Algebra	14	(2.4)	18	(2.4)	35	(2.7)
Used Numbers: Collecting and Analyzing Real Data	12	(1.9)	16	(2.2)	15	(1.4)
Middle Grades Mathematics Project	10	(1.3)	29	(2.8)	20	(1.4)
Quantitative Literacy Series	8	(1.1)	10	(2.0)	14	(1.3)
Geometer's Sketchpad	7	(1.3)	20	(2.0)	54	(2.8)
Jasper Series	6	(0.8)	8	(1.7)	7	(0.9)
High School Math and Its Applications Project (HIMAP)	4	(0.7)	10	(1.6)	29	(2.4)

Chapter Three
Teachers as Professionals

A. Overview

The *National Council of Teachers of Mathematics' Professional Standards for Teaching* and the *National Science Education Standards* describe a vision for teaching in which teachers are treated as professionals—respected for their expertise, allowed to exercise their professional judgement, and provided ample opportunities to work collaboratively with their peers and to continue to learn throughout their careers. The 1993 National Survey of Science and Mathematics Education collected data related to teacher professionalism, including teacher perceptions of their autonomy in making curriculum and instructional decisions, their opportunities for collaborative work, and their participation in in-service education and other professional activities. These data are discussed in the following sections.

B. The School as a Collegial Work Place

Teacher perceptions on issues related to collegiality are shown in Tables 3.1 and 3.2 for science and mathematics, respectively. On the positive side, most science and mathematics teachers in each grade range feel supported by their colleagues to try out new ideas in teaching (from 74 to 87 percent); indicate that teachers in their school share ideas and materials on a regular basis (52 to 72 percent); and feel that they have many opportunities to learn new things in their job (57 to 76 percent). Similarly, most science and mathematics teachers feel supported by their administrators. However, fewer than 1 in 5 have time during the regular school week to work with their peers on science/mathematics curriculum and instruction and only about 1 in 8 indicated that science/mathematics teachers in their school regularly observe each other teaching classes as part of sharing and improving instructional strategies. The picture that emerges is one where teachers feel supported by their colleagues, but have to "steal" moments to work with them.

Table 3.1
Science Teachers Agreeing* with Each of a Number of Statements Related to Teacher Collegiality

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
I feel supported by colleagues to try out new ideas in teaching science	74	(2.3)	76	(3.1)	87	(1.6)
I feel that I have many opportunities to learn new things in my present job	74	(2.2)	68	(3.9)	66	(2.0)
Science teachers in this school regularly share ideas and materials	55	(2.5)	56	(3.1)	72	(2.1)
Most science teachers in this school contribute actively to making decisions about the science curriculum	44	(2.8)	47	(3.8)	66	(2.3)
I receive little support from the school administration for teaching science	21	(2.3)	23	(3.5)	23	(2.6)
I have time during the regular school week to work with my peers on science curriculum and instruction	14	(1.6)	14	(2.4)	16	(3.6)
Science teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	11	(1.8)	11	(1.8)	14	(3.1)
I am required to follow rules at this school that conflict with my best professional judgment	10	(1.4)	13	(1.7)	18	(1.6)

* Includes teachers indicating "strongly agree" and "agree" to each statement.

Table 3.2
Mathematics Teachers Agreeing* with Each of a Number of Statements Related to Teacher Collegiality

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
I feel supported by colleagues to try out new ideas in teaching mathematics	84	(2.0)	83	(3.3)	80	(2.3)
I feel that I have many opportunities to learn new things in my present job	76	(2.3)	72	(2.5)	57	(3.0)
Mathematics teachers in this school regularly share ideas and materials	65	(2.3)	52	(3.2)	67	(2.8)
Most mathematics teachers in this school contribute actively to making decisions about the mathematics curriculum	47	(1.8)	46	(2.8)	69	(2.6)
I have time during the regular school week to work with my peers on mathematics curriculum and instruction	21	(1.9)	17	(1.8)	16	(1.6)
I receive little support from the school administration for teaching mathematics	14	(1.5)	19	(3.1)	20	(2.6)
Mathematics teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	12	(1.8)	10	(2.1)	11	(1.8)
I am required to follow rules at this school that conflict with my best professional judgment	10	(1.8)	14	(2.0)	16	(1.7)

* Includes teachers indicating "strongly agree" and "agree" to each statement.

C. Teacher Perceptions of Their Decisionmaking Autonomy

Underlying many school reform efforts is the notion that classroom teachers are in the best position to know their students' needs and interests, and therefore should be the ones to make decisions for tailoring instruction to a particular group of students. The 1993 National Survey of Science and Mathematics Education asked teachers the extent to which they had control over a number of curriculum and instructional decisions for their classes. Results for grades 1–4, 5–8, and 9–12 science and mathematics teachers are presented in Tables 3.3 and 3.4, respectively. Note that in both science and mathematics, in all grade ranges, teachers are most likely to perceive themselves as having autonomy in selecting teaching techniques (from 66 to 79 percent); determining the amount of homework to be assigned (68 to 81 percent); choosing criteria for grading students (53 to 69 percent); and selecting both the sequence (52 to 68 percent) and the pace (55 to 71 percent) for covering topics. Fewer science and mathematics teachers, especially in the elementary and middle grades, perceive themselves as having strong control in determining the goals and objectives of their courses; selecting the content, topics, and skills to be taught; or selecting textbooks. For example, while teachers in 72 percent of grade 5–8 classes report having strong control over the selection of teaching techniques, only 36 percent of these teachers report strong control in selecting the content, topics, and skills to be taught.

Table 3.3
Science Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Determining the amount of homework to be assigned	72	(2.1)	75	(3.1)	81	(2.5)
Selecting teaching techniques	66	(2.1)	72	(3.0)	79	(3.0)
Choosing criteria for grading students	60	(3.4)	66	(3.1)	69	(2.5)
Selecting the sequence in which topics are covered	56	(2.0)	62	(3.0)	68	(2.7)
Setting the pace for covering topics	56	(2.5)	63	(2.8)	71	(2.6)
Determining goals and objectives	32	(1.9)	40	(3.0)	53	(3.7)
Selecting other instructional materials	30	(2.0)	42	(2.8)	55	(3.8)
Selecting content, topics, and skills to be taught	27	(2.5)	36	(2.6)	50	(3.3)
Selecting textbooks	11	(1.5)	25	(2.3)	45	(4.2)

* Teachers were given a five-point scale for each decision, with 1 labeled as "no control" and 5 labeled "strong control."

Table 3.4
Mathematics Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Selecting teaching techniques	69	(2.7)	71	(2.7)	76	(1.4)
Determining the amount of homework to be assigned	68	(3.1)	72	(2.9)	79	(1.8)
Setting the pace for covering topics	60	(3.3)	55	(3.1)	56	(2.4)
Choosing criteria for grading students	53	(2.7)	63	(2.7)	66	(2.3)
Selecting the sequence in which topics are covered	52	(2.1)	52	(2.9)	54	(2.4)
Selecting other instructional materials	36	(2.3)	40	(2.1)	52	(2.2)
Determining goals and objectives	29	(3.1)	33	(1.8)	41	(2.4)
Selecting content, topics, and skills to be taught	22	(2.0)	27	(2.2)	39	(2.4)
Selecting textbooks	12	(1.4)	20	(2.0)	35	(2.6)

* Teachers were given a five-point scale for each decision, with 1 labeled as "no control" and 5 labeled "strong control."

As can be seen in Table 3.5, there are some large regional differences among science teachers in perceived control over decisionmaking. Given that state-wide textbook adoption is primarily a Southern and Western practice, it is not surprising that science and mathematics teachers in these regions are less likely to consider themselves as having strong control over textbook selection. However, science teachers in the South are substantially less likely than teachers in the other regions to perceive themselves as having strong control over decisions in many other areas as well. For example, only about half of the science teachers in the South feel empowered to select the sequence or pace in which topics are covered, compared to roughly two-thirds of the teachers in the Midwest, Northeast, and West. Regional differences among mathematics teachers are much less pronounced. (See Table 3.6)

Table 3.5
Science Classes Where Grade 1–12 Teachers Report Having Strong Control* Over Various Curriculum and Instructional Decisions, by Region

	Percent of Classes							
	Midwest		Northeast		South		West	
Determining the amount of homework to be assigned	80	(2.2)	76	(1.8)	69	(3.7)	76	(2.3)
Selecting teaching techniques	75	(2.1)	73	(2.0)	65	(3.3)	72	(2.5)
Choosing criteria for grading students	70	(2.7)	68	(2.3)	54	(3.0)	66	(3.9)
Selecting the sequence in which topics are covered	68	(1.9)	64	(2.3)	53	(3.4)	61	(2.4)
Setting the pace for covering topics	66	(2.0)	67	(1.8)	51	(3.0)	66	(2.4)
Selecting content, topics, and skills to be taught	43	(2.5)	40	(3.9)	27	(2.8)	35	(2.3)
Selecting other instructional materials	43	(2.5)	43	(4.8)	34	(3.3)	42	(2.5)
Determining goals and objectives	43	(2.3)	42	(3.2)	30	(3.0)	46	(1.9)
Selecting textbooks	35	(2.2)	31	(3.6)	13	(2.8)	23	(2.8)

* Teachers were given a five-point scale for each decision, with 1 labeled as "no control" and 5 labeled "strong control."

Table 3.6
Mathematics Classes Where Grade 1–12 Teachers Report Having Strong Control* Over Various Curriculum and Instructional Decisions, by Region

	Percent of Classes							
	Midwest		Northeast		South		West	
Selecting teaching techniques	73	(1.6)	70	(3.2)	71	(2.6)	72	(2.7)
Determining the amount of homework to be assigned	71	(1.9)	68	(3.4)	76	(3.7)	74	(3.2)
Choosing criteria for grading students	60	(3.4)	62	(2.2)	56	(2.5)	62	(2.3)
Setting the pace for covering topics	58	(4.0)	54	(3.7)	54	(3.4)	61	(2.6)
Selecting the sequence in which topics are covered	57	(2.1)	48	(3.0)	51	(3.8)	54	(2.5)
Selecting other instructional materials	47	(3.4)	39	(2.8)	38	(3.0)	42	(3.1)
Determining goals and objectives	35	(2.4)	31	(2.3)	32	(4.7)	36	(2.1)
Selecting content, topics, and skills to be taught	33	(2.9)	28	(2.9)	23	(2.4)	30	(2.3)
Selecting textbooks	29	(2.0)	23	(2.2)	14	(1.9)	20	(2.8)

* Teachers were given a five-point scale for each decision, with 1 labeled as "no control" and 5 labeled "strong control."

D. Professional Development

Having discretion in making curriculum and instructional decisions is one of the hallmarks of teachers as professionals. Another is keeping up with advances in their field. Table 3.7 shows the percentages of science and mathematics teachers in grades 1–4, 5–8, and 9–12 spending various amounts of time on in-service education in their field in the last three years. While most science and mathematics teachers have had at least some in-service education in their field during that time, relatively few have devoted a substantial amount of time to these activities; percentages of teachers spending 35 or more hours on in-service education in science/mathematics in the prior three years ranged from 9 percent of grade 1–4 science teachers to 38 percent of high school science teachers.

Table 3.7
Time Spent on In-Service Education in Science and Mathematics in Last Three Years

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
None	26	(2.8)	17	(1.9)	12	(1.5)
< 6 Hours	30	(1.8)	22	(2.6)	14	(1.8)
6–15 Hours	22	(2.1)	27	(4.2)	18	(3.0)
16–35 Hours	14	(1.9)	14	(2.8)	19	(1.4)
> 35 Hours	9	(1.8)	20	(2.4)	38	(3.1)
Mathematics						
None	17	(1.5)	15	(1.5)	10	(1.8)
< 6 Hours	22	(2.0)	22	(3.5)	14	(2.8)
6–15 Hours	29	(2.4)	23	(2.5)	21	(1.8)
16–35 Hours	18	(2.4)	24	(2.5)	24	(2.6)
> 35 Hours	15	(2.0)	17	(2.0)	31	(2.2)

Trend data available for science and mathematics teachers in grades 1–6, 7–9, and 10–12 indicate an increase in the percent of teachers participating in in-service education. For example, in 1993 only 19 percent of grade 10–12 mathematics teachers indicated they had not participated in any in-service activities in mathematics in the last 12 months, down from 35 percent in 1985–86. (See Table 3.8.)

Earlier it was noted that high school mathematics teachers who do not teach advanced classes have weaker content backgrounds than do teachers of advanced mathematics classes. Unfortunately, while these teachers appear to be more in need of in-service education to strengthen their content knowledge, they are less likely to receive it. As can be seen in Table 3.9, only 44 percent of high school mathematics teachers who teach lower level classes had 16 or more hours of in-service education in the last three years, compared to 63 percent of those who teach at least one advanced mathematics class.

Table 3.8
Time Spent on In-Service Education in Science and Mathematics in Last 12 Months: 1985–86 and 1993

	Percent of Teachers											
	1985–86						1993					
	Grades 1–6		Grades 7–9		Grades 10–12		Grades 1–6		Grades 7–9		Grades 10–12	
Science												
None	53	(2.0)	31	(2.8)	28	(1.8)	43	(3.1)	23	(4.3)	21	(2.5)
< 6 Hours	24	(1.7)	23	(2.5)	22	(1.7)	31	(2.0)	23	(3.0)	23	(2.3)
6–15 Hours	14	(1.4)	23	(2.5)	25	(1.7)	20	(1.6)	30	(3.0)	32	(3.0)
16–35 Hours	5	(0.9)	13	(2.0)	12	(1.3)	4	(0.5)	16	(1.8)	13	(1.3)
> 35 Hours	3	(0.7)	11	(1.9)	12	(1.3)	3	(0.5)	9	(2.1)	11	(1.2)
Mathematics												
None	43	(2.0)	31	(2.8)	35	(2.6)	33	(3.2)	20	(2.4)	19	(3.1)
< 6 Hours	33	(1.9)	27	(2.7)	19	(2.2)	32	(2.4)	32	(3.6)	25	(1.9)
6–15 Hours	16	(1.5)	23	(2.5)	22	(2.3)	21	(1.8)	26	(2.5)	31	(2.9)
16–35 Hours	5	(0.9)	12	(1.9)	14	(1.9)	8	(0.9)	11	(1.6)	14	(1.7)
> 35 Hours	3	(0.7)	8	(1.6)	9	(1.6)	6	(1.2)	10	(1.2)	11	(1.2)

Table 3.9
Time Spent by Mathematics Teachers on In-Service Education in Mathematics in Last 12 Months and Last Three Years, by Teaching Assignment

	Percent of Teachers			
	Teach No Advanced Mathematics Courses		Teach At Least One Advanced Mathematics Course	
Last 12 Months				
None	23	(3.9)	15	(2.6)
Less Than 16 Hours	56	(4.7)	57	(3.0)
16 or More Hours	21	(2.8)	28	(2.3)
Last Three Years				
None	13	(2.5)	7	(2.0)
Less Than 16 Hours	42	(4.3)	30	(2.8)
16 or More Hours	44	(3.8)	63	(3.2)

Tables 3.10 and 3.11 show that science and mathematics teachers in the higher grades are more likely than those in the lower grades to have taken college coursework in their discipline in recent years. The pattern is much more pronounced in science than in mathematics. For example, in 1993 50 percent of grade 9–12 science teachers compared to 36 percent in grades 5–8 and 18 percent in grades 1–4 had taken a science course for college credit since 1989. Analogous figures for mathematics teachers are 33 percent in grades 9–12, 29 percent in grades 5–8, and 23 percent in grades 1–4.

Table 3.10
Science Teachers' Most Recent College Coursework in Field

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
1989–1993	18	(2.0)	36	(3.0)	50	(2.9)
1983–1988	23	(1.8)	18	(1.8)	22	(1.3)
Prior to 1983	60	(2.3)	46	(2.8)	28	(3.3)
Science Education						
1989–1993	23	(2.6)	33	(2.0)	40	(2.5)
1983–1988	20	(2.1)	16	(1.5)	20	(1.3)
Prior to 1983	57	(2.7)	52	(3.3)	40	(3.7)
Science or Science Education						
1989–1993	26	(3.0)	41	(2.8)	55	(3.2)
1983–1988	20	(2.1)	18	(1.6)	21	(1.5)
Prior to 1983	53	(2.5)	41	(3.0)	24	(3.8)

Table 3.11
Mathematics Teachers' Most Recent College Coursework in Field

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Mathematics						
1989–1993	23	(1.9)	29	(2.6)	33	(2.2)
1983–1988	24	(2.2)	24	(3.2)	29	(3.2)
Prior to 1983	53	(2.6)	47	(3.6)	39	(1.8)
Mathematics Education						
1989–1993	34	(2.1)	36	(3.7)	36	(2.0)
1983–1988	24	(1.8)	18	(2.1)	24	(2.3)
Prior to 1983	42	(2.3)	46	(3.7)	40	(2.1)
Mathematics or Mathematics Education						
1989–1993	38	(2.6)	44	(3.3)	45	(2.2)
1983–1988	22	(1.9)	20	(3.1)	24	(2.7)
Prior to 1983	40	(2.3)	36	(3.8)	31	(1.8)

Teachers were also asked whether or not they had participated in each of a number of professional activities in the 12-month period preceding the survey; these data are presented in Tables 3.12 and 3.13. In both science and mathematics, grade 9–12 teachers were generally more likely than grade 5–8 teachers, who in turn were more likely than grade 1–4 teachers, to have participated in each activity. For example, 51 percent of high school mathematics teachers indicated serving on a school or district mathematics curriculum committee in the past 12 months, compared to 25 percent of grade 5–8 mathematics teachers and 18 percent of those in grades 1–4.

Similarly, 37 percent of high school science teachers, compared to 20 percent in grades 5–8 and 7 percent in grades 1–4, had attended a state or national science teachers association meeting in the previous year. And roughly 1 in 6 high school science teachers, but only about 1 in 20 at the elementary level had been involved in teaching science in-service workshops for other teachers. Finally, high school science teachers were considerably more likely than science teachers in the lower grades or mathematics teachers in any grade to have received a local, state, or national grant or award related to their teaching in these fields.

Table 3.12
Science Teachers Participating in Various Science-Related Professional Activities in Last 12 Months

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Served on a school or district curriculum committee	17	(3.4)	26	(2.3)	40	(2.7)
Served on a school or district textbook selection committee	14	(2.0)	19	(2.1)	37	(2.9)
Attended any national or state teacher association meeting	7	(1.0)	20	(3.0)	37	(3.3)
Taught any in-service workshop or course in science or science teaching	5	(1.1)	9	(1.2)	16	(2.0)
Received a local, state, or national grant or award	3	(0.7)	8	(1.3)	17	(0.7)

Table 3.13
Mathematics Teachers Participating in Various Mathematics-Related Professional Activities in Last 12 Months

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Served on a school or district curriculum committee	18	(1.9)	25	(2.6)	51	(2.5)
Served on a school or district textbook selection committee	16	(2.0)	31	(2.7)	47	(2.9)
Attended any national or state teacher association meeting	9	(1.4)	19	(2.1)	39	(2.6)
Taught any in-service workshop or course in mathematics or mathematics teaching	6	(1.4)	6	(0.8)	13	(1.2)
Received a local, state, or national grant or award	3	(0.7)	3	(0.8)	8	(0.6)

Chapter Four

Science and Mathematics Courses

A. Overview

The 1993 National Survey of Science and Mathematics Education collected data on science and mathematics course offerings in the nation's schools. Teachers provided information about time spent in elementary science and mathematics instruction; titles and duration of secondary science and mathematics courses; class sizes; ability levels; gender and race/ethnic composition; and number of students with various types of special needs. These data are presented in the following sections.

B. Time Spent in Elementary Science and Mathematics Instruction

Each teacher was asked to indicate the number of minutes spent in the most recent lesson in the selected subject and class. It was recognized that some subjects are not taught every day in some classes; for example, some elementary classes have instruction in reading and mathematics every day and in science and social studies only on alternate days. Consequently, teachers were asked to indicate if the selected lesson had taken place on the most recent school day. As can be seen in Table 4.1, mathematics is taught more frequently than science in the early grades. On a typical day, 95 percent of grade 1–4 classes spend time on mathematics instruction, but only 62 percent spend time on science instruction.

Table 4.1
Science and Mathematics Lessons
Taught on Most Recent Day of School

	Percent of Classes			
	Science		Mathematics	
Grades 1–4	62	(2.8)	95	(1.1)
Grades 5–8	85	(2.2)	93	(1.8)
Grades 9–12	94	(1.0)	93	(1.1)

To avoid overestimating the number of minutes typically spent on science and mathematics, if the most recent lesson did not take place on the last day school was in session, the number of minutes was treated as zero when the average was computed. Table 4.2 shows the average number of minutes per day spent in grade 1–3 and 4–6 science and mathematics instruction in 1977, 1985–86, and 1993.[2] Note that the time spent on science and mathematics instruction in grades 1–3 has increased in the last decade, but that at each grade level, considerably more time is spent on mathematics instruction than on science instruction.

Table 4.2
Average Number of Minutes Per Day Spent in Elementary Science and Mathematics: 1977, 1985–86 and 1993*

	Number of Minutes					
	1977		1985–86		1993	
Science						
Grades 1–3**	19	(4.1)	19	(1.0)	24	(1.6)
Grades 4–6	35	(1.7)	38	(5.3)	34	(1.3)
Mathematics						
Grades 1–3**	38	(2.5)	38	(1.2)	45	(1.3)
Grades 4–6	44	(2.1)	49	(1.5)	48	(1.1)

* Classes in which the most recent lesson was not on the last day school was in session were assigned zeros for the number of minutes spent in the lesson.

** 1977 and 1985–86 figures include Kindergarten.

In addition to asking teachers about the number of minutes spent in their most recent lesson in a particular subject, each elementary teacher was asked to write in the approximate number of minutes *typically* spent teaching mathematics, science, social studies, and reading. The average number of minutes per day typically spent on instruction in each subject in grades 1–3 and 4–6 is shown in Table 4.3; to facilitate comparisons among the subject areas, only teachers who teach all four of these subjects to one class of students were included in these analyses. In 1993, grade 1–3 self-contained classes spent an average of 84 minutes on reading instruction, and 51 minutes on mathematics instruction, compared to only 24 minutes on science and 23 minutes on social studies instruction. Differences in instructional time on the various subjects are less pronounced in grades 4–6, ranging from 62 minutes spent on reading and 54 minutes on mathematics to from 33 to 36 minutes on science and social studies instruction. Note that the time spent on reading in the primary grades declined between 1977 and 1985–86, but then leveled off. In contrast, the time spent on both mathematics and science has increased steadily since 1977, especially in grades 1–3.

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[2] The reader should exercise caution in interpreting these results since they are based on teacher estimates of time spent, rather than on actual measurements.

Table 4.3
Average Number of Minutes Per Day Spent Teaching Each Subject in Self-Contained Classes: 1977, 1985–86, and 1993*

	Number of Minutes							
	Reading		Mathematics		Science		Social Studies	
1977								
K–3**	96	(1.6)	41	(0.6)	17	(0.2)	21	(0.6)
4–6	66	(1.3)	51	(0.4)	28	(0.6)	34	(0.7)
1985–86								
1–3	84	(1.6)	46	(0.6)	20	(0.4)	20	(0.4)
4–6	63	(1.3)	52	(0.6)	29	(0.6)	33	(0.5)
1993								
1–3	84	(1.4)	51	(0.7)	24	(0.6)	23	(0.6)
4–6	62	(1.3)	54	(0.6)	33	(1.0)	36	(0.7)

* Only teachers who indicated they teach reading, mathematics, science, and social studies to one class of students were included in these analyses.

** Note that figures for 1977 include Kindergarten teachers.

C. Science and Mathematics Course Offerings

Each sample school that included grades seven or higher was given a list of science and mathematics courses and asked to specify the number of sections of each course offered in the school. Respondents were also asked to write in course names for those science and mathematics courses offered in the school which were not already on the list.

Table 4.4 shows the percent of schools with grades 7 or 8 offering each science course; data for grade 9–12 science courses are provided in Table 4.5. The most commonly offered science course in grades 7–8 is life science, with 68 percent of schools with one or both of these grades offering life science courses. Slightly more than half of schools with grades 7 or 8 offer earth science courses; 36 percent offer physical science in grades 7 or 8; and 42 percent offer some form of general, coordinated, or integrated science in these grades.

At the high school level, a total of 98 percent of schools with one or more of grades 10, 11, or 12 offer courses in biology, with 96 percent offering such first year courses as Biology I, Introductory Biology, General Biology, Regents Biology, and College-Prep Biology; and 22 percent offering applied courses such as Basic Biology; 22 percent offering Advanced Placement Biology; and 49 percent offering another second year advanced biology course.

Table 4.4
Schools Offering Various Science Courses, Grades 7 or 8

	Percent of Schools	
Life Science	68	(5.5)
Earth Science	53	(4.9)
Physical Science	36	(4.8)
General Science	18	(3.6)
Coordinated Science	17	(5.9)
Integrated Science	10	(3.7)
General, Coordinated, or Integrated Science	42	(5.8)

The vast majority of high schools (94 percent) offer such courses as Chemistry I, or General, Introductory, or Regents Chemistry; 14 percent offer applied chemistry courses such as Consumer, Technical, or Practical Chemistry; 18 percent offer Advanced Placement Chemistry; and 16 percent offer another second year advanced chemistry course.

Overall, 88 percent of high schools offer a course in first year physics, such as Physics I, or General, Introductory, or Regents Physics; only 9 percent offer a first-year course in applied physics such as Practical Physics, Electronics, or Radiation Physics. Relatively few high schools (14 percent) offer one or more advanced physics courses, with 10 percent offering advanced placement physics and only 5 percent offering other advanced physics courses.

Far fewer high schools offer coursework in earth science (38 percent) than in the other science disciplines, with first-year courses in earth science, or earth/space science, considerably more common than courses in specific earth science disciplines such as oceanography, astronomy, geology, or meteorology. Only 3 percent of high schools offer any second-year earth science courses.

While a sizeable number of high schools offer courses in general science (29 percent), only 6 percent indicated they offer courses in either "coordinated" or "integrated" science, defined for this survey as courses than "include content from more than one science discipline, e.g., life and physical science," either coordinated (keeping the disciplines separate) or integrated by blurring the distinctions among disciplines.

Table 4.5
Schools Offering Various Science Courses, Grade 9 and Grades 10, 11, or 12

	Percent of Schools			
	Schools with Grade 9		Schools with Grades 10, 11, or 12	
1st Year Biology	90	(3.8)	96	(1.8)
1st Year Applied Biology	19	(2.1)	22	(2.1)
Any 1st Year Biology	91	(3.6)	98	(1.0)
2nd Year AP Biology	19	(2.7)	22	(2.8)
2nd Year Advanced Biology	44	(3.2)	49	(3.0)
2nd Year Other Biology	18	(2.5)	20	(2.4)
Any 2nd Year Biology	66	(3.1)	74	(1.9)
Any Advanced 2nd Year Biology	57	(3.2)	64	(2.6)
1st Year Chemistry	86	(3.7)	94	(2.2)
1st Year Applied Chemistry	13	(1.9)	14	(2.0)
Any 1st Year Chemistry	86	(3.7)	94	(2.2)
2nd Year AP Chemistry	15	(1.6)	18	(1.6)
2nd Year Advanced Chemistry	14	(1.5)	16	(1.5)
Any 2nd Year Chemistry	15	(1.6)	18	(1.6)
1st Year Physics	80	(4.8)	88	(3.9)
1st Year Applied Physics	8	(1.2)	9	(1.5)
Any 1st Year Physics	80	(4.7)	88	(3.8)
2nd Year AP Physics	8	(1.0)	10	(1.1)
2nd Year Advanced Physics	5	(1.0)	5	(1.1)
Any 2nd Year Physics	13	(1.2)	14	(1.3)
Physical Science	42	(3.3)	44	(3.0)
Astronomy/Space Science	6	(1.0)	6	(1.1)
Geology	4	(1.4)	5	(1.5)
Meteorology	1	(0.4)	1	(0.5)
Oceanography/Marine Science	6	(0.9)	7	(1.0)
1st Year Earth Science	31	(3.7)	30	(3.0)
1st Year Applied Earth Science	2	(0.3)	2	(0.3)
Any 1st Year Earth Science Course	39	(3.8)	38	(3.3)
2nd Year Advanced Earth Science	1	(0.6)	2	(0.6)
Any 2nd Year Earth Science	3	(1.4)	3	(1.5)
Other Earth Science	2	(1.3)	2	(1.4)
General Science	27	(3.5)	29	(3.4)
Environmental Science	22	(2.2)	24	(2.3)
Science, Technology, and Society	5	(1.2)	5	(1.3)
Coordinated Science	2	(0.6)	2	(0.6)
Integrated Science	4	(1.3)	4	(1.3)
Coordinated and Integrated Science	6	(1.4)	6	(1.4)
General, Coordinated, or Integrated Science	32	(3.4)	34	(3.2)

In mathematics, most schools with grades 7 or 8 offer courses in regular mathematics at those grades, 91 percent offering Regular Math 7 and 79 percent offering Regular Math 8. (See Table 4.6.) Overall, 58 percent of schools at this level offer Algebra I to their eighth graders.

Table 4.6
Schools Offering Various Mathematics Courses, Grades 7 or 8

	Percent of Schools	
Remedial Math, Grade 7	33	(5.4)
Regular Math, Grade 7	91	(2.4)
Accelerated Math, Grade 7	51	(6.0)
Remedial Math, Grade 8	32	(4.8)
Regular Math, Grade 8	79	(5.1)
Enriched Math, Grade 8	34	(4.4)
Algebra I, Grade 8	58	(5.5)
Enriched or Algebra I, Grade 8	69	(5.0)

At the high school level, the traditional three year formal mathematics sequence is offered in virtually all schools with grades 10, 11, or 12, with 98 percent offering Introductory Algebra or the first year in a unified/integrated mathematics sequence; 97 percent offering Geometry or a second formal unified course; and 97 percent offering Intermediate Algebra or a third year of unified/integrated mathematics. While 90 percent of high schools offer a fourth year in the formal mathematics sequence, including such courses as Trigonometry, Advanced Algebra, and Pre-Calculus, only 41 percent of high schools offer level five courses such as Calculus and only 34 percent offer a course in Advanced Placement Calculus. (See Table 4.7.)

Table 4.7
Schools Offering Various Mathematics Courses, Grade 9 and Grades 10, 11, or 12

	Percent of Schools			
	Grade 9		Grades 10, 11, or 12	
Review Math Level 1 (e.g., Remedial Math)	40	(2.9)	41	(2.7)
Review Math Level 2 (e.g., Consumer Math)	51	(3.9)	56	(3.7)
Review Math Level 3 (e.g., General Math 3)	25	(3.4)	28	(3.5)
Review Math Level 4 (e.g., General Math 4)	10	(3.0)	11	(3.2)
Informal Math Level 1 (e.g., Pre-Algebra)	59	(3.6)	57	(3.5)
Informal Math Level 2 (e.g., Basic Geometry)	28	(3.3)	31	(3.3)
Informal Math Level 3 (e.g., after Pre-Algebra, but not Algebra I)	15	(2.4)	17	(2.6)
Formal Math Level 1 (e.g., Algebra I)	97	(1.2)	98	(1.2)
Formal Math Level 2 (e.g., Geometry)	95	(1.4)	97	(1.4)
Formal Math Level 3 (e.g., Algebra II)	89	(3.4)	97	(1.5)
Formal Math Level 4 (e.g., Advanced Algebra)	81	(4.0)	90	(2.7)
Formal Math Level 5 (Calculus)	37	(2.9)	41	(2.8)
Advanced Placement Calculus	29	(2.6)	34	(2.7)
Probability/Statistics	12	(1.8)	13	(2.0)
Math integrated with other subjects	3	(0.8)	3	(0.8)

In addition to obtaining information on school course offerings, the survey instruments requested that each science and mathematics teacher provide the title of a randomly selected class. As can be seen in Table 4.8, the most common science courses in grades 7 and 8 are Life Science (44 percent of classes) and Earth Science (21 percent). Physical Science, General Science, and Coordinated/Integrated Science each account for slightly more than 10 percent of grade 7 and 8 science classes. One out of every three science classes in grades 9–12 is first-year Biology, first-year Chemistry, Physical Science, and Earth Science each account for 10 to 16 percent of classes at that level.

Slightly more than half of seventh and eighth grade mathematics classes are "regular mathematics"; 42 percent are some kind of enriched or accelerated mathematics; and 5 percent are remedial mathematics. In grades 9–12, the most commonly offered courses are Algebra I, Geometry, and Algebra II, each accounting for approximately 20 percent of mathematics classes. More advanced mathematics, including Algebra III, Pre-Calculus, and

Calculus, comprise 15 percent of grade 9–12 classes. "Informal" mathematics classes such as Basic Algebra and Basic Geometry account for 13 percent of grade 9–12 mathematics classes, while 10 percent of classes at this level focus on review mathematics.

Table 4.8
Most Commonly Offered Grade 7–12
Science and Mathematics Classes

	Percent of Classes	
Grades 7–8 Science		
Life Science	44	(5.0)
Earth Science	21	(3.6)
Physical Science	12	(2.1)
General Science	11	(2.4)
Coordinated Science	9	(2.0)
Integrated Science	3	(0.7)
	100	
Grades 9–12 Science		
1st Year Biology	33	(2.1)
Advanced Biology	7	(1.3)
1st Year Chemistry	16	(1.1)
Advanced Chemistry	2	(2.1)
1st Year Physics	7	(0.6)
Advanced Physics	2	(0.5)
Physical Science	15	(1.5)
Earth Science	10	(2.2)
General Science	4	(1.2)
Integrated/Coordinated/Other Science	4	(0.7)
	100	
Grades 7–8 Mathematics		
Regular Mathematics, 7	32	(3.3)
Accelerated Mathematics, 7	18	(2.8)
Remedial Mathematics, 7	2	(0.7)
Regular Mathematics, 8	22	(3.1)
Enriched Mathematics, 8	14	(2.4)
Algebra I, Grade 8	10	(2.1)
Remedial Mathematics, 8	3	(0.9)
	100	
Grades 9–12 Mathematics		
Algebra I/Mathematics 1	22	(1.5)
Geometry/Mathematics 2	21	(1.7)
Algebra II/Mathematics 3	19	(1.8)
Advanced Mathematics/Calculus	15	(1.2)
Informal/Basic Mathematics	13	(1.3)
Review/General Mathematics	10	(1.3)
	100	

D. Other Characteristics of Science and Mathematics Classes

As can be seen in Table 4.9, the average size of science and mathematics classes varies slightly by subject and grade range, but is generally around 22 to 25 students. Table 4.10 shows trends in average class size since 1977 for the grade range categories used in the earlier reports. Note that average science and mathematics class sizes decreased between 1977 and 1985–86 in most grade ranges and leveled off between 1985–86 and 1993.

Table 4.9
Average Science and Mathematics Classroom Size

	Average Size			
	Science		Mathematics	
Grades 1–4	22.7	(0.4)	22.2	(0.3)
Grades 5–8	24.9	(0.4)	23.6	(0.6)
Grades 9–12	23.0	(0.4)	21.9	(0.4)
Grade 9–12 Science Courses				
1st Year Biology	24.8	(0.4)	--	--
1st Year Chemistry	22.4	(0.6)	--	--
1st Year Physics	19.9	(0.7)	--	--
Advanced Science Courses	18.7	(1.0)	--	--
Grade 9–12 Mathematics Courses				
Review Mathematics	--	--	18.9	(0.8)
Informal Mathematics	--	--	23.3	(0.7)
Algebra I	--	--	23.4	(0.8)
Geometry	--	--	23.0	(0.6)
Algebra II and Higher Mathematics	--	--	20.1	(0.6)

Table 4.10
Trends in Average Science and Mathematics Class Sizes: 1977, 1985–86, and 1993

	Average Size					
	1977		1985–86		1993	
Science						
Grades 1–3*	23.5	(0.4)	23.8	(0.4)	22.6	(0.4)
Grades 4–6	26.6	(0.7)	24.6	(0.5)	24.3	(0.5)
Grades 7–9	30.6	(0.7)	23.7	(0.4)	24.1	(0.4)
Grades 10–12	22.8	(0.4)	22.1	(0.3)	22.8	(0.4)
Mathematics						
Grades 1–3*	24.2	(0.2)	22.9	(0.3)	22.0	(0.3)
Grades 4–6	27.7	(0.5)	23.5	(0.6)	24.0	(0.6)
Grades 7–9	26.7	(0.3)	23.5	(0.4)	22.7	(0.4)
Grades 10–12	23.6	(0.5)	21.8	(0.4)	21.6	(0.5)

* 1977 figures include Kindergarten.

Teachers were asked whether students in the randomly selected science or mathematics class were assigned to that class by level of ability. Table 4.11 shows that the practice of assigning students to classes by ability level is more prevalent in mathematics than in science, and in each case is much more common in the higher grades, with half of grade 9–12 science classes and two-thirds of grade 9–12 mathematics classes having students assigned by ability level.

Table 4.11
Students Assigned to Science and Mathematics Classes, by Ability Level

	Percent of Classes			
	Science		Mathematics	
Grades 1–4	6	(2.6)	14	(2.3)
Grades 5–8	15	(1.7)	46	(2.5)
Grades 9–12	50	(2.5)	66	(1.8)

Teachers were also asked to indicate the ability make-up of the selected class, specifying the ability level of the students if the class was fairly homogeneous in ability or indicating that it was a mixture of ability levels. As can be seen in Table 4.12, roughly two-thirds of classes in grades 1–4 are heterogeneous in ability; most of the remaining classes are composed primarily of average ability students. The percent of classes that are heterogeneous in ability declines with increasing grade level; only about one-third of high school science and mathematics classes are comprised of students of varying ability levels. And, as can be seen in Table 4.13, the high school science and mathematics courses that are typically taken in the ninth or tenth grade (Biology, Geometry) are more likely to be heterogeneously grouped than are the more advanced courses in the traditional college-preparatory sequence.

Table 4.12
Ability Grouping in Science and Mathematics Classes, by Grade Range

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science Classes						
Fairly homogeneous and low in ability	6	(1.8)	4	(0.5)	10	(1.7)
Fairly homogeneous and average in ability	24	(2.2)	26	(2.2)	26	(1.9)
Fairly homogeneous and high in ability	4	(1.1)	12	(1.9)	27	(3.0)
Heterogeneous, with a mixture of two or more ability levels	66	(2.6)	58	(2.4)	37	(1.5)
Mathematics Classes						
Fairly homogeneous and low in ability	6	(0.9)	8	(1.1)	11	(1.3)
Fairly homogeneous and average in ability	24	(2.1)	25	(2.7)	34	(1.5)
Fairly homogeneous and high in ability	7	(1.7)	22	(2.5)	24	(2.4)
Heterogeneous, with a mixture of two or more ability levels	63	(2.6)	46	(2.3)	32	(2.0)

Table 4.13
Ability Grouping in Selected High School Science and Mathematics Classes

	Percent of Classes							
	Low		Average		High		Heterogeneous	
Science Classes								
1st Year Biology	12	(3.7)	33	(3.8)	16	(2.7)	39	(5.8)
1st Year Chemistry	3	(1.2)	35	(3.7)	36	(5.0)	26	(3.3)
1st Year Physics	1	(0.9)	23	(4.1)	50	(6.8)	26	(5.0)
Mathematics Classes								
Geometry/Integrated Math 2	5	(2.0)	37	(4.6)	20	(2.7)	39	(4.2)
Algebra II/Integrated Math 3	4	(1.2)	33	(3.8)	35	(7.5)	28	(5.6)
Algebra III/Integrated Math 4/Calculus	1	(0.5)	15	(2.6)	62	(3.3)	23	(3.7)

Table 4.14 presents data on ability grouping for science classes categorized by the percent of minority students in the class; comparable data for mathematics classes are shown in Table 4.15. Note that in both science and mathematics, classes with a high proportion of minority students are more likely to be labeled "low ability." For example, while overall 26 percent of mathematics classes in grades 5–8 have at least 40 percent minority students, 57 percent of the "low ability" classes are high minority.

Table 4.14
Ability Grouping in Grade 1–12 Science Classes with Low, Medium, and High Percentages of Minority Students

	Percent of Classes									
	Total		Low		Average		High		Heterogeneous	
Grades 1–4										
< 10% Minority	39	(3.5)	23	(13.8)	43	(5.1)	43	(15.6)	38	(3.4)
10–39% Minority	34	(2.8)	19	(6.5)	29	(4.6)	48	(18.8)	37	(3.5)
≥ 40% Minority	27	(3.1)	58	(11.4)	28	(5.0)	9	(8.1)	25	(3.1)
Grades 5–8										
< 10% Minority	46	(3.5)	24	(8.2)	51	(5.0)	55	(8.3)	43	(5.0)
10–39% Minority	29	(2.6)	26	(7.7)	26	(4.8)	36	(7.9)	29	(3.5)
≥ 40% Minority	26	(2.7)	50	(7.2)	24	(4.2)	10	(2.8)	28	(4.3)
Grades 9–12										
< 10% Minority	52	(2.6)	44	(9.2)	52	(2.7)	60	(5.2)	49	(5.0)
10–39% Minority	29	(2.6)	28	(6.2)	32	(2.7)	30	(4.0)	26	(3.8)
≥ 40% Minority	19	(1.7)	28	(5.9)	16	(2.4)	9	(1.5)	25	(3.5)

Table 4.15
Ability Grouping in Grade 1–12 Mathematics Classes with Low, Medium, and High Percentages of Minority Students

	Percent of Classes									
	Total		Low		Average		High		Heterogeneous	
Grades 1–4										
< 10% Minority	43	(2.4)	13	(5.9)	43	(3.5)	52	(12.6)	44	(3.5)
10–39% Minority	33	(2.6)	12	(3.3)	38	(4.4)	26	(9.4)	33	(3.3)
≥ 40% Minority	25	(2.5)	75	(6.3)	19	(3.6)	22	(9.7)	22	(2.9)
Grades 5–8										
< 10% Minority	40	(2.7)	23	(4.9)	44	(5.8)	53	(7.7)	36	(4.5)
10–39% Minority	34	(1.8)	20	(5.9)	36	(5.6)	26	(5.2)	38	(2.8)
≥ 40% Minority	26	(2.8)	57	(6.2)	21	(4.0)	21	(2.0)	26	(3.6)
Grades 9–12										
< 10% Minority	51	(1.9)	29	(5.7)	55	(2.0)	61	(5.1)	47	(3.7)
10–39% Minority	29	(1.5)	29	(5.8)	30	(2.0)	30	(4.6)	28	(4.7)
≥ 40% Minority	20	(1.4)	42	(6.6)	15	(1.6)	9	(2.2)	25	(3.8)

Teachers were also asked to indicate if the randomly selected science/mathematics class included students who were formally classified as limited English proficiency, learning disabled, mentally handicapped, or physically handicapped. As can be seen in Table 4.16, slightly more than half of the science and mathematics classes in grades 1–4 include students with learning disabilities, decreasing to fewer than 1 in 3 overall in grades 9–12 at the high school level and only 6 percent of science classes and 13 percent of mathematics classes in grade 12 (see Table 4.17) suggesting that students with learning disabilities tend to stop taking elective science and mathematics courses.

Table 4.16
Science and Mathematics Classes With One or More Disabled Students

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
Learning Disabled	53	(3.2)	54	(3.3)	31	(2.7)
Limited English Proficiency	22	(2.3)	18	(2.0)	14	(1.3)
Mentally Handicapped	9	(1.4)	7	(1.2)	2	(0.3)
Physically Handicapped	4	(0.8)	6	(1.3)	5	(1.0)
Mathematics						
Learning Disabled	52	(2.6)	40	(2.6)	24	(1.4)
Limited English Proficiency	20	(2.1)	16	(2.1)	15	(1.4)
Mentally Handicapped	5	(0.6)	2	(0.6)	1	(0.2)
Physically Handicapped	6	(1.1)	4	(1.4)	2	(0.4)

Table 4.17
Science and Mathematics Classes with One or More Learning Disabled Students

	Percent of Classes			
	Science		Mathematics	
Grade 9	44	(5.0)	36	(3.1)
Grade 10	34	(5.1)	20	(2.6)
Grade 11	16	(3.6)	19	(5.0)
Grade 12	6	(1.5)	13	(4.2)

From 14 to 22 percent of science and mathematics classes in grades 1–4, 5–8, and 9–12 include one or more students with limited English proficiency (LEP), depending on subject and grade range. However, as can be seen in Table 4.18, the percentages of science and mathematics classes including students with limited English proficiency varies considerably more by region and type of community. For example, only 11 percent of science classes in the Midwest, but 33 percent of those in the West, include LEP students. Similarly, more than 1 in 5 urban and suburban science and mathematics classes, but fewer than 1 in 10 in rural areas, include LEP students.

Table 4.18
Science and Mathematics Classes with One or More Limited English Proficiency Students, by Region and Community Type

	Percent of Classes			
	Science		Mathematics	
Region				
Midwest	11	(1.8)	8	(1.7)
Northeast	17	(2.5)	14	(2.5)
South	13	(1.9)	12	(0.8)
West	33	(3.3)	34	(2.5)
Type of Community				
Urban	28	(2.9)	21	(2.9)
Suburban	22	(2.1)	21	(1.6)
Rural	6	(1.4	9	(1.6)

Students with mental handicaps are more likely to be included in regular science instruction than in mathematics instruction. For example, 9 percent of grade 1–4 science classes, but only 5 percent of grade 1–4 mathematics classes include one or more students with mental handicaps. However, very few such students continue in regular science and mathematics classes past the middle grades. Students with physical handicaps are more evenly distributed across science and mathematics classes and across the grades; typically from 4 to 6 percent of classes include students with physical handicaps.

While females in each grade range are as likely as males to be enrolled in science and mathematics classes overall, females are underrepresented in physics classes. (See Table 4.19.) Non-Asian minority students make up roughly 25 percent of the enrollment in grade 1–4 and 5–8 science and mathematics classes, but only 18 to 19 percent of the enrollment in grades 9–12 science and mathematics classes. In general, the higher the level class, the lower the non-Asian minority representation. For example, non-Asian minority students comprise 34 percent of the enrollment in informal/review mathematics courses, but only 13 percent of the enrollment in Geometry, 13 percent in Algebra II, and 8 percent of more advanced mathematics courses. Similarly, non-Asian minority students constitute 22 percent of the enrollment in first-year biology, but only 12 percent of the enrollment in introductory chemistry and 11 percent in first-year physics.

Table 4.19
Female and Non-Asian Minority Students in Science and Mathematics Classes

	Percent of Students							
	Science				Mathematics			
	Female		Non-Asian Minority		Female		Non-Asian Minority	
Grades 1–4	48	(0.6)	26	(2.4)	50	(0.4)	24	(2.0)
Grades 5–8	50	(0.7)	24	(2.1)	49	(0.7)	25	(2.7)
Grades 9–12	50	(1.1)	18	(1.2)	50	(0.7)	19	(1.0)
Science Courses								
1st Year Biology	52	(1.7)	22	(2.9)	--	--	--	--
1st Year Chemistry	53	(1.8)	12	(1.7)	--	--	--	--
1st Year Physics	42	(2.9)	11	(2.1)	--	--	--	--
Mathematics Courses								
Review/Informal Mathematics	--	--	--	--	45	(1.6)	34	(2.9)
Algebra I	--	--	--	--	50	(1.3)	20	(2.4)
Geometry/Mathematics 2	--	--	--	--	53	(1.5)	13	(1.3)
Algebra II/Mathematics 3	--	--	--	--	53	(2.1)	13	(1.9)
Advanced Mathematics	--	--	--	--	49	(1.6)	8	(1.3)

Course enrollment data for particular race/ethnic groups are shown in Table 4.20. It is interesting to note that in both science and mathematics much of the decrease in non-Asian minority enrollment is due to a smaller representation of Hispanic students at the high school level.

Table 4.20
Race/Ethnic Composition of Science and Mathematics Classes

	Percent of Students					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
White	72	(2.5)	74	(2.2)	79	(1.2)
Black	11	(1.0)	13	(1.5)	11	(0.8)
Hispanic	13	(2.2)	10	(1.4)	7	(0.6)
Asian-American	2	(0.6)	1	(0.3)	3	(0.3)
American Indian	1	(0.4)	1	(0.4)	0	(0.0)
Mathematics						
White	74	(2.0)	72	(2.6)	78	(1.0)
Black	12	(1.6)	13	(1.5)	11	(0.8)
Hispanic	11	(1.9)	12	(2.5)	7	(0.5)
Asian-American	2	(0.4)	2	(0.4)	3	(0.3)
American Indian	1	(0.2)	1	(0.3)	0	(0.1)

Chapter Five

Instructional Objectives and Activities

A. Overview

Teachers were asked to provide detailed information about instruction in a particular, randomly selected science or mathematics class. Questions focused on their objectives for instruction, the class activities they use in accomplishing these objectives, and how student performance is assessed. These results are presented in the following sections.

B. Objectives of Science and Mathematics Instruction

Teachers were given a list of possible objectives of science and mathematics instruction and asked how much emphasis each would receive in the entire course. Table 5.1 shows the percent of science classes whose teachers indicated heavy emphasis for each objective; analogous data for mathematics classes are shown in Table 5.2.

Three instructional objectives stand out as key in science classes at all grade levels, with two-thirds or more of grade 1–4, 5–8, and 9–12 science classes giving heavy emphasis to learning basic science concepts; increasing awareness of the importance of science in daily life; and developing problem solving/inquiry skills.

While increasing student interest in science is more likely to be emphasized in the lower grades, many of the other objectives in the list are much more likely to be emphasized by middle and high school than by elementary science classes. For example, learning important terms and facts of science, and preparing for further study in science are emphasized heavily in about 2 out of 3 middle and high school science classes, but only about 1 in 2 grade 1–4 science classes. Similarly, about half of middle and high school science classes, but fewer than 1 in 3 in grades 1–4, focus on having students learn about the relationship between science, technology, and society or learn to evaluate arguments based on scientific evidence. The objectives least likely to be emphasized heavily in science classes are preparing students for standardized tests and having students learn about the history of science.

Table 5.1
Science Classes with Heavy Emphasis on Various Instructional Objectives*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Increase awareness of the importance of science in daily life	78	(3.0)	80	(2.1)	73	(2.6)
Learn basic science concepts	77	(2.5)	86	(1.8)	87	(1.2)
Increase interest in science	74	(2.3)	77	(2.0)	60	(2.7)
Develop problem solving/inquiry skills	68	(3.0)	77	(2.4)	78	(1.1)
Learn important terms and facts of science	51	(3.0)	65	(2.6)	64	(2.1)
Learn scientific methods	45	(3.2)	75	(2.4)	70	(2.3)
Prepare for further study in science	45	(3.5)	65	(2.4)	67	(1.9)
Learn to explain ideas in science effectively	43	(4.1)	63	(2.1)	57	(2.7)
Learn about the relationship between science, technology, and society	31	(2.3)	53	(2.7)	52	(3.0)
Learn to evaluate arguments based on scientific evidence	29	(4.4)	51	(2.8)	50	(2.7)
Learn about the applications of science in business and industry	24	(2.0)	41	(2.8)	49	(2.6)
Prepare for standardized tests	18	(2.1)	22	(2.2)	23	(1.9)
Learn about the history of science	9	(1.3)	21	(3.4)	14	(1.1)

* Teachers were given a six-point scale for each objective, with 0 labeled "none"; 1, "minimal emphasis"; 3, "moderate emphasis"; and 5, "very heavy emphasis." These numbers represent the total circling 4 or 5.

Instructional objectives in mathematics classes are more similar among the grade levels. Learning mathematical concepts, learning how to solve problems, and learning how to reason mathematically are emphasized heavily in from 86 to 94 percent of grade 1–4, 5–8, and 9–12 mathematics classes. Other objectives that have similar emphasis across grade ranges include, in decreasing order of emphasis, learning how mathematical ideas connect with one another (from 78 to 84 percent); preparing for further study in mathematics (68 to 79 percent); learning to explain ideas in mathematics effectively (48 to 56 percent); learning mathematical algorithms (41 to 54 percent); learning about applications of mathematics in science (39 to 41 percent); preparing for standardized tests (35 to 43 percent); and learning about the history of mathematics (4 to 7 percent).

Table 5.2
Mathematics Classes with Heavy Emphasis on Various Instructional Objectives*

	Percent of Mathematics Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Learn mathematical concepts	93	(1.9)	94	(0.9)	88	(2.3)
Learn how to solve problems	93	(1.0)	91	(1.6)	89	(1.8)
Learn to reason mathematically	86	(1.6)	88	(1.5)	87	(2.0)
Increase awareness of importance of mathematics in daily life	83	(2.0)	84	(2.0)	60	(2.4)
Learn how mathematical ideas connect with one another	79	(2.8)	84	(1.7)	78	(2.0)
Increase interest in mathematics	77	(2.8)	72	(2.3)	57	(1.6)
Prepare for further study in mathematics	68	(2.1)	76	(3.1)	79	(1.9)
Learn to perform computations with speed and accuracy	67	(2.7)	59	(2.6)	39	(1.5)
Understand logical structure of mathematics	55	(2.2)	72	(2.5)	67	(2.2)
Learn to explain ideas in mathematics effectively	50	(2.0)	56	(2.9)	48	(2.3)
Prepare for standardized tests	43	(3.5)	42	(3.3)	35	(2.3)
Learn mathematical algorithms	41	(1.9)	49	(3.5)	54	(2.5)
Learn about applications of mathematics in science	41	(2.5)	40	(2.7)	39	(2.8)
Learn about applications of mathematics in business and industry	24	(2.3)	49	(2.6)	37	(1.8)
Learn about the history of mathematics	4	(0.7)	7	(1.5)	6	(0.9)

* Teachers were given a six-point scale for each objective, with 0 labeled "none"; 1, "minimal emphasis"; 3, "moderate emphasis"; and 5, "very heavy emphasis." These numbers represent the total circling 4 or 5.

In contrast, several objectives are treated differently depending on grade range. Elementary and middle grade mathematics classes are much more likely than high school mathematics classes to emphasize awareness of the importance of mathematics in daily life, increasing interest in mathematics, and learning to perform computations with speed and accuracy. Middle and high school classes, on the other hand, are much more likely than those in grades 1–4 to emphasize understanding the logical structure of mathematics and learning about the applications of mathematics in business and industry.

C. Determining What is Taught

Science and mathematics teachers were given a list of factors that might affect what they teach in a randomly selected class and asked to indicate the extent of influence of each. Tables 5.3 and 5.4 show the percent of grade 1–4, 5–8, and 9–12 science and mathematics teachers, respectively, indicating that each factor is a major influence on what they teach.

Table 5.3
Science Classes Where Teachers Report that Various Factors Have a Major Influence on What They Teach*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Your own understanding of what motivates your students	92	(1.3)	94	(0.9)	89	(2.8)
Your own science content background	82	(2.7)	83	(2.3)	91	(1.0)
Your district's curriculum framework/course of study	79	(4.7)	74	(3.7)	62	(2.5)
Available laboratory facilities, equipment, and supplies	75	(2.9)	84	(1.8)	91	(1.0)
Your state's curriculum framework/course of study	64	(3.6)	61	(4.1)	51	(3.2)
Textbook	53	(3.1)	66	(2.9)	69	(1.6)
Parents/community	41	(3.5)	37	(3.1)	33	(2.4)
State test	27	(2.5)	33	(3.1)	25	(2.1)
District test	22	(1.9)	24	(2.2)	15	(1.5)
Scope, Sequence, and Coordination philosophy or *Content Core* (NSTA's SS&C project)	12	(1.4)	18	(2.1)	10	(1.5)
Science for All Americans (AAAS' Project 2061)	4	(1.3)	8	(1.3)	7	(1.5)

* Teachers were given a four-point scale for each factor, with 1 labeled as "no influence" and 4 labeled "extensive influence." These percentages include the total circling either 3 or 4.

In both science and mathematics, teachers were most likely to report that their understanding of what motivates their students (from 89 to 97 percent) and their own content background (from 82 to 91 percent) was a major influence on what they taught. Large numbers of science and mathematics teachers (from 75 to 91 percent) also reported that available facilities, equipment, and supplies had a major influence on what they taught.

The districts' curriculum framework/course of study tended to be more of a factor in mathematics (75 to 87 percent) than in science (62 to 79 percent), and in each subject more of an influence in the elementary and middle grades than at the high school level. The state's curriculum framework followed the same pattern of greater influence on mathematics and in the early grades although fewer teachers in each subject reported state frameworks as a major influence. In contrast, textbooks appear more influential on choice of content in the high school grades (major influence in 69 percent of science classes and 84 percent of mathematics classes) than at the elementary level (53 percent in science and 77 percent in mathematics).

Table 5.4
Mathematics Classes Where Teachers Report that Various Factors Have a Major Influence on What They Teach*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Your own understanding of what motivates your students	96	(1.0)	97	(0.6)	90	(1.6)
Your own mathematics content background	89	(1.6)	88	(1.9)	89	(0.8)
Available facilities, equipment, and supplies	88	(1.4)	83	(2.4)	79	(1.4)
Your district's curriculum framework/course of study	87	(2.3)	83	(2.9)	75	(2.2)
Your state's curriculum framework/course of study	78	(1.9)	74	(2.3)	60	(2.4)
Textbook	77	(1.9)	76	(2.5)	84	(1.4)
State test	57	(2.7)	55	(2.8)	37	(1.5)
Parents/community	57	(2.8)	54	(2.9)	40	(2.7)
District test	51	(2.1)	39	(2.9)	23	(2.3)
NCTM's *Curriculum and Evaluation Standards*	24	(1.5)	43	(2.9)	54	(2.2)
NCTM's *Professional Standards for Teaching Mathematics*	21	(1.6)	39	(3.0)	46	(2.3)
Science for All Americans (AAAS' Project 2061)	4	(0.5)	6	(0.9)	3	(1.0)

* Teachers were given a four-point scale for each factor, with 1 labeled as "no influence" and 4 labeled "extensive influence." These percentages include the total circling either 3 or 4.

As would be expected, given that states and districts are more likely to test mathematics than science, these tests were more likely to be a major influence on what is taught in mathematics than in science, especially in the elementary and middle grades.[3] Apparently, parent and community expectations are also quite influential in determining what is taught in elementary and middle grade mathematics classes, with teachers in more than half of these classes reporting that parents/community were a major influence.

Finally, science and mathematics teachers were asked about the extent of influence of a number of national reform efforts. In mathematics, high school teachers are more likely than

[3] Similarly, in a related question, results of which were presented in Tables 2.21 and 2.22 in Chapter Two, more than half of all grade 1–4 and 5–8 mathematics teachers, compared to 30 to 40 percent of science teachers and high school mathematics teachers, agreed that "the testing program in my state/district dictates what I teach."

middle grade teachers, who are in turn more likely than teachers in grades 1–4, to indicate that the *NCTM Curriculum and Evaluation Standards* and the *Professional Standards for Teaching* were a major influence on what they taught; percentages ranged from 21 to 24 percent in grades 1–4 to 46 to 54 percent at the high school level. In science, middle grade teachers (18 percent) were more likely than their elementary or high school counterparts (12 and 10 percent, respectively) to indicate that the National Science Teachers Association's Scope, Sequence and Coordination Project, aimed at grades 6–9, was a major influence on what they taught. Fewer than 10 percent of science or mathematics teachers in any grade range indicated that the American Association for the Advancement of Science's *Science for All Americans* (Project 2061) was a major influence on what they taught, not surprising given that project's focus on curriculum developers rather than on teachers.

As can be seen in Table 5.5, there are fairly large regional differences in curriculum influences. While district curriculum frameworks are influential in more than 3 out of 4 science and mathematics classes in each region, state curriculum frameworks appear to exert a much greater influence in the South and West regions. (States in the South and West typically have statewide textbook adoption processes, with the state purchasing textbooks for the districts as long as they are on the state approved lists.) Similarly, state and district tests appear more influential in determining curriculum content in the South and West regions.

Table 5.5
Grade 1–12 Science and Mathematics Classes Where Selected Factors Have a Major Influence on What is Taught, by Region

	Percent of Classes							
	South		West		Midwest		Northeast	
Science								
State's curriculum framework/course of study	77	(5.9)	70	(4.6)	58	(2.9)	47	(3.4)
District's curriculum framework/course of study	77	(6.2)	80	(4.3)	80	(3.4)	82	(2.9)
State tests	49	(4.0)	37	(3.8)	32	(2.3)	23	(2.9)
District tests	40	(2.8)	31	(2.8)	24	(1.4)	22	(2.8)
Mathematics								
State's curriculum framework/course of study	83	(2.0)	78	(2.6)	63	(2.2)	60	(2.9)
District's curriculum framework/course of study	79	(1.8)	86	(2.8)	82	(3.6)	82	(2.9)
State tests	61	(1.7)	53	(2.4)	43	(3.1)	44	(4.5)
District tests	45	(2.0)	45	(1.9)	29	(3.2)	34	(2.2)

D. Class Activities

Teachers were given a list of activities and asked to indicate how often students in the randomly selected science or mathematics class took part in each; response options were: never, once or twice per semester, once or twice a month, and almost daily. Table 5.6 shows the percent of grade 1–4, 5–8, and 9–12 science classes participating in various instructional activities at least once a week; the percent of classes participating in selected activities on a daily basis is shown in Table 5.7.

A frequent instructional activity in science classes is having the students engage in dialogue with the teacher to develop an idea, with about 3 out of 4 classes in each grade range participating in this type of activity at least once a week. As would be expected, having students listen and take notes during a teacher presentation increases in frequency with increasing grade range; 25 percent of grade 1–4 science classes compared to 67 percent in grades 5–8 and 93 percent in grades 9–12 do so at least once a week. At the same time, classes in the higher grades are more likely to work on science in small groups at least once a week (ranging from 60 percent of grade 1–4 science classes to 74 percent of grade 5–8 and 9–12 science classes); do laboratory activities at least weekly (ranging from 41 percent in grades 1–4 to 67 percent in grades 9–12); and watch the teacher demonstrate a scientific principle at least once a week (30 percent in grades 1–4 compared to 53 percent in grades 9–12).

Table 5.6
Science Classes Participating in Various Instructional Activities at Least Once a Week

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Participate in dialogue with the teacher to develop an idea	76	(2.8)	82	(2.3)	76	(2.3)
Work in small groups	60	(3.5)	74	(2.5)	74	(3.1)
Read a science textbook in class	51	(3.6)	55	(3.2)	39	(2.2)
Do hands-on/laboratory science activities	41	(2.6)	59	(2.3)	67	(2.6)
Use a computer	38	(2.5)	18	(2.0)	4	(0.7)
Watch the teacher demonstrate a scientific principle	30	(2.5)	48	(3.1)	53	(2.1)
Listen and take notes during presentation by teacher	25	(2.3)	67	(2.3)	93	(1.0)
Watch films, filmstrips, or videotapes	17	(1.6)	19	(2.8)	18	(1.5)
Watch television programs	9	(1.4)	8	(1.8)	4	(0.9)
Prepare written science reports	8	(2.0)	15	(2.1)	25	(2.1)

In contrast, grade 1–4 science classes are more likely than others to use computers at least weekly (38 percent, compared to only 4 percent in grades 9–12), and grades 1–4 and 5–8 science classes are more likely to read from the textbook during class at least once a week than are high school science classes (51 percent, 55 percent, and 39 percent, respectively). Nearly 1 in 5 science classes in each grade range watches films, filmstrips, or videotapes at least weekly; far fewer watch science television programs (from 4 to 9 percent).

Table 5.7
Science Classes Engaged in Various Instructional Activities on a Daily Basis

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Participate in dialogue with the teacher to develop an idea	36	(3.6)	48	(3.5)	41	(3.1)
Work in small groups	18	(1.6)	27	(3.1)	18	(2.0)
Read a science textbook in class	13	(1.9)	16	(1.7)	10	(1.9)
Listen and take notes during presentation by teacher	8	(1.2)	17	(1.9)	44	(2.0)
Do hands-on/laboratory science activities	7	(1.6)	10	(1.8)	7	(1.0)
Use a computer	7	(1.3)	4	(0.9)	1	(0.1)
Watch the teacher demonstrate a scientific principle	3	(1.2)	6	(1.0)	8	(1.1)

Table 5.8 shows the percent of science classes which *never* participate in particular instructional activities. Note that more than 1 in 5 elementary and middle grade science classes and 2 in 5 at the high school level never have class projects of a week's duration. Similarly, large percentages of science classes never use computers (from 38 percent in grades 1–4 to 54 percent in grades 9–12); and 23 percent of grade 1–4 classes, 35 percent of grade 5–8 classes, and 62 percent of grade 9–12 science classes never take field trips.

Table 5.8
Science Classes Never Taking Part in Various Instructional Activities

	Percent of Classes					
	Grade 1–4		Grade 5–8		Grade 9–12	
Listen and take notes during presentation by teacher	52	(1.8)	6	(1.0)	0	(0.2)
Work at home on science projects that take a week or more	51	(1.9)	27	(2.3)	49	(2.3)
Watch television programs	43	(3.6)	40	(2.3)	60	(2.7)
Use a computer	38	(3.0)	44	(3.0)	54	(3.2)
Prepare written science reports	36	(2.1)	10	(1.1)	12	(2.3)
Work in class on science projects that take a week or more	28	(2.5)	22	(2.1)	43	(3.4)
Take field trips	23	(2.7)	35	(2.9)	62	(2.3)
Read a science textbook in class	23	(2.4)	9	(1.4)	21	(1.2)
Watch films, filmstrips, or videotapes	6	(1.9)	2	(0.5)	8	(1.5)
Watch the teacher demonstrate a scientific principle	3	(0.8)	4	(1.6)	1	(0.4)
Participate in dialogue with the teacher to develop an idea	3	(1.0)	1	(0.5)	1	(0.4)
Do hands-on/laboratory science activities	2	(0.7)	2	(0.6)	1	(0.3)
Work in small groups	2	(1.0)	1	(0.2)	1	(0.1)

In addition to asking about class activities in the course as a whole, the 1993 National Survey of Science and Mathematics Education gave teachers a list of possible class activities and asked teachers to indicate those that took place during their most recent lesson in the randomly selected class. As can be seen in Table 5.9, approximately 8 out of 10 science lessons in each grade range included lecture, and roughly 60 percent involved students completing textbook or worksheet problems.

Approximately 6 out of 10 science lessons in grades 1–4 involved students in reading about science, compared to 5 out of 10 in grades 5–8 and 4 out of 10 in grades 9–12. Similarly, classes in the lower grades were more likely than those in the higher grades to have students working in cooperative learning groups "where the entire group receives a single grade," ranging from 51 percent of science lessons in grades 1–4 to 31 percent in grades 9–12. Use of calculators was much more common in high school science classes (28 percent of lessons) than in elementary and middle grade science classes (2 percent and 6 percent, respectively), and only 3 to 4 percent of science lessons in any grade range involved computer use.

Table 5.9
Science Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Lecture	78	(2.9)	79	(2.6)	86	(2.1)
Students reading about science	62	(2.6)	51	(3.4)	39	(2.3)
Students completing textbook/workbook problems	58	(3.1)	59	(2.8)	62	(2.3)
Students working in cooperative learning groups where the entire group receives a single grade	51	(3.0)	47	(2.9)	31	(2.1)
Student use of other technologies	15	(2.2)	19	(2.1)	19	(2.2)
Test or quiz	12	(1.7)	13	(1.8)	20	(1.9)
Student use of computers	3	(0.6)	4	(0.9)	4	(1.1)
Student use of calculators	2	(0.8)	6	(1.5)	28	(1.7)

Tables 5.10 and 5.11 present results on frequency of class activities in mathematics classes. Note that students doing problems from textbooks is a very frequent activity in mathematics classes, especially in the higher grades. Ninety-eight percent of grade 9–12 classes participate in this activity at least weekly, with 86 percent doing so on a daily basis; comparable figures for grades 5–8 are 93 percent weekly, and 72 percent daily; and for grades 1–4, 82 percent weekly and 55 percent daily. Many mathematics classes also do problems from worksheets at least once a week, ranging from 58 percent of grade 9–12 classes to 81 percent of those in grades 1–4.

In addition to working on textbook and worksheet problems, many mathematics classes participate in dialogue with the teacher to develop ideas; approximately 70 percent of mathematics classes in each grade range do this at least weekly. Other frequent activities in grade 1–4 mathematics classes include small group work (84 percent of classes work in small groups at least once a week) and the use of manipulatives and models (83 percent). Use of these techniques is less common at the middle and high school levels, with 70 percent and 64 percent of classes, respectively, working in small groups once a week or more, and only 39 percent of grade 5–8 classes and 18 percent of those in grades 9–12 using manipulatives that often.

Table 5.10
Mathematics Classes Participating in Various Instructional Activities at Least Once a Week

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Work in small groups	84	(2.5)	70	(2.8)	64	(2.3)
Use manipulative materials or models	83	(1.8)	39	(2.6)	18	(1.5)
Do mathematics problems from textbooks	82	(2.4)	93	(1.4)	98	(0.5)
Do mathematics problems from worksheets	81	(1.8)	69	(2.6)	58	(2.2)
Participate in dialogue with the teacher to develop an idea	71	(2.5)	72	(2.7)	72	(2.7)
Learn about mathematics through real-life applications	62	(2.6)	61	(3.1)	40	(1.3)
Use computers/calculators to do computations	45	(2.5)	57	(3.3)	76	(2.4)
Use computers/calculators to explore problems	44	(2.3)	53	(3.5)	54	(2.9)
Make conjectures and explore possible methods to solve a mathematical problem	44	(2.8)	51	(2.7)	41	(2.1)
Use computers/calculators to develop an understanding of mathematics concepts	37	(2.1)	39	(2.9)	40	(3.0)
Write their reasoning about how to solve a problem	28	(2.3)	31	(2.6)	31	(1.4)
Listen and take notes during presentation by teacher	18	(1.5)	66	(2.5)	94	(1.4)
Watch films, filmstrips, or videotapes	4	(0.8)	2	(0.6)	2	(0.6)
Watch television programs	2	(0.7)	2	(0.5)	1	(0.4)

Table 5.11
Mathematics Classes Engaged in Various Instructional Activities on a Daily Basis

	Percent of Classes					
	Grade 1–4		Grade 5–8		Grade 9–12	
Do mathematics problems from textbooks	55	(2.7)	72	(2.3)	86	(1.5)
Use manipulative materials/models	44	(1.8)	7	(1.5)	3	(0.5)
Participate in dialogue with the teacher to develop an idea	38	(2.9)	39	(3.2)	38	(2.0)
Do mathematics problems from worksheets	35	(1.7)	20	(2.5)	13	(1.2)
Work in small groups	34	(2.7)	27	(2.5)	24	(1.7)
Learn about mathematics through real-life applications	23	(2.0)	19	(2.7)	11	(1.4)
Listen and take notes during presentation by teacher	13	(1.4)	43	(2.2)	73	(1.8)
Make conjectures and explore possible methods to solve a mathematical problem	13	(1.9)	13	(2.1)	15	(1.7)
Use computers/calculators to do computations	7	(1.1)	26	(3.3)	55	(2.7)
Use computers/calculators to explore problems	7	(1.3)	21	(3.0)	27	(1.5)
Write their reasoning about how to solve a problem	6	(1.3)	6	(1.4)	8	(1.1)
Use computers/calculators to develop an understanding of mathematics concepts	5	(1.1)	13	(2.3)	15	(1.4)

As is the case in science, many middle grade mathematics classes (66 percent) and the vast majority of those in grades 9–12 (94 percent), listen and take notes during teacher presentations at least once a week. High school mathematics classes are also most likely, and those in grades 1–4 least likely, to use computers and calculators to do computations, with 76 percent of high school classes doing so at least weekly compared to 45 percent in grades 1–4. Use of computers or calculators to explore problems and develop an understanding of mathematics concepts is more consistent across grade ranges, with from 44 to 54 percent of classes doing the former and 37 to 40 percent doing the latter at least weekly.

Roughly 60 percent of elementary and middle grade classes and 40 percent of those in grades 9–12 learn about mathematics through real-life applications at least weekly and from 41 to 51 percent, depending on grade range, make conjectures and explore possible methods to solve mathematical problems on a weekly basis. Somewhat fewer, from 28 to 31 percent, are asked to write their reasoning about how to solve mathematics problems.

Table 5.12 shows the percent of mathematics classes that *never* take part in various instructional activities. Note particularly that the majority of grade 9–12 mathematics classes and 41 to 48 percent of those in the lower grades never work on class mathematics projects of a week or more duration.

Table 5.12
Mathematics Classes Never Taking Part in Various Instructional Activities

	Percent of Classes					
	Grade 1–4		Grade 5–8		Grade 9–12	
Watch television programs	74	(1.8)	69	(2.7)	81	(1.9)
Work at home on mathematics projects that take a week or more	72	(2.3)	53	(2.8)	66	(2.0)
Listen and take notes during presentation by teacher	63	(3.2)	12	(2.7)	1	(0.2)
Watch films, filmstrips, or videotapes	51	(2.2)	51	(2.4)	54	(2.4)
Work in class on mathematics projects that take a week or more	48	(1.8)	41	(2.7)	58	(2.1)
Write their reasoning about how to solve a problem	31	(1.9)	14	(1.5)	20	(1.6)
Use computers/calculators to develop an understanding of mathematics concepts	21	(1.6)	14	(2.3)	19	(2.2)
Use computers/calculators to explore problems	17	(1.3)	10	(3.0)	15	(1.5)
Use computers/calculators to do computations	17	(1.3)	8	(3.1)	7	(1.4)
Make conjectures and explore possible methods to solve a mathematical problem	16	(2.1)	8	(1.3)	14	(1.9)
Do mathematics problems from textbooks	11	(2.1)	1	(0.4)	1	(0.3)
Participate in dialogue with the teacher to develop an idea	8	(1.7)	5	(1.3)	4	(0.7)
Learn about mathematics through real-life applications	3	(1.2)	3	(1.1)	8	(1.2)
Do mathematics problems from worksheets	2	(0.7)	2	(0.4)	3	(0.6)
Use manipulative materials/models	1	(0.3)	7	(1.3)	19	(1.6)
Work in small groups	1	(0.3)	2	(0.6)	4	(0.6)

Table 5.13 shows the percent of "most recent lessons" in grades 1–4, 5–8, and 9–12 mathematics classes that included various instructional activities. Again we see the preponderance of having students work textbook/worksheet problems, with roughly 85 percent of mathematics lessons in each grade range involving these activities. Most mathematics lessons also include lecture, ranging from 82 percent in grades 1–4 to 94 percent in grades 9–12. As is the case in science, use of cooperative learning groups is highest in grades 1–4, with 43 percent of mathematics lessons including this technique compared to 34 percent in grades 5–8 and 24 percent in grades 9–12. While computer use is generally low (ranging from 2 percent of lessons in grades 9–12 to 9 percent in grades 1–4), calculator use is fairly common, especially in the high school grades, where 67 percent of lessons involve the use of calculators.

Table 5.13
Mathematics Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Students completing textbook/workbook problems	86	(1.9)	87	(2.1)	84	(1.5)
Lecture	82	(2.0)	90	(1.8)	94	(1.4)
Students working in cooperative learning groups where the entire group receives a single grade	43	(2.4)	34	(2.8)	24	(2.0)
Students reading about mathematics	28	(2.9)	47	(3.6)	32	(2.3)
Student use of other technologies	16	(2.3)	13	(1.5)	7	(1.3)
Test or quiz	12	(1.5)	14	(1.8)	17	(1.3)
Student use of calculators	11	(1.5)	37	(3.4)	67	(1.6)
Student use of computers	9	(1.1)	6	(1.5)	2	(0.4)

Similar surveys conducted in 1977 and 1985–86 reported results for four grade ranges—1–3, 4–6, 7–9, and 10–12. Table 5.14 compares the percent of science and mathematics lessons in 1977, 1985–86, and 1993 in those grades using lecture and hands-on activities in their most recent lesson. Note that in science, use of lecture increased between 1977 and 1985–86 and then tended to level off. Note also that frequency of hands-on use in science decreased markedly between 1977 and 1985–86. While there was a substantial rebound in use of hands-on science between 1985–86 and 1993, the frequency of hands-on activities is still lower than it was in 1977 at the junior high and high school levels. In mathematics, frequency of lecture increased between 1977 and 1985–86 and continued to increase between 1985–86 and 1993. Use of hands-on activities in mathematics, which had declined in some grade ranges between 1977 and 1985–86, increased dramatically between 1985–86 and 1993.

Table 5.14
Science and Mathematics Classes Using Lecture and Hands-On Activities in Most Recent Lesson: 1977, 1985–86, and 1993

	Percent of Classes							
	Science				Mathematics			
	Lecture		Hands-On		Lecture		Hands-On	
1977								
K–3*	60	(3.4)	67	(3.3)	58	(3.4)	58	(3.4)
4–6	69	(3.3)	54	(3.6)	68	(3.3)	38	(3.5)
7–9	72	(2.3)	59	(2.5)	83	(1.9)	23	(2.1)
10–12	76	(2.1)	53	(2.4)	89	(1.6)	24	(2.2)
1985–86								
1–3	73	(2.3)	54	(2.5)	70	(2.3)	61	(2.5)
4–6	78	(2.8)	45	(3.3)	82	(2.4)	31	(2.9)
7–9	83	(2.2)	43	(3.0)	90	(1.8)	19	(2.3)
10–12	84	(2.0)	39	(2.7)	92	(1.5)	11	(1.7)
1993								
1–3	75	(4.1)	62	(3.7)	79	(2.6)	79	(1.9)
4–6	82	(2.5)	50	(3.3)	90	(2.0)	51	(4.1)
7–9	80	(2.9)	50	(3.9)	93	(1.4)	26	(2.7)
10–12	88	(1.5)	43	(2.3)	94	(2.1)	26	(3.1)

* Note that 1977 figures include Kindergarten teachers

In 1993, science and mathematics teachers were also asked to estimate the time spent on each of a number of kinds of activities in their most recent lesson in the randomly selected class. These results are shown in Table 5.15. Note that on the average, science lessons appear to be relatively similar in instructional arrangements in the various grade ranges, with roughly 35 to 40 percent of class time spent on whole class lecture/discussion, a little less than 20 percent of time with students working individually reading textbooks and completing worksheets; and a little more than 20 percent of time on hands-on activities. Mathematics classes vary considerably more by grade range, with more time spent in whole class lecture/discussion in the higher grades and more time working with manipulative materials in the lower grades.

Table 5.15
Science and Mathematics Class Time
Spent on Different Types of Activities

	Average Percent of Lesson					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science Classes						
Daily routines, interruptions, and other non-instructional activities	8	(0.5)	11	(0.5)	11	(0.3)
Whole class lecture/discussion	36	(1.2)	36	(1.1)	42	(1.3)
Individual students reading textbooks, completing worksheets, etc.	21	(0.8)	18	(1.2)	17	(0.7)
Working with hands-on, manipulative, or laboratory materials	26	(1.5)	23	(1.2)	21	(1.2)
Non-laboratory small group work	9	(0.7)	12	(1.0)	10	(1.2)
Mathematics Classes						
Daily routines, interruptions, and other non-instructional activities	9	(0.6)	11	(0.5)	11	(0.3)
Whole class lecture/discussion	26	(0.9)	37	(1.1)	48	(1.0)
Individual students reading textbooks, completing worksheets, etc.	26	(0.6)	26	(1.1)	19	(0.8)
Working with hands-on, manipulative, or laboratory materials	29	(1.1)	12	(0.9)	7	(0.9)
Non-laboratory small group work	9	(0.7)	15	(1.3)	14	(0.6)

E. Homework and Grading Practices

Science and mathematics teachers were asked about the amount of homework assigned per week in a randomly selected class. As can be seen in Tables 5.16 and 5.17, teachers in only about 1 in 5 grade 1–4 science classes and about 1 in 2 grade 1–4 mathematics classes expect their students to do more than 30 minutes of homework in these subjects per week. Students in the higher grades are typically expected to spend more time on homework, with a median amount of 31 to 60 minutes in science and 61 to 90 minutes in mathematics in grades 5–8. In grades 9–12, the median amount of homework assigned is 61 to 90 minutes in science and 91 to 120 minutes in mathematics.

Table 5.16
Amount of Homework Assigned in Science Classes Per Week

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
0–30 Minutes	82	(2.1)	33	(2.9)	12	(1.4)
31–60 Minutes	12	(2.4)	40	(2.9)	23	(2.0)
61–90 Minutes	6	(2.2)	19	(2.1)	32	(2.3)
91–120 Minutes	0	(0.2)	5	(1.1)	17	(1.3)
2–3 Hours	0	(0.0)	2	(0.7)	11	(0.9)
More than 3 Hours	0	(0.4)	0	(0.3)	5	(0.7)

Table 5.17
Amount of Homework Assigned in Mathematics Classes Per Week

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
0–30 Minutes	52	(3.5)	11	(2.7)	5	(0.7)
31–60 Minutes	26	(2.3)	17	(2.1)	12	(1.7)
61–90 Minutes	12	(1.6)	34	(2.9)	16	(1.4)
91–120 Minutes	7	(1.8)	21	(2.1)	23	(1.9)
2–3 Hours	3	(0.9)	13	(1.7)	31	(1.9)
More than 3 Hours	1	(0.6)	5	(1.1)	14	(1.5)

Teachers were also given a list of factors that might be considered in determining student grades in their science and mathematics classes and asked to indicate the importance they gave to each in setting grades; these results are shown in Tables 5.18 and 5.19. More than 70 percent of teachers in grades 1–4 consider each of several factors important in setting grades in both science and mathematics: individual improvement over past performance; effort; participation in whole class discussion; and contribution to small group work. Teachers in these grades report being much more likely to use systematic observations of students, hands-on performance tasks, and interviewing students about what they understand than written products such as objective or essay tests.

While many of the same factors that are considered important for setting grades in elementary science and mathematics continue to be used by middle and high school teachers, the percentages considering them important decrease with increasing grade range. In contrast, larger numbers of teachers in the higher grades consider objective tests in setting grades, especially in science, and homework assignments, especially in mathematics.

Table 5.18
Science Classes Where Teachers Report Various Types of Activities Are Important in Determining Student Grades*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Participation in whole class discussion	92	(1.6)	72	(3.0)	48	(1.8)
Effort	91	(1.6)	83	(1.8)	60	(2.1)
Individual improvement or progress over past performance	88	(1.1)	77	(2.0)	54	(2.5)
Contribution to small group work	87	(2.0)	77	(2.6)	50	(2.4)
Systematic observations of students	85	(2.3)	72	(2.4)	50	(2.6)
Hands-on/performance tasks	83	(2.9)	77	(2.3)	65	(3.1)
Interviewing students about what they understand	75	(3.0)	56	(3.2)	37	(2.4)
Class attendance	62	(3.0)	58	(2.8)	43	(2.6)
Behavior	60	(3.2)	48	(3.0)	32	(1.7)
Objective tests (e.g., multiple choice, true/false)	47	(3.0)	79	(2.7)	85	(1.9)
Science projects	52	(3.0)	67	(2.9)	35	(1.7)
Homework assignments	29	(2.2)	62	(2.6)	64	(2.0)
Laboratory reports	26	(2.8)	61	(2.5)	68	(2.8)
Essay tests	24	(2.7)	56	(2.8)	52	(2.2)

* Teachers were given a four-point scale for each activity, with 1 labeled "not important" and 4 labeled "very important." These percentages include the total circling either 3 or 4.

Table 5.19
Mathematics Classes Where Teachers Report Various Types of Activities Are Important in Determining Student Grades*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Individual improvement or progress over past performance	91	(1.6)	77	(2.1)	60	(2.0)
Systematic observations of students	86	(2.0)	73	(2.3)	54	(1.8)
Participation in whole class discussion	82	(2.4)	69	(2.3)	54	(2.4)
Effort	81	(2.4)	78	(2.2)	60	(1.6)
Hands-on/performance tasks	81	(1.4)	62	(2.6)	48	(2.1)
Contribution to small group work	79	(2.0)	64	(3.0)	45	(1.5)
Interviewing students about what they understand	72	(2.1)	55	(2.4)	32	(1.5)
Objective tests (e.g., multiple choice, true/false)	53	(2.9)	64	(3.3)	62	(1.6)
Class attendance	53	(2.5)	49	(2.4)	42	(2.7)
Behavior	44	(4.0)	39	(2.8)	28	(1.8)
Homework assignments	39	(3.5)	77	(2.4)	75	(2.6)
Mathematics projects	36	(1.8)	41	(3.1)	23	(2.0)
Essay tests	12	(1.3)	22	(2.4)	19	(1.5)

* Teachers were given a four-point scale for each activity, with 1 labeled "not important" and 4 labeled "very important." These percentages include those circling either 3 or 4.

Chapter Six

Instructional Resources

A. Overview

The nature of science and mathematics teaching is affected by the quality and availability of instructional resources. The 1993 National Survey of Science and Mathematics Education included a series of items on science and mathematics textbooks—which ones were being used, how much of the textbook was covered, and teachers' perceptions of textbook quality. Teachers were also asked about the availability and use of a number of other instructional resources, including computers and various types of calculators. These results are presented in the following sections, along with comparisons to 1977 and 1985–86 results when data are available.

B. Textbook Usage

Each teacher was asked if a particular, randomly selected class was using one or more commercially published textbooks or programs. As can be seen in Table 6.1, 95 percent or more of grade 1–4, 5–8, and 9–12 mathematics classes and grade 9–12 science classes use published textbooks/programs. Textbook usage is somewhat lower in grade 5–8 science classes (91 percent of classes) and markedly lower in grade 1–4 science classes (72 percent). Moreover, as can be seen in Table 6.2, textbook usage in grade 1–3 science classes has declined since 1985–86.

Table 6.1
Science and Mathematics Classes Using Commercially Published Textbooks/Programs

	Percent of Classes			
	Science		Mathematics	
Grades 1–4	72	(3.1)	95	(1.5)
Grades 5–8	91	(2.2)	95	(1.3)
Grades 9–12	97	(1.0)	96	(1.0)

Table 6.2
Science and Mathematics Classes Using Commercially Published Textbooks/Programs: 1977, 1985–86, and 1993

	Percent of Classes					
	1977		1985–86		1993	
Science						
Grades 1–3*	63	(3.4)	78	(2.1)	66	(3.5)
Grades 4–6	90	(2.2)	89	(2.0)	87	(3.3)
Grades 7–9	94	(1.2)	93	(1.5)	96	(1.3)
Grades 10–12	92	(1.3)	93	(1.0)	97	(1.0)
Mathematics						
Grades 1–3*	92	(1.9)	93	(1.3)	94	(1.7)
Grades 4–6	96	(1.4)	94	(1.6)	96	(1.4)
Grades 7–9	95	(1.1)	96	(1.3)	96	(1.1)
Grades 10–12	95	(1.1)	94	(1.4)	95	(1.3)

* 1977 figures include Kindergarten teachers.

Teachers who indicated that the randomly selected class used a published textbook/program were given a list of science and mathematics textbook publishers and asked to indicate the publisher of the one textbook/program used most often by students in that class. Table 6.3 shows the share of the market held by each of the major science and mathematics textbook publishers. It is interesting to note that two publishers (Scott, Foresman and Silver, Burdett, & Ginn) account for 60 percent of the textbook usage in grade 1–4 science classes. Similarly, three publishers (Merrill/Glencoe; Prentice Hall; and Silver, Burdett, & Ginn) account for 54 percent of the grade 5–8 science textbook usage, and three publishers (Holt, Rinehart, Winston; Merrill/Glencoe; and Prentice Hall) account for 56 percent of the grade 9–12 science textbook usage.

The publishers with the largest grade 1–4 mathematics textbook market share are Addison-Wesley; Harcourt, Brace, & Jovanovich; Scott, Foresman; and Silver, Burdett, & Ginn; together they account for 61 percent of textbook usage. Similarly, four publishers—Addison-Wesley; Scott, Foresman; Houghton Mifflin; and Harcourt, Brace, & Jovanovich—account for 57 percent of the textbook usage in grade 5–8 mathematics classes, and three (Houghton Mifflin, Addison-Wesley, and Merrill/Glencoe) for 52 percent of mathematics textbook usage in grades 9–12.

Table 6.3
Market Share of Commercial Science and Mathematics Textbook Publishers

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
Scott, Foresman	31	(2.9)	13	(1.2)	2	(0.6)
Silver, Burdett, & Ginn	29	(2.4)	17	(2.2)	2	(0.7)
Merrill/Glencoe	11	(2.2)	20	(2.3)	18	(2.5)
Addison-Wesley	6	(1.1)	4	(0.8)	7	(0.7)
Holt, Rinehart, Winston	4	(1.2)	10	(2.0)	20	(2.0)
D.C. Heath	3	(1.2)	4	(0.9)	8	(1.5)
Harcourt, Brace, & Jovanovich	3	(0.4)	4	(0.7)	6	(0.8)
MacMillan	3	(1.5)	3	(0.7)	1	(0.4)
Prentice Hall	0	(0.0)	17	(3.4)	18	(1.5)
Houghton Mifflin	0	(0.1)	0	(0.0)	1	(0.4)
Mathematics						
Addison-Wesley	23	(3.1)	16	(1.8)	11	(1.0)
Harcourt, Brace, & Jovanovich	15	(2.9)	12	(2.1)	5	(0.9)
Scott, Foresman	12	(2.5)	15	(2.5)	8	(0.8)
Silver, Burdett. & Ginn	11	(2.2)	6	(1.1)	0	(0.0)
D.C. Heath	8	(1.0)	6	(0.9)	4	(0.5)
Houghton Mifflin	7	(1.8)	14	(2.6)	30	(2.9)
Holt, Rinehart, Winston	6	(1.8)	6	(1.3)	4	(0.8)
MacMillan	5	(1.1)	4	(1.1)	0	(0.0)
Merrill/Glencoe	2	(1.0)	7	(1.6)	11	(1.4)
Prentice Hall	0	(0.0)	0	(0.2)	6	(0.7)

Teachers were also asked to provide the title, author, and publication year of this textbook/program. Tables 6.4 and 6.5 list the most commonly used science and mathematics textbooks in each grade range; secondary textbooks are shown by discipline, as well.

Table 6.4
Most Commonly Used Science Textbooks

Grades and Course	Publisher	Title
Grades 1–6		
Elementary Science	Scott, Foresman	*Discover Science*
	Silver, Burdett, & Ginn	*Science Horizons*
	Merrill/Glencoe	*Science*
Grades 7–8		
Life Science	Prentice Hall	*Life Science*
	Merrill/Glencoe	*Focus on Life Science*
Earth Science	Prentice Hall	*Earth Science*
	Merrill/Glencoe	*Focus on Earth Science*
Physical Science	Merrill/Glencoe	*Focus on Physical Science*
	Prentice Hall	*Physical Science*
	Silver, Burdett, & Ginn	*The Natural World*
General/Integrated/Coordinated Science	Merrill/Glencoe	*Principles of Science*
	Prentice Hall	*General Science: A Voyage*
Grades 9–12		
Biology	Holt, Rinehart, Winston	*Modern Biology*
	Prentice Hall	*Biology*
	Harcourt, Brace, & Jovanovich	*Biology*
Chemistry	Holt, Rinehart, Winston	*Modern Chemistry*
	Addison-Wesley	*Chemistry*
	Merrill/Glencoe	*Chemistry: A Modern Course*
	Prentice Hall	*Chemistry: The Study of Matter*
Physics	Merrill/Glencoe	*Physics: Principles and Problems*
	Holt, Rinehart, Winston	*Modern Physics*
Physical Science	Prentice Hall	*Physical Science*
	Merrill/Glencoe	*Focus on Physical Science*
	Addison-Wesley	*Physical Science*
	Holt, Rinehart, Winston	*Modern Physical Science*
Earth Science	Merrill/Glencoe	*Focus on Earth Science*
	Prentice Hall	*Earth Science*
	D.C. Heath	*Earth Science*
	Holt, Rinehart, Winston	*Modern Earth Science*
General/Integrated/Coordinated Science	Merrill/Glencoe	*Focus on Physical Science*
	Prentice Hall	*Physical Science*
	Prentice Hall	*General Science*

Table 6.5
Most Commonly Used Mathematics Textbooks

Grades and Course	Publisher	Title
Grades 1–6		
Elementary Mathematics	Addison-Wesley	*Mathematics*
	Silver, Burdett, & Ginn	*Mathematics*
	Scott, Foresman	*Exploring Mathematics*
	Harcourt, Brace, & Jovanovich	*Mathematics Today*
Grades 7–8		
Middle School Mathematics	Addison-Wesley	*Mathematics*
	Scott, Foresman	*Mathematics*
	Scott, Foresman	*Transition Mathematics*
Grades 9–12		
Algebra I	Houghton Mifflin	*Algebra I*
	Addison-Wesley	*Algebra: Structure and Method*
	Scott, Foresman	*UCSMP Algebra I*
Geometry	Houghton Mifflin	*Geometry*
	Merrill/Glencoe	*Geometry*
Algebra II	Houghton Mifflin	*Algebra and Trigonometry*
	Merrill/Glencoe	*Algebra II with Trigonometry*
	Addison-Wesley	*Algebra and Trigonometry*
Algebra III	Houghton Mifflin	*Algebra III*
	Merrill/Glencoe	*Advanced Mathematics*
	Harcourt, Brace, & Jovanovich	*Advanced Mathematics*

Table 6.6 shows the distribution of publication years of science and mathematics textbooks. In 1993, roughly 1 in 4 science classes and nearly 1 in 2 mathematics classes were using textbooks published since 1990. Only 3 percent of grade 1–4 mathematics classes and 5 percent of those in grades 5–8 were using textbooks published prior to 1985; in contrast, 23 percent of grade 9–12 mathematics classes and from 12 to 18 percent of science classes in the various grade ranges were using textbooks published prior to 1985.

Table 6.6
Publication Year of Science and Mathematics Textbooks/Programs

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
1979 or Earlier	2	(0.7)	2	(1.1)	3	(0.4)
1980–1984	16	(2.7)	10	(1.5)	11	(0.8)
1985–1989	59	(4.3)	62	(3.4)	57	(2.9)
1990 or Later	23	(4.8)	25	(2.2)	29	(1.8)
Mathematics						
1979 or Earlier	1	(0.5)	0	(0.1)	5	(1.0)
1980–1984	2	(0.9)	5	(1.1)	18	(1.9)
1985–1989	47	(3.3)	48	(3.6)	34	(1.8)
1990 or Later	50	(2.7)	47	(4.0)	44	(1.8)

Table 6.7 shows the percentages of science and mathematics classes in grades 1–4, 5–8, and 9–12 which use published textbooks/programs "covering" various proportions of their textbooks. Note that in each grade range mathematics classes are more likely than science classes to go through a substantial portion of their textbook, with from 69 to 74 percent of mathematics classes, compared to 43 percent to 52 percent of science classes, covering 75 percent or more of their textbooks.

Table 6.7
Percent of Science and Mathematics Textbooks/Programs Covered During the Course*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science Classes						
< 25%	10	(2.6)	9	(1.7)	3	(0.8)
25–49%	17	(3.7)	19	(2.0)	16	(2.3)
50–74%	20	(2.8)	30	(3.3)	36	(1.8)
75–90%	30	(2.4)	33	(3.7)	37	(2.7)
> 90%	22	(3.3)	10	(1.5)	8	(1.1)
Mathematics						
< 25%	1	(0.5)	1	(0.2)	0	(0.2)
25–49%	4	(0.8)	4	(0.9)	7	(0.7)
50–74%	21	(1.9)	23	(2.6)	23	(2.1)
75–90%	44	(2.2)	50	(2.7)	48	(2.3)
> 90%	30	(2.1)	22	(2.1)	21	(1.3)

* Only classes using commercially published textbooks/programs were included in these analyses.

It is interesting to note that while many science and mathematics education reformers are critical of textbooks, most teachers consider their textbooks to be of relatively high quality. As can be seen in Table 6.8, the majority of science and mathematics teachers in each grade range consider their textbooks/programs to be good or better, with percentages ranging from 63 to 80 percent in science and from 72 to 84 percent in mathematics.

Table 6.8
Teacher Perception of the Quality of Textbooks/Programs Used in Science and Mathematics Classes*

	Percent of Classes					
	Grades 1–4		Grades 5–8		Grades 9–12	
Science						
Very Poor	3	(0.8)	3	(0.5)	2	(0.5)
Poor	8	(1.4)	5	(1.1)	4	(0.4)
Fair	27	(2.5)	23	(2.3)	14	(2.0)
Good	38	(3.4)	30	(1.8)	36	(2.0)
Very Good	18	(1.8)	29	(2.6)	33	(2.5)
Excellent	7	(1.4)	10	(3.5)	11	(1.1)
Mathematics						
Very Poor	3	(1.4)	0	(0.7)	1	(0.3)
Poor	4	(0.6)	5	(0.7)	3	(0.7)
Fair	21	(1.9)	20	(3.2)	11	(1.1)
Good	32	(2.4)	32	(2.7)	30	(2.7)
Very Good	30	(3.5)	31	(2.7)	38	(1.8)
Excellent	10	(1.5)	14	(1.8)	16	(1.7)

* Only classes using commercially published textbooks/programs were included in these analyses.

C. Facilities and Equipment

Science and mathematics teachers were given a list of equipment and asked to indicate the approximate number of times per semester each is used in the randomly selected class. Tables 6.9 through 6.14 show the percent of grade 1–4, 5–8, and 9–12 science and mathematics classes reporting at least some use of each type of equipment, as well as the percentages of classes where each is "not needed" or "needed, but not available."

Note that overhead projectors are commonly used, with from 74 to 88 percent of science and mathematics classes in the various grade ranges making use of them. Videotape players are more likely to be used in science instruction, with from 88 to 94 percent of classes reporting usage, compared to from 38 to 44 percent of mathematics classes. Similarly, science classes are more likely than mathematics classes to use both videodisc and CD-ROM players.

Table 6.9
Equipment Usage in Grade 1–4 Science Classes

	Percent of Classes					
	Used		Not Needed		Needed, But Not Available	
Videotape player	88	(2.0)	9	(1.3)	2	(0.7)
Overhead projector	74	(2.8)	21	(2.9)	6	(1.3)
Videodisc player	18	(1.6)	59	(1.9)	23	(2.5)
CD-ROM player	10	(1.5)	65	(2.4)	25	(2.7)
Four function calculators	31	(2.8)	57	(1.7)	12	(2.0)
Fraction calculators	2	(0.6)	88	(1.5)	10	(1.5)
Graphing calculators	0	(0.2)	89	(1.9)	11	(1.6)
Scientific calculators	0	(2.6)	88	(2.4)	12	(1.6)
Electrical outlets in laboratories	51	(2.6)	32	(2.2)	17	(2.3)
Running water in laboratories	49	(2.7)	28	(2.2)	24	(1.9)
Gas for burners in laboratories	7	(2.1)	73	(3.0)	20	(2.1)
Hoods or air hoses in laboratories	3	(1.6)	79	(2.5)	18	(1.6)
Computers	52	(2.4)	30	(1.8)	18	(2.2)
Computer/lab interfacing devices	13	(1.8)	64	(1.9)	23	(1.9)

Table 6.10
Equipment Usage in Grade 5–8 Science Classes

	Percent of Classes					
	Used		Not Needed		Needed, But Not Available	
Videotape player	94	(1.1)	6	(1.0)	1	(0.3)
Overhead projector	88	(1.5)	10	(1.2)	2	(0.6)
Videodisc player	27	(2.5)	49	(3.3)	24	(2.1)
CD-ROM player	10	(2.0)	60	(2.9)	30	(2.4)
Four function calculators	34	(3.0)	60	(3.3)	7	(1.0)
Fraction calculators	8	(1.5)	81	(2.2)	11	(1.3)
Graphing calculators	2	(1.0)	86	(1.8)	13	(1.3)
Scientific calculators	6	(1.3)	81	(2.1)	13	(1.4)
Electrical outlets in laboratories	75	(2.3)	10	(1.5)	15	(1.8)
Running water in laboratories	70	(2.7)	7	(1.3)	23	(2.6)
Gas for burners in laboratories	28	(3.1)	42	(3.0)	30	(2.7)
Hoods or air hoses in laboratories	13	(3.3)	52	(3.0)	35	(2.5)
Computers	50	(3.0)	21	(2.5)	29	(2.4)
Computer/lab interfacing devices	18	(3.2)	41	(2.8)	41	(3.0)

Computer use is most common in elementary mathematics, with 77 percent of grade 1–4 classes using computers at some point in the semester, compared to 60 percent in grade 5–8 mathematics classes and from 40 to 52 percent of science classes at the various grade ranges.

One-half of all grade 1–4 mathematics classes and approximately two-thirds of those in the middle/high school grades use four-function calculators, as do roughly one-third of science classes in each grade range. As expected, more sophisticated calculators are more likely to be used in the higher grades. For example, 22 percent of grade 5–8 mathematics classes and 67 percent of grade 9–12 mathematics classes use scientific calculators at some point during the semester; comparable figures for science are 6 percent in grades 5–8 and 38 percent in grades 9–12.

Science teachers were also asked about the use of specific laboratory facilities and equipment. About half of grade 1–4 science classes, three-fourths of those in grades 5–8, and 94 percent in grades 9–12 use electrical outlets in their laboratory work; similar percentages make use of running water. Fewer classes make use of gas for burners or hoods/air hoses in their laboratory work.

Table 6.11
Equipment Usage in Grade 9–12 Science Classes

	Percent of Classes					
	Used		Not Needed		Needed, But Not Available	
Videotape player	90	(1.8)	8	(1.4)	2	(0.3)
Overhead projector	83	(2.6)	14	(2.8)	3	(0.9)
Videodisc player	29	(2.1)	47	(3.1)	24	(2.0)
CD-ROM player	7	(1.4)	60	(3.2)	33	(3.3)
Four function calculators	38	(2.2)	54	(2.6)	8	(2.1)
Fraction calculators	11	(1.1)	83	(1.9)	6	(1.3)
Graphing calculators	7	(1.4)	82	(1.6)	11	(2.1)
Scientific calculators	38	(2.1)	53	(2.9)	9	(1.8)
Electrical outlets in laboratories	94	(0.9)	4	(0.9)	2	(0.8)
Running water in laboratories	90	(2.7)	3	(0.8)	7	(2.5)
Gas for burners in laboratories	67	(2.7)	24	(3.1)	9	(1.0)
Hoods or air hoses in laboratories	36	(2.1)	38	(2.3)	26	(2.3)
Computers	40	(2.5)	24	(2.2)	36	(2.1)
Computer/lab interfacing devices	18	(1.2)	37	(1.6)	46	(1.9)

Many science teachers reported needing particular types of equipment and not having them available. Lack of computers and computer/lab interfacing devices were most frequently noted as needed but not available, especially in the higher grades. Running water and gas for burners in laboratories were noted as needed, but not available for 20 to 30 percent of grade 1–4 and 5–8 science classes (but fewer than 10 percent of those in grades 9–12). In addition, roughly 1 out of 4 science classes in each grade range reportedly need videodisc and CD-ROM players, but do not have them available.

It is also interesting to note that sizeable percentages of teachers reported "not needing" items that seem quite central to effective science and mathematics teaching. For example, 32 percent of grade 1–4 teachers indicated they did not need electrical outlets and 28 percent said they did not need running water in laboratories. Similarly, 30 percent of grade 1–4 teachers, 21 percent of grade 5–8 teachers, and 24 percent of grade 9–12 science teachers indicated they didn't need computers.

Table 6.12
Equipment Usage in Grade 1–4 Mathematics Classes

	Percent of Classes					
	Used		Not Needed		Needed, But Not Available	
Videotape player	42	(2.8)	54	(2.7)	4	(1.0)
Overhead projector	78	(3.2)	15	(2.1)	8	(1.7)
Videodisc player	8	(1.0)	80	(2.2)	12	(1.8)
CD-ROM player	3	(0.8)	81	(1.9)	16	(2.1)
Four function calculators	50	(2.5)	34	(2.2)	16	(1.1)
Fraction calculators	3	(0.7)	85	(1.6)	13	(1.6)
Graphing calculators	1	(0.3)	88	(1.4)	12	(1.8)
Scientific calculators	1	(0.4)	90	(1.2)	9	(1.7)
Computers	77	(2.1)	11	(1.4)	12	(1.8)
Computer/lab interfacing devices	33	(2.4)	46	(3.0)	21	(2.3)

Table 6.13
Equipment Usage in Grade 5–8 Mathematics Classes

	Percent of Classes					
	Used		Not Needed		Needed, But Not Available	
Videotape player	44	(2.8)	51	(2.7)	5	(2.4)
Overhead projector	79	(3.7)	16	(2.3)	5	(2.5)
Videodisc player	5	(1.0)	80	(2.9)	15	(2.4)
CD-ROM player	3	(0.9)	84	(1.8)	13	(1.8)
Four function calculators	72	(3.0)	17	(2.2)	11	(2.9)
Fraction calculators	26	(2.3)	35	(2.2)	39	(2.9)
Graphing calculators	5	(1.0)	66	(3.0)	30	(2.7)
Scientific calculators	22	(3.0)	61	(3.4)	17	(2.0)
Computers	60	(3.1)	12	(1.3)	29	(3.1)
Computer/lab interfacing devices	26	(2.0)	35	(2.4)	39	(3.1)

Table 6.14
Equipment Usage in Grade 9–12 Mathematics Classes

	Percent of Classes					
	Used		Not Needed		Needed, but Not Available	
Videotape player	38	(2.1)	57	(1.7)	5	(1.2)
Overhead projector	76	(2.9)	20	(2.3)	5	(1.2)
Videodisc player	2	(0.7)	88	(1.6)	10	(1.4)
CD-ROM player	1	(0.3)	88	(1.4)	12	(1.3)
Four function calculators	65	(2.3)	30	(2.2)	5	(1.3)
Fraction calculators	28	(2.3)	53	(1.7)	19	(2.2)
Graphing calculators	40	(2.3)	40	(1.6)	20	(1.9)
Scientific calculators	67	(2.0)	27	(2.1)	6	(1.2)
Computers	44	(2.4)	29	(1.8)	28	(2.4)
Computer/lab interfacing devices	21	(2.1)	43	(2.0)	36	(2.7)

In mathematics, teachers in 34 percent of grade 1–4 classes reported not needing four-function calculators and 16 percent reported needing them, but not having them available. Mathematics teachers in the middle grades were particularly likely to report needing more sophisticated calculators but not having them available, with 30 percent of grade 5–8 mathematics classes needing graphing calculators and 39 percent needing fraction calculators. While smaller percentages of high school classes need fraction and graphing calculators and do not have them available (19 and 20 percent, respectively), teachers in surprisingly large percentages of classes reported not needing to use these calculators in their mathematics instruction.

Eleven percent of grade 1–4 mathematics classes, 12 percent of those in grades 5–8, and a sizeable 29 percent of grade 9–12 mathematics classes reportedly do not need computers. Many other mathematics classes need computers, but do not have them available, including 12 percent of those in grades 1–4 and nearly 30 percent of those in grades 5–8 and 9–12.

The school and teacher surveys also included a number of questions about the amount of money spent on science and mathematics equipment and supplies and who had input into decisions about how that money would be spent. As can be seen in Table 6.15, the typical elementary school spent $300 on science equipment and $150 on consumable science supplies in their most recently completed budget year. Middle schools spent somewhat more (a median of $500 on science equipment and $300 on science supplies) and high schools considerably more (a median of $1,100 on science equipment and $1,000 on science supplies). In contrast, in mathematics there was relatively little difference by grade range in the median amount spent on equipment (from $300 to $400 per year) and the typical elementary school spent considerably more on consumable mathematics supplies ($350 per year) than did schools with higher grades ($110 for middle schools and $150 for high schools).

Table 6.15
Median Amount Schools Spend Per Year on Science and Mathematics Equipment, Consumable Supplies, and Software

	Median Amount Spent		
	Equipment	Consumable Supplies	Software
Science			
Elementary Schools	$ 300	$ 150	$ 40
Middle Schools	$ 500	$ 300	$ 50
High Schools	$ 1,100	$ 1,000	$ 125
Mathematics			
Elementary Schools	$ 300	$ 350	$ 100
Middle Schools	$ 300	$ 110	$ 100
High Schools	$ 400	$ 150	$ 100

Table 6.16 shows the amount elementary, middle, and high schools reported spending on science and mathematics equipment, consumable supplies, and software in their most recently completed budget year, expressed as a per pupil amount. The typical elementary school spent only $.51 per student on consumable science supplies such as chemicals, glassware, batteries, etc. and $1.00 per student on mathematics manipulative materials/supplies in the same time period. These amounts are clearly insufficient when a single meter stick costs $3.00 and a set of mathematics pattern blocks costs $24.00. Note that the amount spent on mathematics supplies per student enrolled in the school is lower at the middle and high school levels, while the amount spent on science supplies increases with increasing grade levels. As can be seen in Table 6.17, while schools were likely to make at least some purchases to replenish consumable supplies, this was by no means universal. For example, 15 percent of elementary schools reported spending *no* money on consumable science supplies in the previous year.

Table 6.16
Median Amount Schools Spend Per Pupil Per Year on Science and Mathematics Equipment, Consumable Supplies, and Software

	Median Amount		
	Equipment	Consumable Supplies	Software
Science			
Elementary Schools	$ 1.06	$ .51	$ .09
Middle Schools	$ 1.78	$ .88	$ .16
High Schools	$ 2.11	$ 2.22	$ .25
Mathematics			
Elementary Schools	$ 1.40	$ 1.00	$ .46
Middle Schools	$ 1.00	$ .40	$ .49
High Schools	$ .87	$ .38	$ .22

Table 6.17
Schools Purchasing Science and Mathematics Equipment, Consumable Supplies, and Software in Previous Year

	Percent of Schools							
	Equipment		Consumable Supplies		Software		Any Purchase	
Science								
Elementary Schools	83	(4.9)	85	(5.9)	53	(5.0)	92	(4.5)
Middle Schools	84	(5.7)	88	(6.0)	56	(5.1)	89	(5.8)
High Schools	94	(2.2)	98	(1.8)	64	(2.9)	100	(1.5)
Mathematics								
Elementary Schools	85	(4.7)	85	(3.7)	74	(3.5)	94	(3.3)
Middle Schools	85	(5.1)	79	(5.9)	69	(4.3)	91	(3.7)
High Schools	87	(3.2)	79	(3.4)	63	(3.0)	93	(2.8)

School representatives were also asked about the amount of input the state, central office, principal, science and mathematics departments, and individual teachers have in decisions about equipment and materials purchases. As can be seen in Table 6.18, teachers and departments tend to have considerably more say in these decisions than do school, district, or state level personnel. For example, 75 percent of high schools report that individual teachers have a major say in purchases of science equipment and supplies; only 7 percent indicate that teachers have little input.

Table 6.18
Extent of Teacher Input in Science and Mathematics Decisions About Equipment/Materials Purchases

	Percent of Schools					
	Science			Mathematics		
	Little Input	Moderate Input	Major Input	Little Input	Moderate Input	Major Input
Elementary Schools						
State	80 (3.0)	10 (2.4)	10 (2.5)	65 (4.5)	18 (2.7)	18 (2.3)
Department, as a whole	59 (4.0)	14 (2.8)	27 (4.1)	56 (3.4)	11 (2.1)	33 (3.1)
Central Office	54 (4.5)	17 (2.8)	28 (3.3)	42 (4.6)	23 (2.4)	25 (3.2)
Department Chair	54 (5.3)	10 (2.2)	36 (5.6)	59 (5.2)	13 (2.7)	27 (3.8)
Principal	41 (3.3)	41 (3.5)	38 (5.1)	15 (2.6)	33 (3.5)	52 (4.0)
Individual Teachers	19 (2.8)	19 (3.7)	61 (3.7)	15 (2.6)	23 (3.1)	62 (4.2)
Middle Schools						
State	89 (2.2)	7 (1.4)	4 (1.2)	78 (4.3)	12 (2.8)	10 (2.1)
Department, as a whole	38 (5.1)	15 (3.2)	48 (5.3)	28 (5.1)	21 (3.0)	51 (4.8)
Central Office	64 (4.4)	17 (3.1)	19 (3.5)	53 (5.2)	19 (3.1)	28 (3.1)
Department Chair	39 (3.8)	12 (2.3)	48 (5.0)	38 (5.0)	18 (2.5)	44 (5.3)
Principal	27 (3.7)	38 (5.9)	34 (6.3)	16 (2.6)	32 (5.1)	52 (5.1)
Individual Teachers	10 (2.7)	16 (2.9)	75 (3.4)	11 (2.2)	29 (4.1)	60 (4.7)
High Schools						
State	87 (2.3)	9 (1.7)	4 (1.4)	79 (3.0)	12 (2.3)	10 (1.7)
Department, as a whole	21 (3.9)	22 (2.2)	58 (4.0)	15 (2.7)	25 (2.7)	60 (3.6)
Central Office	61 (2.3)	18 (2.4)	21 (2.5)	49 (3.3)	24 (2.7)	27 (2.5)
Department Chair	27 (3.1)	23 (2.0)	50 (3.4)	20 (2.1)	25 (3.3)	56 (3.4)
Principal	44 (2.3)	29 (3.0)	27 (2.5)	28 (2.2)	34 (2.4)	38 (2.5)
Individual Teachers	7 (1.7)	19 (3.0)	75 (3.1)	9 (1.4)	31 (3.0)	60 (3.4)

Either because school funds are scarce and/or ordering procedures are cumbersome, most teachers wind up spending some of their own money for supplies for their science and mathematics classes, with a median amount ranging from $25 to $50 per class. (See Table 6.19.) The typical self-contained elementary teacher spends a total of about $80 per year on science and mathematics supplies; the typical high school mathematics teacher spends a total of $125 for five classes; and the typical high school science teacher, a total of $250 for five classes.

Table 6.19
Amount of Own Money Science and Mathematics Teachers Spend on Supplies Per Class

	Median Amount	
	Science	Mathematics
Grades 1–4	$ 30	$ 50
Grades 5–8	$ 50	$ 50
Grades 9–12	$ 50	$ 25

Chapter Seven
Factors Affecting Instruction

A. Overview

The 1993 National Survey of Science and Mathematics Education asked the principal of each school in the sample to designate persons to answer questions about the school's science and mathematics programs; typically these were the science and mathematics chairs or other knowledgeable teachers. Among the data collected about each school were the extent of use of various programs and practices in the school and the extent of influence of the NCTM *Standards*. Teachers were also asked about problems that affect science and mathematics instruction in the school. These data are presented in the following sections.

B. School Programs and Practices

The designated school representatives were given a list of programs and practices and asked to indicate the extent to which each was being implemented in the school, Tables 7.1 and 7.2 show the percentages of elementary, middle, and high schools indicating considerable use (3 or 4 on a scale from 1, "not used" to 4, "used extensively") of each program or practice.

Of those listed, the most extensively used practice in both science and mathematics is an emphasis on problem-solving and reasoning skills. Percentages of schools reporting considerable use of this practice in science and mathematics ranged from 83 to 88 percent, depending on grade range. There was a sharp drop-off between this and the next most common practice, with roughly two-thirds of schools reporting considerable use of hands-on/performance-assessment in science and from 33 to 60 percent in mathematics.[4]

Elementary, middle, and high school science programs were equally likely to emphasize integration of science and mathematics instruction, ranging from 43 percent at the high school level to 50 percent at the elementary level. In contrast, only 23 percent of high school mathematics programs and 32 percent of those in middle schools, compared to 47 percent at the elementary level, emphasize integrating science and mathematics instruction.

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[4] These percentages seem much higher than observation of science and mathematics classes would suggest, raising concern that some respondents may have interpreted the question as hands-on *instruction* in general rather than using hands-on activities specifically as a part of student assessment.

Emphasis on integrating science/mathematics instruction with language arts instruction is greatest in the lower grades. For example, only 9 percent of high schools report an emphasis on integrating mathematics and language arts, compared to 35 percent of elementary schools.

Table 7.1
Science Programs Indicating Considerable Use* of Various Programs/Practices, by School Type

	Percent of Programs					
	Elementary Schools		Middle Schools		High Schools	
School-based management	49	(4.2)	45	(5.3)	45	(2.8)
Common daily planning period for members of the science department	13	(2.8)	16	(3.4)	29	(4.9)
Common work space for members of the science department	13	(2.3)	20	(3.2)	27	(4.3)
Interdisciplinary teams of teachers who share the same students (e.g., school within a school)	31	(3.4)	33	(3.8)	8	(1.8)
Students assigned to science classes by ability	6	(2.1)	19	(3.4)	40	(2.8)
Independent study projects for credit in science	27	(2.9)	27	(3.5)	18	(3.2)
Emphasis on problem solving, reasoning skills in science	83	(3.1)	86	(3.3)	87	(2.6)
Use of computers to solve science problems	12	(2.4)	22	(2.7)	40	(2.5)
Hands-on/performance assessment in science classes	66	(4.0)	69	(4.0)	66	(2.8)
Integration of science and mathematics instruction	50	(5.0)	46	(5.1)	43	(3.0)
Integration of science and language arts instruction	46	(4.8)	32	(5.6)	21	(2.7)
Use of vocational/technical applications in science instruction	18	(6.0)	24	(5.7)	17	(2.2)
Science content changes recommended by AAAS' Project 2061 (*Science for All Americans*)	11	(2.3)	10	(2.7)	10	(2.0)
Science content changes recommended by NSTA's Scope, Sequence, and Coordination Project (SS&C *Content Core*)	10	(2.2)	10	(2.4)	11	(2.5)

* Respondents were given a four-point scale for each program/practice, with 1 labeled "not used" and 4 labeled "used extensively." These numbers represent the total circling either 3 or 4.

Nearly one-third of elementary and middle schools, compared to only about 10 percent of high schools, report considerable use of interdisciplinary teams of teachers who share the same students. In contrast, high schools are more likely than elementary or middle schools to provide a common daily planning period and common work space for members of the science and mathematics departments (due in large measure to the fact that high schools are more likely to have science and mathematics departments.)

Ability grouping is more common in mathematics than in science, and becomes more widespread in the higher grades. For example, 6 percent of elementary schools, compared to 40 percent of high schools, frequently assign students to science classes by ability level;

comparable figures for mathematics are 25 percent at the elementary level and 69 percent at the high school level.

Table 7.2
Mathematics Programs Indicating Considerable Use*
of Various Programs/Practices, by School Type

	Percent of Programs					
	Elementary Schools		Middle Schools		High Schools	
School-based management	52	(4.0)	49	(5.8)	41	(5.7)
Common daily planning period for members of the mathematics department	15	(3.3)	18	(3.6)	24	(3.4)
Common work space for members of the mathematics department	13	(3.1)	18	(3.8)	32	(3.9)
Interdisciplinary teams of teachers who share the same students (e.g., school within a school)	26	(3.6)	33	(4.7)	12	(1.9)
Students assigned to mathematics classes by ability	25	(5.5)	54	(5.8)	69	(4.5)
Independent study projects for credit in mathematics	16	(4.7)	17	(6.1)	14	(4.0)
Emphasis on problem solving, reasoning skills in mathematics	87	(1.8)	84	(3.1)	88	(2.2)
Use of computers to solve mathematics problems	47	(4.0)	27	(5.0)	24	(2.9)
Hands-on/performance assessment in mathematics	60	(3.5)	41	(5.0)	33	(3.7)
Integration of mathematics and science instruction	47	(5.0)	32	(6.3)	23	(3.4)
Integration of mathematics and language arts instruction	35	(3.8)	20	(6.5)	9	(2.8)
Use of vocational/technical applications in mathematics instruction	20	(3.4)	26	(4.9)	25	(2.3)
Content changes recommended by AAAS' Project 2061 (*Science for All Americans*)	7	(2.3)	7	(2.8)	6	(1.1)
Content changes recommended by NCTM's *Curriculum and Evaluation Standards*	39	(3.2)	50	(5.1)	56	(3.9)
Pedagogical shifts recommended by NCTM's *Professional Standards for Teaching Mathematics*	36	(3.0)	44	(5.0)	44	(4.2)
Integration of mathematics subjects (e.g., algebra, probability, geometry, etc. all taught together each year)	33	(3.7)	39	(6.3)	19	(3.8)

* Respondents were given a four-point scale for each program/practice, with 1 labeled "not used" and 4 labeled "used extensively." These numbers represent the total circling either 3 or 4.

School representatives were also asked if their schools were changing their curricula based on various reform recommendations. Roughly 1 in 10 schools at each level indicated that NSTA's Scope Sequence, and Coordination Project and AAAS' Project 2061 had led to changes in science content. Much larger percentages indicated that NCTM's *Curriculum and Evaluation Standards* had influenced the mathematics content taught, ranging from 39 percent of elementary schools to 56 percent of high schools. Somewhat fewer schools (from 36 to 44 percent) indicated that they had made considerable effort to implement the pedagogical shifts recommended by NCTM's *Professional Standards for Teaching Mathematics.*

School representatives were asked about several instructional arrangements for elementary students—whether they were pulled out from self-contained classes for remediation or enrichment in science and mathematics and whether they received science and mathematics instruction from specialists instead of, or in addition to, their regular teacher. These results are shown in Tables 7.3. Note that pulling students out of self-contained classes for remedial instruction is much more common in mathematics than in science, with 61 percent of elementary schools doing so in mathematics, but only 10 percent in science. Elementary schools are also more likely to pull students out for enrichment in mathematics (44 percent of schools) than in science (27 percent). In contrast, use of specialists for instruction is equally common in science and mathematics, with roughly 1 in 4 schools having students receive instruction in mathematics and science in addition to their regular teacher and 1 in 8 instead of from their regular teacher.

Table 7.3
Use of Science and Mathematics Instructional Arrangements in Elementary Schools

	Percent of Schools									
	Not Used 1		2		3		Used Extensively 4		Don't Know or Not Applicable	
Science										
Students pulled out from self-contained classes for remedial instruction in science	83	(3.9)	6	(2.2)	2	(0.5)	2	(1.0)	7	(1.9)
Students pulled out from self-contained classes for enrichment in science	66	(5.3)	16	(3.5)	7	(1.8)	4	(1.4)	7	(3.3)
Students receiving instruction from science specialists in addition to their regular teacher	72	(3.1)	16	(3.1)	5	(1.1)	3	(1.1)	4	(1.4)
Students receiving instruction from science specialists instead of their regular teacher	82	(2.8)	5	(0.8)	3	(1.0)	4	(1.0)	5	(1.4)
Mathematics										
Students pulled out from self-contained classes for remedial instruction in mathematics	32	(3.7)	23	(3.4)	25	(3.3)	13	(2.2)	8	(3.3)
Students pulled out from self-contained classes for enrichment in mathematics	53	(4.0)	19	(3.6)	18	(3.9)	7	(1.9)	3	(1.0)
Students receiving instruction from mathematics specialists in addition to their regular teacher	69	(4.5)	12	(2.7)	10	(3.2)	4	(1.0)	5	(1.6)
Students receiving instruction from mathematics specialists instead of their regular teacher	79	(4.3)	9	(2.1)	3	(0.9)	2	(1.1)	7	(1.8)

Finally, school representatives were asked about opportunities for students to take courses that are not a regular part of the school's course offerings. As can be seen in Table 7.4, 11 percent of high schools offer mathematics courses by telecommunications and 14 percent offer science courses that way. High schools are more likely to have students go to colleges and universities for courses in mathematics (40 percent of schools) than science (29 percent). Relatively few high schools send students to other K–12 schools for courses in either mathematics (8 percent) or science (6 percent).

Table 7.4
Opportunities for High School Students to Take Science and Mathematics Courses Not Offered in School

	Percent of High Schools									
	Not Used 1		2		3		Used Extensively 4		Don't Know or Not Applicable	
Science										
Students going to another K–12 school for science courses	80	(1.8)	4	(0.8)	1	(0.5)	1	(0.8)	13	(1.9)
Science courses offered by telecommunications	75	(2.2)	11	(1.5)	3	(0.6)	0	(0.2)	10	(2.5)
Students going to a college or university for science courses	63	(2.9)	23	(1.8)	5	(1.0)	1	(0.8)	9	(2.4)
Mathematics										
Students going to another K–12 school for mathematics courses	81	(2.9)	5	(1.4)	2	(0.3)	1	(0.3)	12	(2.8)
Mathematics courses offered by telecommunications	79	(2.7)	7	(1.8)	4	(1.4)	0	(0.3)	11	(2.1)
Students going to a college or university for mathematics courses	56	(3.7)	31	(2.9)	8	(1.6)	1	(0.7)	4	(1.5)

C. Extent of Influence of the NCTM *Standards*

School mathematics representatives were given a series of statements about the influence of the NCTM *Standards* in their school and district and asked the extent to which they agreed with each. As can be seen in Table 7.5, in 1993, sizeable proportions (from 45 to 53 percent) of elementary, middle, and high schools were reportedly engaged in school-wide efforts to make changes inspired by the *Standards*. Similarly, 34 percent of high schools, 41 percent of middle schools, and 50 percent of the elementary schools reported that their districts are organizing staff development based on the standards.

Table 7.5
Respondents Agreeing* with Various Statements Regarding NCTM *Standards*, by School Type

	Percent of Programs					
	Elementary Schools		Middle Schools		High Schools	
The principal of this school is well-informed about the *Standards*	59	(2.8)	55	(3.9)	35	(3.3)
The superintendent of this district is well-informed about the *Standards*	55	(3.4)	49	(4.1)	33	(2.6)
Our district is organizing staff development based on the *Standards*	50	(4.3)	41	(3.9)	34	(2.4)
There is a school-wide effort to make changes inspired by the *Standards*	48	(2.8)	53	(4.1)	45	(2.4)
The school board is well-informed about the *Standards*	28	(2.7)	23	(3.4)	14	(1.7)
The *Standards* have been thoroughly discussed by teachers in this school	21	(2.6)	30	(4.0)	39	(3.5)
Our district has changed how it evaluates teachers based on the *Standards*	19	(2.8)	17	(3.8)	6	(1.4)
Parents of students in this school are well-informed about the *Standards*	8	(2.2)	10	(3.0)	6	(1.3)

* Includes responses of "strongly agree" and "agree" to each statement. "Don't know" responses were excluded from the analyses.

More than 40 percent of elementary and middle school representatives, compared to 28 percent of the high school representatives, reported that their principals were well-informed about the *Standards*. Superintendents were generally less likely to be considered knowledgeable of the *Standards* (from 24 to 31 percent). And relatively few school representatives indicated that their school boards (from 10 to 15 percent) or parents of students in the schools (5 to 8 percent) were well-informed about the *Standards*.

D. Problems Affecting Instruction

Teachers were given a list of "factors" that might affect science and mathematics instruction in their school and asked to indicate which, if any, cause serious problems. (The other response options were "not a significant problem" and "somewhat of a problem.") Results for science are presented in Table 7.6 and those for mathematics in Table 7.7.

Resource-related issues were typically the ones most often cited as serious problems. In science, inadequate funds for purchasing equipment and supplies and lack of materials for individualizing instruction were labeled serious problems by more than 30 percent of teachers in grades 1–4, 5–8, and 9–12, and inadequate facilities by from 18 to 28 percent. Inadequate access to computers and lack of appropriate computer software for teaching science appear to be more problematic in the higher grades. For example, 19 percent of grade 1–4 science teacher compared to 29 percent of those in grades 5–8 and 40 percent of those in grades 9–12 cited access to computers as a serious problem.

Other issues that appear to become increasingly problematic for science education in the higher grades include large classes; student absences; student reading ability; student interest in science; interruptions for announcements, assemblies, and other school activities; and parental support for education. In contrast, time to teach science is more problematic in the lower grades, with 17 percent of grade 1–4 teachers and 16 percent of those in grades 5–8 compared to 9 percent in grades 9–12 citing lack of time to teach science as a serious problem.

Two other areas were considered serious problems for science instruction by sizeable proportions of teachers in each grade range; from 20 to 27 percent of teachers cited lack of opportunities for teachers to share ideas as a serious problem and from 14 to 19 percent indicated that lack of in-service education opportunities was a serious problem. Teacher interest in science; teacher preparation to teach science; state/district testing policies; and maintaining discipline were less often cited as serious problems for science instruction.

As was the case in science, resource-related issues were the ones most likely to be cited as problematic in mathematics. Approximately 1 in 5 mathematics teachers in grades 1–4 and 1 in 3 in grades 5–8 and 9–12 indicated that access to computers and lack of appropriate computer software caused serious problems for mathematics education in their schools. Lack of funds for purchasing equipment and supplies and lack of materials for individualizing instruction were also rated as serious problems by many mathematics teachers in each grade range, ranging from 21 to 25 percent. Other problems considered serious by sizeable percentages of mathematics teachers in each grade range included large classes and lack of opportunities for teachers to share ideas.

Several areas appear to be more problematic in the higher grades, essentially the same areas cited in science, including student reading abilities; lack of student interest in mathematics; student absences; lack of parental support; and interruptions for announcements, assemblies, and other school activities. Similarly, most of the areas that rarely cause serious problems in science instruction were not likely to be considered serious for mathematics instruction, including teacher preparation and interest in mathematics and maintaining discipline. It is interesting to note that so few mathematics teachers (ranging from 7 to 11 percent, depending on grade range) consider state/district testing problems as problematic for mathematics instruction, essentially the same percentages as in science even though mathematics tests are much more prevalent.

Table 7.6
Science Teachers Viewing Each of a Number of Factors as a Serious Problem for Science Instruction in Their School

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Funds for purchasing equipment and supplies	39	(3.1)	40	(3.2)	36	(2.3)
Materials for individualizing instruction	32	(2.5)	45	(2.8)	38	(2.4)
Appropriate computer software	27	(3.1)	42	(3.0)	45	(2.8)
Opportunities for teachers to share ideas	24	(2.7)	27	(3.0)	20	(2.1)
Facilities	21	(2.1)	28	(2.1)	18	(1.9)
Access to computers	19	(1.7)	29	(2.5)	40	(2.2)
Large classes	17	(2.4)	27	(3.0)	26	(2.5)
Time to teach science	17	(2.4)	16	(2.8)	9	(0.8)
In-service education opportunities	14	(1.6)	16	(2.8)	19	(2.8)
State/district testing policies	10	(1.6)	12	(2.7)	9	(2.2)
Teacher preparation to teach science	10	(1.8)	6	(1.7)	1	(0.3)
Parental support for education	9	(1.4)	12	(1.7)	22	(2.6)
Student reading abilities	8	(1.0)	12	(2.2)	26	(3.8)
Maintaining discipline	8	(1.2)	12	(2.1)	9	(1.0)
Interruptions for announcements, assemblies, other school activities	4	(0.9)	9	(1.5)	18	(1.7)
Teacher interest in science	3	(0.8)	2	(0.8)	0	(0.2)
Student interest in science	2	(0.9)	7	(1.1)	14	(1.5)
Student absences	2	(0.4)	4	(0.8)	21	(1.4)

Table 7.7
Mathematics Teachers Viewing Each of a Number of Factors as a Serious Problem for Mathematics Instruction in Their School

	Percent of Teachers					
	Grades 1–4		Grades 5–8		Grades 9–12	
Appropriate computer software	23	(1.9)	35	(3.6)	32	(2.3)
Funds for purchasing equipment and supplies	23	(2.6)	24	(4.4)	25	(2.1)
Access to computers	21	(2.0)	33	(3.3)	31	(2.5)
Materials for individualizing instruction	21	(3.0)	23	(3.6)	24	(1.9)
Large classes	19	(1.8)	23	(3.0)	19	(1.6)
Opportunities for teachers to share ideas	18	(1.3)	17	(2.6)	16	(2.6)
Student reading abilities	13	(1.9)	16	(2.6)	20	(1.4)
In-service education opportunities	12	(1.8)	11	(1.6)	12	(1.6)
Parental support	11	(1.2)	16	(2.3)	17	(1.3)
State/district testing policies	11	(1.4)	11	(1.7)	7	(1.2)
Maintaining discipline	8	(1.5)	13	(2.3)	9	(1.7)
Interruptions for announcements, assemblies, other school activities	5	(0.9)	7	(1.0)	14	(1.8)
Student absences	4	(0.8)	8	(1.3)	20	(1.4)
Time to teach mathematics	4	(0.8)	4	(1.3)	3	(0.5)
Teacher preparation to teach mathematics	4	(0.9)	2	(0.8)	1	(0.2)
Student interest in mathematics	3	(0.7)	12	(2.3)	24	(2.6)
Facilities	3	(0.8)	3	(1.0)	6	(0.9)
Teacher interest in mathematics	1	(0.3)	1	(0.5)	1	(0.2)

A similar question was administered to teachers in both the 1977 and 1985–86 national surveys. Trend results for science and mathematics teachers are shown in Table 7.8, using grades 7–9 for illustrative purposes. Note that resource-related issues were generally more likely to be considered serious problems in 1993 than in previous years. For example, the percent of grade 7–9 science teachers citing access to computers as a serious problem increased from 23 percent in 1985–86 to 37 percent in 1993; in mathematics the increase was even larger, from 18 percent to 39 percent. Similarly, while funds for purchasing equipment and supplies was rarely cited as a serious problem for mathematics instruction in 1977 and 1985–86, 31 percent of teachers in 1993 cited lack of funds as a serious problem, which may be a reflection of the increased use of manipulatives in mathematics instruction.

Table 7.8
Grade 7–9 Science and Mathematics Teachers Viewing Each Factor as a Serious Problem: 1977, 1985–86, and 1993

	Percent of Teachers					
	1977		1985–86		1993	
Science						
Student reading abilities	40	(2.5)	19	(2.3)	24	(3.5)
Materials for individualizing instruction	27	(2.3)	27	(2.7)	38	(2.9)
Facilities	26	(2.2)	25	(2.6)	23	(3.7)
Funds for purchasing equipment/supplies	24	(2.2)	26	(2.6)	33	(3.2)
Large classes	19	(2.0)	19	(2.3)	25	(2.4)
Student interest in science	19	(2.0)	14	(2.1)	13	(1.5)
Maintaining discipline	6	(1.2)	9	(1.7)	10	(1.5)
Teacher preparation to teach science	3	(0.9)	5	(1.3)	2	(1.0)
Teacher interest in science	2	(0.7)	2	(0.8)	0	(0.2)
Access to computers	--	--	23	(2.5)	37	(2.9)
Student absences	--	--	11	(1.9)	14	(1.2)
Mathematics						
Student reading abilities	42	(2.5)	18	(2.3)	18	(2.1)
Student interest in mathematics	31	(2.3)	22	(2.5)	18	(1.7)
Large classes	23	(2.1)	15	(2.2)	18	(1.9)
Materials for individualizing instruction	21	(2.1)	15	(2.2)	24	(2.3)
Funds for purchasing equipment/supplies	13	(1.7)	11	(1.9)	31	(5.8)
Maintaining discipline	12	(1.6)	6	(1.4)	12	(1.6)
Facilities	10	(1.5)	3	(1.0)	7	(1.7)
Teacher preparation to teach mathematics	5	(1.1)	3	(1.0)	1	(0.5)
Teacher interest in mathematics	2	(0.7)	1	(0.6)	0	(0.1)
Access to computers	--	--	18	(2.3)	39	(3.2)
Student absences	--	--	13	(2.2)	16	(2.2)

Appendix A

Sample Design

Sample Design

A. Design Overview

The sample design for the 1993 National Survey of Science and Mathematics Education (NSSME) is a national probability sample of science and mathematics program heads and teachers in grades 1–12 in the 50 states and the District of Columbia. The sample was designed to allow national estimates (totals and ratios of totals) of science and mathematics course offerings and enrollment; teacher background preparation; textbook usage; instructional techniques; and availability and use of science and mathematics facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being drawn into the sample.

The sample design involved clustering and stratification. The first stage units consisted of elementary and secondary schools. Science and mathematics teachers constituted the second stage units. From the mathematics and science classes taught by sample teachers, a sample of one class was selected for each teacher. The target sample sizes were 1,250 schools and 6,000 teachers selected within sample schools. These sample sizes are large enough to allow subdomain estimates such as for particular regions or types of community.

The sampling frame for the school sample was constructed from the Quality Education Data, Inc. (QED) database, which includes school name and address and information about other characteristics needed for stratification and sample selection. The sampling frame for the teacher sample was constructed from lists provided by sample schools identifying active teachers and the specific mathematics and science subjects they were teaching in the Spring of 1993.

B. School Sample

This section describes the sample design features of the NSSME school sample. It is organized as follows:

- Target Population
- Sampling Frame
- Stratification
- Sample Allocation
- Sample Selection
- School Weight

Target Population

The target population for the school sample includes all regular public and private schools in the 50 states and the District of Columbia. Excluded from the target universe are vocational/technical schools, schools offering alternative, special or adult education only, and preschool/kindergarten only schools.

Sampling Frame

The sampling frame for the school sample was constructed from the Quality Education Data (QED) school-level database. Educational institutions classified by QED as public, private and Catholic elementary and secondary schools were included. Excluded were Bureau of Indian Affairs (BIA) schools and Department of Defense (DOD) schools. A file was extracted from the original QED file including records for all eligible schools.

For all schools in the database, QED includes information on grade span by indicating the lowest and highest grade offered in the school. Schools eligible for the survey were classified on the basis of the grade span variables into one of three sampling frames corresponding to the three primary sampling strata. In schools with nonconsecutive grade spans, school eligibility and assignment to strata were based on the four grade-level fields on the QED file that provide the low and high grades for the nonconsecutive grade levels.

Stratification

Three primary sampling strata were defined for the school sample. The strata definition is based on grade span as follows:

- Stratum 1: Schools with any grade 10, 11 or 12
- Stratum 2: Schools not in stratum 1, but with no grades lower than 5
- Stratum 3: All other schools

Secondary strata were defined by Census geographic region—Northeast, Midwest, South and West; metropolitan status—urban, suburban and rural; and private (including parochial schools) versus public auspices. Implicit stratification was achieved by sorting the file by Orshansky percentile (i.e. proportion of the students in the school district who live in families with incomes under the poverty line) within secondary stratum.

Sample Allocation

The allocation of the total school sample (1,250 schools) among the three primary strata was based on the minimum sample size desired for each stratum and the desired sample sizes for teachers of advanced mathematics and physics/chemistry. The sample allocation was the following:

- Stratum 1: 650 schools
- Stratum 2: 300 schools
- Stratum 3: 300 schools

Sample Selection

The school sample was selected with probability proportional to size (PPS). The measure of size was defined for each of the primary strata as follows:

- Stratum 1: Estimated number of teachers in grades 10–12 [computed as: (number of grades in 10–12 range) x (Total teachers from QED/number of grades)]
- Stratum 2: Total number of teachers, from QED
- Stratum 3: Total number of teachers, from QED

For school records with missing teacher counts, the measure of size was estimated by imputing a total number of teachers in the relevant grades based on grade specific student to teacher ratios, estimated separately for private and public schools.

Within primary stratum, the file was sorted by secondary strata and two independent half-samples of the specified sizes were selected using the standard PPS selection procedure. Independent random starts were generated to achieve independent half-samples within secondary strata. In the process of sample selection, a half-sample identifier was assigned to each sample record. The table below shows the distribution of the sample by primary and secondary stratum.

SECONDARY STRATUM				PRIMARY STRATUM		
#	REGION	STATUS	PUBLIC/ PRIVATE	1 Including Grades 10+	2 No Grade Less Than 5	3 Other
1	Midwest	Metropolitan	Public	33	14	11
2			Private	11		2
3		Urban	Public	81	46	33
4			Private	7		8
5		Suburban	Public	36	17	16
6			Private	4		4
7	Northeast	Metropolitan	Public	29	15	12
8			Private	7		6
9		Urban	Public	77	40	30
10			Private	14	1	6
11		Suburban	Public	14	3	7
12			Private	3		
13	South	Metropolitan	Public	55	34	25
14			Private	11		5
15		Urban	Public	105	59	46
16			Private	7		4
17		Suburban	Public	44	20	26
18			Private	5		
19	West	Metropolitan	Public	28	18	14
20			Private	5		3
21		Urban	Public	56	35	24
22			Private	7		6
23		Suburban	Public	13	4	4
24			Private	1		1
TOTAL				653	306	293

School Weight

A base weight, W_{hs}—the reciprocal of the school's probability of selection—was assigned to every school in the sample as follows:

$$w_{hs} = \frac{MOS_h(total)}{n_h\, MOS_{hs}}$$

where:

MOS_h (*total*) = Total measure of size in primary stratum ***h***

MOS_{sh} = Measure of size for school ***s***

This is also the base weight associated with program heads since mathematics and science program questionnaires were distributed in every sample school.

C. Teacher Sample

The following section describes the sample design features of the NSSME teacher sample. It is organized as follows:

- Target Population
- Sampling Frame
- Stratification
- Sample Allocation
- Sample Selection
- Selection of Classes

Target Population

The target population for the teacher sample consists of teachers in eligible schools (see School Sample, Target Population) who teach mathematics and/or science. Science includes biology, chemistry, physics, earth science and other science.

Sampling Frame

The sampling frame for the teacher sample was constructed by requesting that principals in all sample schools provide a list of eligible teachers and identify the courses taught by each teacher. To assist the school in providing the information necessary to build the frame, a listing sheet was provided with appropriate column headings depending on the school's primary stratum. For schools in stratum 1 the following mathematics and science categories were listed:

- Physics or chemistry
- Other science
- Mathematics: Advanced (Algebra III and above)
- Mathematics: Not advanced

For strata 2 and 3 the categories listed were:

- Science
- Mathematics

Stratification

Based on the course information provided for teachers on the school list, each teacher was assigned to one of the following five teacher strata:

- Stratum 1: Physics or chemistry with or without other science (no mathematics)
- Stratum 2: Advanced mathematics (no science)
- Stratum 3: Other science only (no mathematics or physics/chemistry)
- Stratum 4: Other mathematics only (no advanced mathematics)
- Stratum 5: Any combination of mathematics and science

Sample Allocation

The target allocation of the sample of 6,000 teachers to the three primary school strata was the following:

- Stratum 1: 2,900 teachers
- Stratum 2: 1,550 teachers
- Stratum 3: 1,550 teachers

To meet the objectives of the survey, teachers in the higher grades and teachers teaching advanced mathematics and/or physics and/or chemistry were oversampled.

Sample Selection

The sampling rate for teachers in teacher stratum l (l = 1–5) was computed as follows:

$$f_l = n_l / N_l$$

where:

f_l = the overall stratum sampling fraction in teacher stratum l
n_l = Target sample size in stratum l
N_l = Number of listed teachers in stratum l

Within each primary school stratum and teacher stratum, an independent sample was selected at the specified rate. For each of the three school groups, the table below shows the number of teachers selected in the cooperating schools and the sampling rate in each teacher stratum.

Teacher Stratum	Sample Size (n_l)	Sampling Rate (f_l)
School Stratum 1 (including grades 10+):	**3007**	
1: Physics/chemistry with or without other science	747	.470
2: Advanced mathematics only (no science or other mathematics)	753	.461
3: Other science only (no mathematics or physics/chemistry)	702	.248
4: Other mathematics only (no advanced mathematics)	707	.218
5: Any combination of mathematics and science	98	.200
School Stratum 2 (No grades less than 5):	**1596**	
1: Physics/chemistry with or without other science	6	.470
2: Advanced mathematics only (no science or other mathematics)	4	.461
3: Other science only (no mathematics or physics/chemistry)	633	.461
4: Other mathematics only (no advanced mathematics)	628	.395
5: Any combination of mathematics and science	325	.608
School Stratum 3 (Other):	**1517**	
1: Physics/chemistry with or without other science	1	.470
2: Advanced mathematics only (no science or other mathematics)	2	.461
3: Other science only (no mathematics or physics/chemistry)	48	.463
4: Other mathematics only (no advanced mathematics)	54	.281
5: Any combination of mathematics and science	1412	.389

Selection of Subject and Class

Sample teachers were sent a self-administered questionnaire. As part of the sampling process, teachers in sub-stratum five in each stratum were assigned to receive either a mathematics or a science questionnaire. This represented an additional stage of sampling since only half of the sample teachers in this stratum were assigned to report on mathematics and the other half on science. This one-in-two subsampling must be reflected in producing mathematics or science-specific estimates.

Some of the items on the questionnaire apply to individual classes. Teachers with multiple mathematics or science classes each day were asked to report on only one of these classes. Teachers were asked to list all of their mathematics and science classes in order by class period. The questionnaire instructed the teachers to refer to a pre-printed sampling table to make a random selection from among their classes listed. The sampling table was randomly generated so that a random selection of classes would be achieved overall.

D. Weighting and Variances

In surveys involving complex, multistage designs such as NSSME, weighting is necessary to reflect the differential probabilities of selection among sample units at each stage of selection. Weights were developed to produce unbiased estimates of the population of schools and teachers in the NSSME survey. Weighting is also used to adjust for different rates of participation in the survey by different types of schools and teachers.

Variance computation for the NSSME survey must also take into account the survey design. Sampling errors generated by available procedures in SAS, SPSS and other standard statistical software packages are not appropriate because they assume simple random sampling. With the sample design used in NSSME, direct estimators of the variance of an estimated total or ratio are available based on the two independent half-samples and can be programmed in SAS or a higher level language.

Weighting

Weights were developed to permit unbiased estimates for school and teacher characteristics. The base weight associated with a school or teacher is the reciprocal of the respective probabilities of selection. To adjust for different rates of participation in the survey by different types of schools and teachers, both school and teacher non-response adjustments were developed and applied to the base weight.

In addition, because in some cooperating schools the person designated to answer questions about the school mathematics or science program may have failed to participate, it was necessary to adjust the weights for school science and mathematics program level estimates. Accordingly three distinct school non-response adjustments were developed:

- NRA1: To be applied to the school weight to produce teacher-level estimates
- NRA2: To produce mathematics program level estimates
- NRA3: To produce science program level estimates

For non-response adjustment cell *c*, the general form of the NRA is given by:

$$NRA_c = \frac{\sum_{(elig)\,in\,c} w_i}{\sum_{(resp)\,in\,c} w_i}$$

where w_i is the base weight of the ith school in cell ***c***. The numerator of the three adjustment factors is the same—all eligible schools. The denominator (respondents) for NR1 includes all schools that provided lists of teachers for sampling; respondents for NR2 and NR3 include only schools that completed a program questionnaire in mathematics and science, respectively.

Since non-response adjustment through weighting assumes that response patterns of non-respondents are similar to that of respondents, c corresponds to a secondary sampling stratum, except in cases where two or more secondary strata were collapsed because of small cell sizes (all private schools and suburban schools in a region were collapsed into a single stratum).

The three school weights adjusted for non-response are given by:

$$w_1{}^*_{sh} = w_{sh} \cdot NR1_{h\in c}$$
$$w_2{}^*_{sh} = w_{sh} \cdot NR2_{h\in c}$$
$$w_3{}^*_{sh} = w_{sh} \cdot NR2_{h\in c}$$

where:

w_{sh}	= base weight associated with school ***s*** in stratum h
$NR1_{h\in c}$	= school non-response adjustment for estimates of teacher characteristics in cell ***c***
$NR2_{h\in c}$	= school non-response adjustment for estimates of mathematics programs in cell ***c***
$NR3_{h\in c}$	= school non-response adjustment for estimates of science programs in cell ***c***

The final weight associated with a teacher includes additional components related to teacher selection and participation. That is:

$$w^*_{shl} = w^*_{sh} \cdot w_{tl} \cdot NRT_l$$

where:

w_{tl}	= reciprocal of the probability of selection for teacher stratum ***l***
w^*_{sh}	= final weight associated with the teacher's school
$w_3{}^*_{tl}$	= final weight associated with teachers in stratum ***l***, school s
w^*_{shl}	= final weight associated with teachers in stratum ***l***, school s
NRT_l	= non-response adjustment for teacher stratum ***l***,

$$NRT_l = \frac{\sum_{t\in(elig)l} n_t}{\sum_{t\in(resp)l} n_t}$$

Variance Computation

With the NSSME design, direct estimators of the variance of an estimated total are available. Estimating the variance of a ratio, requires estimates of the variances of the numerator and denominator as well as estimates of their covariance. Direct estimates of the covariance are also available. The variance of a total for a given secondary stratum is estimated by:

$$var\,X = \sum_{h=1}^{24} (X_{hl} - X_{h2})^2$$

where X_{hl} and X_{h2} are the sums of the weighed values of the two half-samples in secondary stratum h.

The estimated covariance is:

$$cov\;X,Y = \sum_{h=1}^{24} (X_{h1} - X_{h2})\,(Y_{h1} - Y_{h2})$$

with similar definition of the y values. The estimated variance of the ratio Y/X is then simply:

$$var\;Y/X = 1/X^2\;[var\;\;Y + (Y/X)^2\;var\,X - 2\;(Y/X)\;cov\,X,Y]$$

For the entire universe, the variance of a total is estimated by the sum of the estimated variances of that total over all relevant primary and secondary strata. The same holds for the covariance. The variance of a ratio for the entire universe is estimated by the same formula given above for a single primary stratum.

Appendix B

Survey Questionnaires

Science Program Questionnaire

Mathematics Program Questionnaire

Science Questionnaire

Mathematics Questionnaire

List of Course Titles

Form Approval
OMB No: 3145-0142
Expires: Dec. 31, 1993

NATIONAL SCIENCE FOUNDATION
1993 National Survey of Science and Mathematics Education

Science Program Questionnaire

How to Complete the Questionnaire
You have been selected to answer questions about science instruction in your school. Most of the questions instruct you to "circle one" answer or "circle all that apply". For a few questions, you are asked to write in your answer on the line provided. If you have questions about the study or any items in the questionnaire, call us toll-free at 1-800-598-2888.

About the Survey
The 1993 National Survey of Science and Mathematics Education is supported by the National Science Foundation and is the third in a series. It is being conducted by Horizon Research, Inc., under the direction of Dr. Iris R. Weiss. Data collection is the responsibility of CODA, a survey research firm in Silver Spring, Md. The study has been endorsed by the American Federation of Teachers, the National Catholic Education Association, the National Council of Teachers of Mathematics, the National Education Association, and the National Science Teachers Association.

Approximately 6,000 teachers from 1,200 schools throughout the country have been selected for the survey, which is designed to collect information about science and mathematics education in grades 1-12. Its purpose is to provide the education community with current information about science and mathematics education and to identify trends in the areas of teacher education and experience, course offerings, curriculum and instruction, and the availability and use of equipment.

The 1,200 schools were randomly selected for the survey from the Quality Education Data (QED) database. Last June, Chief State School Officers and district superintendents were notified about the survey. In September, school principals were sent a pre-survey information booklet, requesting the names of all science and mathematics teachers. From these lists, a national sample of teachers was selected to receive science or mathematics questionnaires. Questionnaires are also being sent to the science and mathematics department representatives at each school. Teacher questionnaires are also being sent to all winners (1983 - 1992) of the National Science Foundation's Presidential Awards for Excellence in Science and Mathematics Teaching.

All survey data received will be kept strictly confidential and will be reported only in aggregate form, such as by grade or region of the country. No information identifying individual states, districts, schools or teachers will be released. Each participating school will receive a copy of the study's results in the spring of 1994.

Information About Your Participation
Public reporting burden for this collection of information is estimated to average 15 minutes per response. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Herman Fleming, National Science Foundation, 1800 G Street - NW, Washington, DC 20550 and to the Office of Management and Budget, Paperwork Reduction Project, OMB #3145-0142, Washington, DC 20503.

Thank you very much. Your participation is greatly appreciated. Please return the questionnaire to us in the postage-paid envelope:

1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

Science Program Questionnaire

1. Indicate the extent to which each of the following programs/practices is currently being implemented **in your school.**

(CIRCLE ONE ON EACH LINE.)

		Not used			Used extensively	Don't know/ Not applicable
a.	School-based management	1	2	3	4	8
b.	Common daily planning period for members of the science department	1	2	3	4	8
c.	Common work space for members of the science department	1	2	3	4	8
d.	Interdisciplinary teams of teachers who share the same students (e.g., school within a school)	1	2	3	4	8
e.	Students assigned to science classes by ability	1	2	3	4	8
f.	Independent study projects for credit in science	1	2	3	4	8
g.	Emphasis on problem solving, reasoning skills in science	1	2	3	4	8
h.	Use of computers to solve science problems	1	2	3	4	8
i.	Hands-on/performance assessment in science classes	1	2	3	4	8
j.	Integration of science and mathematics instruction	1	2	3	4	8
k.	Integration of science and language arts instruction	1	2	3	4	8
l.	Use of vocational/technical applications in science instruction	1	2	3	4	8
m.	Science content changes recommended by AAAS' Project 2061 (*Science for All Americans*)	1	2	3	4	8
n.	Science content changes recommended by NSTA's Scope, Sequence, and Coordination Project (*SS&C Content Core*)	1	2	3	4	8
o.	Elementary students pulled out from self-contained classes for remedial instruction in science	1	2	3	4	8
p.	Elementary students pulled out from self-contained classes for enrichment in science	1	2	3	4	8
q.	Elementary students receiving instruction from science specialists **in addition to** their regular teacher	1	2	3	4	8
r.	Elementary students receiving instruction from science specialists **instead of** their regular teacher	1	2	3	4	8
s.	Science courses offered by telecommunications	1	2	3	4	8
t.	Students going to another K - 12 school for science courses	1	2	3	4	8
u.	Students going to a college or university for science courses	1	2	3	4	8

2. Does your school include secondary students (grades 7 or higher)?

Yes .... 1 *(CONTINUE WITH QUESTION 3.)*

No.......... 2 *(SKIP TO QUESTION 8.)*

3. Please give the number of sections of each of the following science courses currently offered in your school. (Additional course titles for these categories are shown on the enclosed blue "List of Course Titles.")

GRADES 7 - 8

Current number of sections	CODE	COURSE CATEGORY
______	108	Life Science, 7 - 8
______	109	Earth Science, 7 - 8
______	110	Physical Science, 7 - 8
______	111	General Science, 7 - 8
______	112	Coordinated Science, 7 - 8
______	113	Integrated Science, 7 - 8
		GRADES 7 - 8, Other Science Courses
______		______________
______		______________
______		______________

GRADES 9 - 12

Current number of sections	CODE	COURSE CATEGORY
______	114	Biology, 1st year
______	115	Biology, 1st year, Applied
______	116	Biology, 2nd year, AP
______	117	Biology, 2nd year, Advanced
______	118	Biology, 2nd year, Other
______	119	Chemistry, 1st year
______	120	Chemistry, 1st year, Applied
______	121	Chemistry, 2nd year, AP
______	122	Chemistry, 2nd year, Advanced
______	123	Physics, 1st year
______	124	Physics, 1st year, Applied
______	125	Physics, 2nd year, AP
______	126	Physics, 2nd year, Advanced
______	127	Physical Science
______	128	Astronomy/Space Science*
______	129	Geology*
______	130	Meteorology*
______	131	Oceanography/Marine Science*
______	132	Earth Science, 1st year
______	133	Earth Science, 1st year, Applied
______	134	Earth Science, 2nd year, Advanced
______	135	Earth Science, Other
______	136	General Science
______	137	Environmental Science
______	138	Science, Technology, Society
______	139	Coordinated Science
______	140	Integrated Science
		GRADES 9 - 12, Other Science Courses
______		______________
______		______________
______		______________

*NOTE: A course that includes substantial content from two or more of the earth sciences should be listed under code 132, 133, 134 or 135.

4. Please give the code number of any science courses offered this year that will <u>not</u> be offered next year.

CHECK BOX, IF ALL WILL BE OFFERED ☐

OR

List code number of courses that will not be offered:

________ ________ ________ ________ ________

5. a. Are 7th grade students (or those in the lowest secondary grade in this school) assigned to science courses, or sections within courses, by ability levels?

Yes .... 1 *(CONTINUE WITH QUESTION 5.b.)*

No.. 2 *(SKIP TO QUESTION 6.)*

b. Please list the **titles of the science course(s)** that low ability, average ability, and high ability students would be likely to take in their first year in this school.

Low ability students: 1) ________ 2) ________ 3) ________

Average ability students: 1) ________ 2) ________ 3) ________

High ability students: 1) ________ 2) ________ 3) ________

6. How many minutes long is a typical class period?

________ MINUTES

7. In many schools science classes meet for five class periods per week. Are any of the science courses in this school organized in some other way? (e.g., meet only three class periods per week or have a double class period once a week for laboratories)

YES .... 1 *(PLEASE DESCRIBE BELOW)*

NO.. 2 *(GO TO QUESTION 8.)*

Course Title	Number of days/week	Length of class period

8. How much money was spent on science equipment and consumable supplies in this school during the most recently completed budget year? (If you don't know the exact amounts, please provide your best estimates.)

a. Science equipment (non-consumable, non-perishable items such as microscopes, scales, etc.)

$ ________ CHECK BOX, IF ESTIMATE ☐

b. Consumable science supplies (materials that must continually be replenished such as chemicals, glassware, batteries, etc.)

$ ________ CHECK BOX, IF ESTIMATE ☐

c. Science software

$ ________ CHECK BOX, IF ESTIMATE ☐

9. How much input does each of the following have in decisions about science equipment/materials purchases?

(CIRCLE ONE ON EACH LINE.)

		No input	Little input	Moderate input	Heavy input	Complete control	Not applicable
a.	State	1	2	3	4	5	8
b.	Central office	1	2	3	4	5	8
c.	Principal	1	2	3	4	5	8
d.	Science department chair	1	2	3	4	5	8
e.	Science department as a whole	1	2	3	4	5	8
f.	Individual science teachers	1	2	3	4	5	8

NOTE: **Questions 10 - 14 are being asked of all science teachers in the sample. If you received a Science Teacher Questionnaire in addition to this School Science Program Questionnaire, please check here ☐ and skip to Question 15.**

10. In your opinion, how great a problem is each of the following for science instruction **in your school as a whole?**

(CIRCLE ONE ON EACH LINE.)

		Not a significant problem	Somewhat of a problem	Serious problem
a.	Facilities	1	2	3
b.	Funds for purchasing equipment and supplies	1	2	3
c.	Materials for individualizing instruction	1	2	3
d.	Access to computers	1	2	3
e.	Appropriate computer software	1	2	3
f.	Student interest in science	1	2	3
g.	Student reading abilities	1	2	3
h.	Student absences	1	2	3
i.	Teacher interest in science	1	2	3
j.	Teacher preparation to teach science	1	2	3
k.	Time to teach science	1	2	3
l.	Opportunities for teachers to share ideas	1	2	3
m.	In-service education opportunities	1	2	3
n.	Interruptions for announcements, assemblies, other school activities	1	2	3
o.	Large classes	1	2	3
p.	Maintaining discipline	1	2	3
q.	Parental support for education	1	2	3
r.	State/district testing policies	1	2	3

11. Indicate your sex: *(CIRCLE ONE.)*

Male	1
Female	2

12. Are you: *(CIRCLE ONE.)*

White (not of Hispanic origin)	1
Black (not of Hispanic origin)	2
Hispanic (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	3
American Indian or Alaskan Native	4
Asian or Pacific Islander	5

13. In what year were you born?

19 ___

14. How many years have you taught in grades K-12 prior to this school year?

_____ YEARS

15. When did you complete this questionnaire?

________/________/________
MONTH DAY YEAR

16. What is your title? *(CIRCLE ONE.)*

Science department chair	1
Science lead teacher	2
Teacher	3
Principal	4
Assistant principal	5
Other (SPECIFY)	6

____

Thank you for your help!

☐ Check here if you are the person originally chosen to complete this questionnaire.

If not, please fill in your name here: ______________________________

Please return the questionnaire to us in the postage-paid envelope:

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1400 Spring Street - Suite 150
Silver Spring, MD 20910

Form Approval
OMB No: 3145-0142
Expires: Dec. 31, 1993

NATIONAL SCIENCE FOUNDATION
1993 National Survey of Science and Mathematics Education

Mathematics Program Questionnaire

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1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

Mathematics Program Questionnaire

1. Indicate the extent to which each of the following programs/practices is currently being implemented **in your school.**

(CIRCLE ONE ON EACH LINE.)

		Not used			Used extensively	Don't know/ Not applicable
a.	School-based management	1	2	3	4	8
b.	Common daily planning period for members of the mathematics department	1	2	3	4	8
c.	Common work space for members of the mathematics department	1	2	3	4	8
d.	Interdisciplinary teams of teachers who share the same students (e.g., school within a school)	1	2	3	4	8
e.	Students assigned to mathematics classes by ability	1	2	3	4	8
f.	Independent study projects for credit in mathematics	1	2	3	4	8
g.	Emphasis on problem solving, reasoning skills in mathematics	1	2	3	4	8
h.	Use of computers to solve mathematics problems	1	2	3	4	8
i.	Hands-on/performance assessment in mathematics classes	1	2	3	4	8
j.	Integration of mathematics and science instruction	1	2	3	4	8
k.	Integration of mathematics and language arts instruction	1	2	3	4	8
l.	Use of vocational/technical applications in mathematics instruction	1	2	3	4	8
m.	Content changes recommended by AAAS' Project 2061 (*Science for All Americans*)	1	2	3	4	8
n.	Content changes recommended by NCTM's *Curriculum and Evaluation Standards*	1	2	3	4	8
o.	Pedagogical shifts recommended by NCTM's *Professional Standards for Teaching Mathematics*	1	2	3	4	8
p.	Elementary students pulled out from self-contained classes for remedial instruction in mathematics	1	2	3	4	8
q.	Elementary students pulled out from self-contained classes for enrichment in mathematics	1	2	3	4	8
r.	Elementary students receiving instruction from mathematics specialists **in addition to** their regular teacher	1	2	3	4	8
s.	Elementary students receiving instruction from mathematics specialists **instead of** their regular teacher	1	2	3	4	8
t.	Mathematics courses offered by telecommunications	1	2	3	4	8
u.	Students going to another K - 12 school for mathematics courses	1	2	3	4	8
v.	Students going to a college or university for mathematics courses	1	2	3	4	8
w.	Integration of mathematics subjects (e.g. algebra, probability, geometry, etc. all taught together each year)	1	2	3	4	8

2. Please give us your opinion about each of the following statements in regard to the National Council of Teachers of Mathematics' work in setting standards for mathematics curriculum, instruction and evaluation.

(CIRCLE ONE ON EACH LINE.)

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree	Don't know
a.	I am well informed about the NCTM Standards for the grades I teach	1	2	3	4	5	8
b.	I am prepared to explain the NCTM Standards to my colleagues	1	2	3	4	5	8
c.	The Standards have been thoroughly discussed by teachers in this school	1	2	3	4	5	8
d.	There is a school-wide effort to make changes inspired by the Standards	1	2	3	4	5	8
e.	The principal of this school is well-informed about the Standards	1	2	3	4	5	8
f.	Parents of students in this school are well-informed about the Standards	1	2	3	4	5	8
g.	The superintendent of this district is well-informed about the Standards	1	2	3	4	5	8
h.	The School Board is well-informed about the Standards	1	2	3	4	5	8
i.	Our district is organizing staff development based on the Standards	1	2	3	4	5	8
j.	Our district has changed how it evaluates teachers based on the Standards	1	2	3	4	5	8

3. Does your school include secondary students (grade 7 or higher)?

Yes .... 1 *(CONTINUE WITH QUESTION 4.)*

No... 2 *(SKIP TO QUESTION 9.)*

4. Please give the number of sections of each of the following mathematics courses currently offered in your school. (Additional course titles for these categories are shown on the enclosed "List of Course Titles.")

GRADES 7 - 8

Current number of sections	CODE	COURSE CATEGORY
______	208	Mathematics 7, Remedial
______	209	Mathematics 7, Regular
______	210	Mathematics 7, Accelerated/ Pre-Algebra
______	211	Mathematics 8, Remedial
______	212	Mathematics 8, Regular
______	213	Mathematics 8, Enriched
______	214	Mathematics 8, Algebra I
		GRADES 7 - 8, OTHER MATHEMATICS
______		______________
______		______________
______		______________

GRADES 9 - 12

Current number of sections	CODE	COURSE CATEGORY
		GRADES 9 - 12, REVIEW MATHEMATICS
______	215	Level 1 (e.g., Remedial Mathematics)
______	216	Level 2 (e.g., Consumer Mathematics)
______	217	Level 3 (e.g., General Mathematics 3)
______	218	Level 4 (e.g., General Mathematics 4)
		GRADES 9 - 12, INFORMAL MATHEMATICS
______	219	Level 1 (e.g., Pre-Algebra)
______	220	Level 2 (e.g., Basic Geometry)
______	221	Level 3 (e.g., after Pre-Algebra, but not Algebra I)
		GRADES 9 - 12, FORMAL MATHEMATICS
______	222	Level 1 (e.g., Algebra I or Integrated Math 1)
______	223	Level 2 (e.g., Geometry or Integrated Math 2)
______	224	Level 3 (e.g., Algebra II or Integrated Math 3)
______	225	Level 4 (e.g., Advanced Algebra or Integrated Math 4)
______	226	Level 5 (e.g., Calculus)
______	227	Advanced Placement Calculus
		GRADES 9 - 12, OTHER MATHEMATICS
______	228	Probability and Statistics
______	229	Mathematics integrated with other subjects
______		______________
______		______________

5. Please give the code number of any mathematics courses offered this year that will not be offered next year.

CHECK BOX, IF ALL WILL BE OFFERED ☐

OR

List code numbers of courses that will not be offered:

______ ______ ______ ______ ______

6. a. Are 7th grade students (or those in the lowest secondary grade in this school) assigned to mathematics courses, or sections within courses, by ability levels?

Yes .... 1 *(CONTINUE WITH QUESTION 6.b.)*

No.. 2 *(SKIP TO QUESTION 7.)*

b. Please list the titles of the mathematics course(s) that low ability, average ability, and high ability students would be likely to take in their <u>first year in this school</u>.

Low ability students: 1) ____________ 2) ____________ 3) ____________

Average ability students: 1) ____________ 2) ____________ 3) ____________

High ability students: 1) ____________ 2) ____________ 3) ____________

7. How many minutes long is a typical class period?

_______ MINUTES

8. In many schools mathematics classes meet for five class periods per week. Are any of the mathematics courses in this school organized in some <u>other</u> way? (e.g., meet only three class periods per week or have a double class period once a week)

Yes .... 1 *(PLEASE DESCRIBE BELOW)*

No.. 2 *(GO TO QUESTION 9.)*

Course Title	Number of days/week	Length of class period
____________	______	____________
____________	______	____________
____________	______	____________
____________	______	____________

9. How much money was spent on mathematics equipment and consumable supplies in this school during the most recently completed budget year? (If you don't know the exact amounts, please provide your best estimates.)

a. Mathematics equipment (non-consumable items such as calculators)

$ ________ CHECK BOX, IF ESTIMATE ☐

b. Consumable mathematics supplies (manipulative materials)

$ ________ CHECK BOX, IF ESTIMATE ☐

c. Mathematics software

$ ________ CHECK BOX, IF ESTIMATE ☐

10. How much input does each of the following have in decisions about mathematics equipment/materials purchases?

(CIRCLE ONE ON EACH LINE.)

	No input	Little input	Moderate input	Heavy input	Complete control	Not applicable
a. State	1	2	3	4	5	8
b. Central office	1	2	3	4	5	8
c. Principal	1	2	3	4	5	8
d. Mathematics department chair	1	2	3	4	5	8
e. Mathematics department as a whole	1	2	3	4	5	8
f. Individual mathematics teachers	1	2	3	4	5	8

NOTE:	**<u>Questions 11 - 15</u> are being asked of all mathematics teachers in the sample. If you received a Mathematics Teacher Questionnaire in addition to this School Mathematics Program Questionnaire, please check ☐ here and skip to question 16.**

11. In your opinion, how great a problem is each of the following for mathematics instruction **in your school as a whole?**

(CIRCLE ONE ON EACH LINE.)

		Not a significant problem	Somewhat of a problem	Serious problem
a.	Facilities	1	2	3
b.	Funds for purchasing equipment and supplies	1	2	3
c.	Materials for individualizing instruction	1	2	3
d.	Access to computers	1	2	3
e.	Appropriate computer software	1	2	3
f.	Student interest in mathematics	1	2	3
g.	Student reading abilities	1	2	3
h.	Student absences	1	2	3
i.	Teacher interest in mathematics	1	2	3
j.	Teacher preparation to teach mathematics	1	2	3
k.	Time to teach mathematics	1	2	3
l.	Opportunities for teachers to share ideas	1	2	3
m.	In-service education opportunities	1	2	3
n.	Interruptions for announcements, assemblies, other school activities	1	2	3
o.	Large classes	1	2	3
p.	Maintaining discipline	1	2	3
q.	Parental support for education	1	2	3
r.	State/district testing policies	1	2	3

12. Indicate your sex: *(CIRCLE ONE.)*

Male	1
Female	2

(OVER)

13. Are you: *(CIRCLE ONE.)*

White (not of Hispanic origin)	1
Black (not of Hispanic origin)	2
Hispanic (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	3
American Indian or Alaskan Native	4
Asian or Pacific Islander	5

14. In what year were you born?

19 ____

15. How many years have you taught in grades K-12 prior to this school year?

_____ YEARS

16. When did you complete this questionnaire?

_________/_________/_________
MONTH DAY YEAR

17. What is your title? *(CIRCLE ONE.)*

Mathematics department chair	1
Mathematics lead teacher	2
Teacher	3
Principal	4
Assistant principal	5
Other (SPECIFY)	6

____

Thank you for your help!

☐ Check here if you are the person originally chosen to complete this questionnaire.

If not, please fill in your name here: ______________________________

Please return the questionnaire to us in the postage-paid envelope:

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NATIONAL SCIENCE FOUNDATION
1993 National Survey of Science and Mathematics Education

Science Questionnaire

You have been selected to answer questions about your science instruction. If you do not currently teach science, please call us toll-free at 1-800-598-2888.

How to Complete the Questionnaire

Most of the questions instruct you to "circle one" answer or "circle all that apply". For a few questions, you are asked to write in your answer on the line provided.

Class Selection

Part of the questionnaire (sections C and D) asks you to provide information about instruction in a particular class. If you teach science to more than one class, use the label at right to determine the science class that has been randomly selected for you to answer about. (If your teaching schedule varies by day, use today's schedule, or if today is not a school day, use the most recent school day.)

If You Have Questions

Please see the inside cover of this questionnaire for more information about this study. If you have questions about the study or any items in the questionnaire, call us toll-free at 1-800-598-2888.

Thank you very much. Your participation is greatly appreciated. Please return the questionnaire to us in the postage-paid envelope:

1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

1993 National Survey of Science and Mathematics Education

The 1993 National Survey of Science and Mathematics Education is supported by the National Science Foundation and is the third in a series. It is being conducted by Horizon Research, Inc., under the direction of Dr. Iris R. Weiss. Data collection is the responsibility of CODA, a survey research organization in Silver Spring, Maryland. The study has received endorsements from the following organizations:

American Federation of Teachers (AFT)
National Catholic Education Association (NCEA)
National Council of Teachers of Mathematics (NCTM)
National Education Association (NEA)
National Science Teachers Association (NSTA)

INFORMATION ABOUT YOUR PARTICIPATION

Public reporting burden for this collection of information is estimated to average 30 minutes per response. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Herman Fleming, National Science Foundation, 1800 G Street - NW, Washington, DC 20550 and to the Office of Management and Budget, Paperwork Reduction Project, OMB #3145-0142, Washington, DC 20503.

ABOUT THE SURVEY

Approximately 6,000 teachers from 1,200 schools throughout the country have been selected for the 1993 National Survey of Science and Mathematics Education. The survey is designed to collect information about science and mathematics education in grades 1 - 12. Its purpose is to provide the education community with current information about science and mathematics education and to identify trends in the areas of teacher education and experience, course offerings, curriculum and instruction, and the availability and use of equipment.

The 1,200 schools were randomly selected for the survey from the Quality Education Data (QED) database. In June of last year, Chief State School Officers and district superintendents were notified about the survey. In September, school principals were sent a pre-survey information booklet, requesting the names of all science and mathematics teachers. From these lists, a national sample of teachers was selected to receive science or mathematics questionnaires. In addition, program questionnaires are being sent to science and mathematics department representatives at each school. Teacher questionnaires are also being sent to all winners (1983 - 1992) of the National Science Foundation's Presidential Awards for Excellence in Science and Mathematics Teaching.

All survey data received will be kept strictly confidential and will be reported only in aggregate form, such as by grade level or region of the country. No information identifying individual states, districts, schools or teachers will be released. No identifying information whatsoever will be included in the dataset.

Each participating school will receive a copy of the study's results in the spring of 1994.

SECTION A: TEACHER OPINIONS

1. Please provide your opinion about each of the following statements.

(CIRCLE ONE ON EACH LINE.)

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
a.	Students learn best when they study science in the context of a personal or social application	1	2	3	4	5
b.	Students learn science best in classes with students of similar abilities	1	2	3	4	5
c.	It is important for students to learn basic scientific terms and formulas before learning underlying concepts and principles	1	2	3	4	5
d.	Laboratory-based science classes are more effective than non-laboratory classes	1	2	3	4	5
e.	Virtually all students can learn to think scientifically	1	2	3	4	5
f.	The testing program in my state/district dictates what science I teach	1	2	3	4	5
g.	I enjoy teaching science	1	2	3	4	5
h.	I consider myself a "master" science teacher	1	2	3	4	5
i.	I feel supported by colleagues to try out new ideas in teaching science	1	2	3	4	5
j.	I receive little support from the school administration for teaching science	1	2	3	4	5
k.	Science teachers in this school regularly share ideas and materials	1	2	3	4	5
l.	Science teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	1	2	3	4	5
m.	Activity-based science experiences aren't worth the time and expense for what students learn	1	2	3	4	5
n.	I feel that I have many opportunities to learn new things in my present job	1	2	3	4	5

1. (continued)

(CIRCLE ONE ON EACH LINE.)

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
o.	I am required to follow rules at this school that conflict with my best professional judgment	1	2	3	4	5
p.	Most science teachers in this school contribute actively to making decisions about the science curriculum	1	2	3	4	5
q.	Our guidance department does a good job of assisting students in selecting their science courses	1	2	3	4	5
r.	I have time during the regular school week to work with my peers on science curriculum and instruction	1	2	3	4	5

2. In your opinion, how great a problem is each of the following for **science** instruction **in your school as a whole?**

(CIRCLE ONE ON EACH LINE.)

		Not a significant problem	Somewhat of a problem	Serious problem
a.	Facilities	1	2	3
b.	Funds for purchasing equipment and supplies	1	2	3
c.	Materials for individualizing instruction	1	2	3
d.	Access to computers	1	2	3
e.	Appropriate computer software	1	2	3
f.	Student interest in science	1	2	3
g.	Student reading abilities	1	2	3
h.	Student absences	1	2	3
i.	Teacher interest in science	1	2	3
j.	Teacher preparation to teach science	1	2	3
k.	Time to teach science	1	2	3
l.	Opportunities for teachers to share ideas	1	2	3
m.	In-service education opportunities	1	2	3
n.	Interruptions for announcements, assemblies, other school activities	1	2	3
o.	Large classes	1	2	3
p.	Maintaining discipline	1	2	3
q.	Parental support for education	1	2	3
r.	State/district testing policies	1	2	3

3. Please rate each of the following in terms of its importance for effective **science** teaching **at the grade levels you teach.**

(CIRCLE ONE ON EACH LINE.)

		Definitely should not be a part of science instruction		Makes no difference		Definitely should be a part of science instruction
a.	Concrete experience before abstract treatments	1	2	3	4	5
b.	Students working in cooperative learning groups	1	2	3	4	5
c.	Emphasis on connections among concepts	1	2	3	4	5
d.	Deeper coverage of fewer science concepts	1	2	3	4	5
e.	Hands-on/laboratory activities	1	2	3	4	5
f.	Applications of science in daily life	1	2	3	4	5
g.	Applications of scientific methods in addressing societal issues	1	2	3	4	5
h.	Coordination of science disciplines	1	2	3	4	5
i.	Coordination of sciences with **mathematical**	1	2	3	4	5
j.	Coordination of sciences with **language arts**	1	2	3	4	5
k.	Coordination of sciences with **social science**	1	2	3	4	5
l.	Coordination of sciences with **vocational/ technology education**	1	2	3	4	5
m.	Revisiting science topics, each time in greater depth	1	2	3	4	5
n.	Every student studying science every year	1	2	3	4	5
o.	Taking student conceptions about a natural phenomenon into account when planning curriculum and instruction	1	2	3	4	5
p.	Inclusion of performance-based assessment	1	2	3	4	5
q.	Use of computers	1	2	3	4	5

SECTION B: TEACHER BACKGROUND

4. Many teachers feel better qualified to teach some subject areas than others. How well qualified do you feel to teach each of the following subjects **at the grade levels you teach**, whether or not they are currently included in your curriculum?

(CIRCLE ONE ON EACH LINE.)

		Not well qualified	Adequately qualified	Very well qualified
a.	Life Sciences	1	2	3
b.	Chemistry	1	2	3
c.	Physics	1	2	3
d.	Earth Sciences	1	2	3
e.	Technology	1	2	3
f.	Integrated Science, drawing from various science disciplines	1	2	3
g.	Mathematics	1	2	3
h.	Reading/Language Arts	1	2	3
i.	Social Studies	1	2	3

5. How well prepared are you to do each of the following?

(CIRCLE ONE ON EACH LINE.)

		Not well prepared	Somewhat prepared	Fairly well prepared	Very well prepared
a.	Present the applications of science concepts	1	2	3	4
b.	Use cooperative learning groups	1	2	3	4
c.	Take into account students' prior conceptions about natural phenomena when planning curriculum and instruction	1	2	3	4
d.	Use computers as an integral part of science instruction	1	2	3	4
e.	Integrate science with other subject areas	1	2	3	4
f.	Manage a class of students who are using hands-on/laboratory activities	1	2	3	4
g.	Use a variety of assessment strategies	1	2	3	4
h.	Use the textbook as a resource rather than as the primary instructional tool	1	2	3	4
i.	Use performance-based assessment	1	2	3	4
j.	Teach groups that are heterogeneous in ability	1	2	3	4
k.	Teach students from a variety of cultural backgrounds	1	2	3	4
l.	Teach students who have limited English proficiency	1	2	3	4

5. (continued)

(CIRCLE ONE ON EACH LINE.)

		Not well prepared	Somewhat prepared	Fairly well prepared	Very well prepared
m.	Teach students who have learning disabilities	1	2	3	4
n.	Encourage participation of females in science	1	2	3	4
o.	Encourage participation of minorities in science	1	2	3	4
p.	Involve parents in the science education of their children	1	2	3	4

6. Which of the following college courses have you completed? Include both **semester hour and quarter hour courses,** whether graduate or undergraduate level. *(CIRCLE ALL THAT APPLY.)*

EDUCATION

Supervised student teaching in science	1
Instructional uses of computers/ other technologies	2

MATHEMATICS

College algebra/trigonometry/ elementary functions	3
Calculus	4
Advanced calculus	5
Differential equations	6
Discrete mathematical	7
Probability and statistics	8

CHEMISTRY

General chemistry	9
Analytical chemistry	10
Organic chemistry	11
Physical chemistry	12
Quantum chemistry	13
Biochemistry	14

EARTH/SPACE SCIENCES

Earth science	15
Astronomy	16
Geology	17
Meteorology	18
Oceanography	19
Physical geography	20
Environmental science	21

LIFE SCIENCES

Life science	22
Introductory biology	23
Botany, plant physiology	24
Cell biology	25
Ecology	26
Genetics, evolution	27
Microbiology	28
Anatomy/Physiology	29
Zoology, animal behavior	30

PHYSICS

Physical science	31
General physics	32
Electricity and magnetism	33
Heat and thermodynamics	34
Mechanics	35
Modern or quantum physics	36
Nuclear physics	37
Solid state physics	38
Optics	39

OTHER

History of science	40
Science and society	41
Electronics	42
Engineering (Any)	43
Integrated science	44
Computer programming	45
Other computer science	46

7. For each of the following subject areas, indicate the number of college **semester and quarter courses** you have completed. Count each course you have taken, regardless of whether it was a graduate or undergraduate course. If your transcripts are not available, provide your best estimates.

NUMBER OF COURSES COMPLETED

	(CIRCLE ONE NUMBER ON EACH LINE.) Semester Courses	*(CIRCLE ONE NUMBER ON EACH LINE.)* Quarter Courses
a. Life sciences	0 1 2 3 4 5 6 7 ≥8	0 1 2 3 4 5 6 7 ≥8
b. Chemistry	0 1 2 3 4 5 6 7 ≥8	0 1 2 3 4 5 6 7 ≥8
c. Physics/physical science	0 1 2 3 4 5 6 7 ≥8	0 1 2 3 4 5 6 7 ≥8
d. Earth/space science	0 1 2 3 4 5 6 7 ≥8	0 1 2 3 4 5 6 7 ≥8
e. Science education	0 1 2 3 4 5 6 7 ≥8	0 1 2 3 4 5 6 7 ≥8

8. Please check the box(es) next to the degree(s) you hold. Use the list of code numbers on the right to indicate your major and minor fields of study for each degree. (If you do not have a second major or minor field, please enter "00.")

		Major field code	Second major or minor field code
Bachelor's Degree	☐	______	______
Master's Degree	☐	______	______
Doctorate Degree	☐	______	______
Other Degree(s)	☐ Specify below:		
1) ____________		______	______
2) ____________		______	______

MAJOR & MINOR FIELD CODES

Education
- 11 Elementary Education
- 12 Middle School Education
- 13 Secondary Education
- 14 Mathematics Education
- 15 Science Education
- 16 Other Education

Mathematics/Computer Science
- 21 Mathematics
- 22 Computer Science

Science
- 31 Biology, Life Science
- 32 Chemistry
- 33 Physics
- 34 Physical Science
- 35 Earth/Space Sciences
- 36 Other Science

Other Disciplines
- 41 History, English Foreign Language, etc.

9. a. In what year did you last take a course for college credit in **science**?

19 ________

b. In what year did you last take a course for college credit in the **teaching of science?**

19 ________

10. What is the **total** amount of time you have spent on in-service education in **science or the teaching of science** in the last 12 months? in the last 3 years? (Include attendance at professional meetings, workshops, and conferences, but **do not** include formal courses for which you received college credit.)

(CIRCLE ONE NUMBER IN EACH COLUMN.)

Hours of In-service Education	Last 12 months	Last 3 years
None	1	1
Less than 6 hours	2	2
6 - 15 hours	3	3
16 - 35 hours	4	4
More than 35 hours	5	5

11. In the past twelve months, have you: *(CIRCLE ONE ON EACH LINE.)*

		No	Yes
a.	Attended any national or state science teacher association meetings?	1	2
b.	Taught any in-service workshops or courses in science or science teaching?	1	2
c.	Received any local, state, or national grants or awards for science teaching?	1	2
d.	Served on a school or district science curriculum committee?	1	2
e.	Served on a school or district science textbook selection committee?	1	2

12. For each of the materials listed below, please mark one of the following categories: (1) have never heard of, (2) have heard of but not seen, (3) have seen but not used, or (4) have used in teaching.

(CIRCLE ONE ON EACH LINE.)

		Have never heard of	Have heard of but not seen	Have seen but not used	Have used in teaching
a.	Biological Science: An Ecological Approach	1	2	3	4
b.	Bottle Biology	1	2	3	4
c.	ChemCom: Chemistry in the Community	1	2	3	4
d.	Chemical Education for Public Understanding Program (CEPUP)	1	2	3	4
e.	Full Option Science System (Foss Science Kits)	1	2	3	4
f.	Grow Lab, National Gardening Association	1	2	3	4
g.	Mechanical Universe, High School Adaptation	1	2	3	4
h.	Middle School Life Science	1	2	3	4
i.	National Geographic Kids Network	1	2	3	4
j.	Quantum Magazine for Students	1	2	3	4
k.	Science for Life and Living: Integrating Science, Technology, and Health (BSCS)	1	2	3	4
l.	ScienceVision	1	2	3	4
m.	Second Voyage of the Mimi (Mayan Expedition)	1	2	3	4
n.	SuperScience Magazine	1	2	3	4
o.	Texas Learning Technology Group (TLTG) Physical Science/Math for Science	1	2	3	4
p.	Wisconsin Fast Plants	1	2	3	4

13. Do you teach in a self-contained classroom, i.e., are you responsible for teaching all or most academic subjects to one class?

YES .... 1 *(COMPLETE 14.a., THEN GO TO 15.)*

NO .... 2 *(COMPLETE 14.b., THEN GO TO 15.)*

14. a. **For Teachers of Self-Contained Classes:** We are interested in knowing how much time your students spend studying various subjects. In a typical week, how many days do you have lessons on each of the following subjects, and how many minutes long is an average lesson? (Please write "0" if you do not teach a particular subject to this class.)

	Number of days per week	Approximate number of minutes per day
Mathematics	______	______
Science	______	______
Social Studies	______	______
Reading	______	______

NOW GO TO Q15.

b. **For Teachers of Non Self-Contained Classes:** For each class period you are currently teaching, regardless of subject, give course title, the code number from the enclosed blue "List of Course Titles" that best describes the content of each course, number of students, and the grade level of most of the students in that class.

Class	Course Title	Code No.	No. of Students	Predominant Grade Level
1	____________	______	______	______
2	____________	______	______	______
3	____________	______	______	______
4	____________	______	______	______
5	____________	______	______	______
6	____________	______	______	______
7	____________	______	______	______
8	____________	______	______	______

SECTION C: YOUR SCIENCE TEACHING IN A PARTICULAR CLASS

The questions in this section are about a particular **science class** you teach. If you teach science to more than one class, please think about the science classes you are teaching today (or the most recent school day). Then consult the label on the front of this questionnaire to determine which science class to consider when answering these questions.

15. a. Please provide the complete title of the course you will be describing:

____
COURSE TITLE

b. Using the blue "List of Course Titles," indicate the code number that best describes this course:

____
COURSE CODE

(If "Other Science" [Code 199], briefly describe content of course: ______________________________
____)

16. What is the duration of this course? *(CIRCLE ONE.)*

a. Year 1
b. Semester 2
c. Quarter 3
d. Other *(PLEASE SPECIFY)* 4
____

17. How many of the students <u>**in this science class**</u> are in each of the following grades?

1	2	3	4	5	6	7	8	9	10	11	12	TOTAL

18. Please indicate the number of students in this science class in each race/sex category.

	<u>Male</u>	<u>Female</u>
a. White (not of Hispanic origin)	_____	_____
b. Black (not of Hispanic origin)	_____	_____
c. Hispanic .... (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	_____	_____
d. American Indian or Alaskan Native	_____	_____
e. Asian or Pacific Islander	_____	_____
TOTAL	_____	_____

(NOTE: The total number of males and females should be the same as the total number of students in question 17.)

19. How many of the students in this science class are **formally** classified as:

a. Limited English Proficiency ________ students

b. Learning Disabled ________ students

c. Mentally Handicapped ________ students

d. Physically Handicapped, please specify handicaps:

1) ________________________ ________ students

2) ________________________ ________ students

20. Are students assigned to this science class by level of ability? *(CIRCLE ONE.)*

Yes 1
No... 2

21. Which of the following best describes the ability of the students in this science class? *(CIRCLE ONE.)*

Fairly homogeneous and low in ability 1
Fairly homogeneous and average in ability.. 2
Fairly homogeneous and high in ability.. 3
Heterogeneous, with a mixture of two or more ability levels........................ 4

22. Think about your plans for this science class for the entire course. How much emphasis will each of the following **student objectives** receive?

(CIRCLE ONE ON EACH LINE.)

		None	Minimal emphasis		Moderate emphasis		Very heavy emphasis
a.	Increase interest in science	0	1	2	3	4	5
b.	Learn basic science concepts	0	1	2	3	4	5
c.	Learn important terms and facts of science	0	1	2	3	4	5
d.	Learn scientific methods	0	1	2	3	4	5
e.	Prepare for further study in science	0	1	2	3	4	5
f.	Develop problem solving/inquiry skills	0	1	2	3	4	5
g.	Learn to evaluate arguments based on scientific evidence	0	1	2	3	4	5
h.	Learn to explain ideas in science effectively	0	1	2	3	4	5
i.	Increase awareness of the importance of science in daily life	0	1	2	3	4	5
j.	Learn about the applications of science in business and industry	0	1	2	3	4	5
k.	Learn about the relationship between science, technology, and society	0	1	2	3	4	5
l.	Learn about the history of science..............................	0	1	2	3	4	5
m.	Prepare for standardized tests	0	1	2	3	4	5

23. How much does each of the following influence what you teach in this science class?

(CIRCLE ONE ON EACH LINE.)

		No influence			Extensive influence	Not applicable
a.	Your state's curriculum framework/course of study	1	2	3	4	8
b.	Your district's curriculum framework/course of study ...	1	2	3	4	8
c.	State test	1	2	3	4	8
d.	District test	1	2	3	4	8
e.	Textbook	1	2	3	4	8
f.	*Science for All Americans* (AAAS' Project 2061)	1	2	3	4	8
g.	Scope, Sequence, and Coordination philosophy or *Content Core* (NSTA's SS&C project)	1	2	3	4	8
h.	Your own science content background	1	2	3	4	8
i.	Your understanding of what motivates your students	1	2	3	4	8
j.	Available laboratory facilities, equipment, and supplies .	1	2	3	4	8
k.	Parents/community	1	2	3	4	8

24. About how often do students in this science class take part in the following types of activities?

(CIRCLE ONE ON EACH LINE.)

		Never	Once or twice semester	Once or twice a month	Once or twice a week	Almost daily
a.	Listen and take notes during presentation by teacher	1	2	3	4	5
b.	Watch the teacher demonstrate a scientific principle	1	2	3	4	5
c.	Work in small groups	1	2	3	4	5
d.	Read a science textbook in class	1	2	3	4	5
e.	Participate in dialogue with the teacher to develop an idea	1	2	3	4	5
f.	Do hands-on/laboratory science activities	1	2	3	4	5
g.	Prepare written science reports	1	2	3	4	5
h.	Work in class on science projects that take a week or more	1	2	3	4	5
i.	Work at home on science projects that take a week or more	1	2	3	4	5
j.	Use a computer	1	2	3	4	5
k.	Take field trips	1	2	3	4	5
l.	Watch films, filmstrips, or videotapes	1	2	3	4	5
m.	Watch television programs	1	2	3	4	5

25. For the following equipment, please indicate the approximate number of times per semester each is used in this science class. For those not used, circle either 1, Not needed, or 2, Needed but not available.

(CIRCLE ONE ON EACH LINE.)

		Not needed	Needed but not available	Number of times used per semester 1-2	3-5	6-10	11+
a.	Overhead projector	1	2	3	4	5	6
b.	Videotape player	1	2	3	4	5	6
c.	Videodisc player	1	2	3	4	5	6
d.	CD-ROM player	1	2	3	4	5	6
e.	Four function calculators	1	2	3	4	5	6
f.	Fraction calculators	1	2	3	4	5	6
g.	Graphing calculators	1	2	3	4	5	6
h.	Scientific calculators	1	2	3	4	5	6
i.	Computers	1	2	3	4	5	6
j.	Computer/lab interfacing devices	1	2	3	4	5	6
k.	Running water in laboratories	1	2	3	4	5	6
l.	Electric outlets in laboratories	1	2	3	4	5	6
m.	Gas for burners in laboratories	1	2	3	4	5	6
n.	Hoods or air hoses in laboratories	1	2	3	4	5	6

26. How much of your own money do you estimate you will spend for supplies for this science class this year?

$ ________________

27. How much control do you have over each of the following for this science class?

(CIRCLE ONE ON EACH LINE.)

		No control				Strong control
a.	Determining goals and objectives	1	2	3	4	5
b.	Selecting textbooks	1	2	3	4	5
c.	Selecting other instructional materials	1	2	3	4	5
d.	Selecting content, topics, and skills to be taught	1	2	3	4	5
e.	Selecting the sequence in which topics are covered	1	2	3	4	5
f.	Setting the pace for covering topics	1	2	3	4	5
g.	Selecting teaching techniques	1	2	3	4	5
h.	Determining the amount of homework to be assigned	1	2	3	4	5
i.	Choosing criteria for grading students	1	2	3	4	5

28. a. Are you using one or more commercially published textbooks or programs for teaching science to this class?

YES	1	*(CONTINUE WITH 28.b.)*
NO	2	*(SKIP TO QUESTION 32.)*

b. Indicate the publisher of the <u>one</u> textbook/program used most often by students in this science class. **(CIRCLE ONE.)**

Addison-Wesley	1	Kendall Hunt	13
Allyn & Bacon	2	Laidlaw Brothers	14
Amsco	3	Little, Brown	15
Delta Education	4	Macmillan	16
Ginn	5	McGraw Hill	17
Glencoe	6	Merrill	18
Globe	7	Prentice Hall	19
Harcourt, Brace, & Jovanovich	8	Scott, Foresman	20
Harper & Row	9	Silver, Burdett, & Ginn	21
D.C. Heath	10	Wiley	22
Holt, Rinehart, Winston	11		
Houghton Mifflin	12	Other (PLEASE SPECIFY) ______________________	23

29. What is the title, author, publication year, and edition of this textbook/program?

Title ____

First Author ______________________ Publication Year __________ Edition __________

30. Approximately what percentage of this textbook/program will you "cover" in this course? *(CIRCLE ONE.)*

Less than 25 percent	1
25 - 49 percent	2
50 - 74 percent	3
75 - 90 percent	4
More than 90 percent	5

31. How would you rate the overall quality of this textbook/program? *(CIRCLE ONE.)*

Very Poor	1
Poor	2
Fair	3
Good	4
Very Good	5
Excellent	6

32. How much homework do you assign in this science class in a typical week? *(CIRCLE ONE.)*

0 - 30 minutes	1
31 - 60 minutes	2
61 - 90 minutes	3
91 - 120 minutes	4
2 - 3 hours	5
More than 3 hours	6

33. Indicate the importance you give to each of the following in setting grades for students in this science class.

(CIRCLE ONE ON EACH LINE.)

		Not important			Very important
a.	Objective tests (e.g., multiple choice, true/false)	1	2	3	4
b.	Essay tests	1	2	3	4
c.	Hands-on/performance tasks	1	2	3	4
d.	Systematic observations of students	1	2	3	4
e.	Interviewing students about what they understand	1	2	3	4
f.	Homework assignments	1	2	3	4
g.	Behavior	1	2	3	4
h.	Effort	1	2	3	4
i.	Laboratory reports	1	2	3	4
j.	Science projects	1	2	3	4
k.	Class attendance	1	2	3	4
l.	Contribution to small group work	1	2	3	4
m.	Participation in whole class discussion	1	2	3	4
n.	Individual improvement or progress over past performance	1	2	3	4

SECTION D: YOUR MOST RECENT SCIENCE LESSON

Use your most recent **science lesson** in this class to answer the following questions. Do not be concerned if this lesson was not typical of instruction in this class.

34. a. How many minutes were allocated to the most recent science lesson?

_________ minutes

b. Of these, how many minutes were spent on the following:

(1)	Daily routines, interruptions, and other non-instructional activities	_________
(2)	Whole class lecture/discussions	_________
(3)	Individual students reading textbooks, completing worksheets, etc.	_________
(4)	Working with hands-on, manipulative, or laboratory materials	_________
(5)	Non-laboratory small group work	_________
	TOTAL MINUTES	_________

(SHOULD BE THE SAME AS 34.a.)

35. Which of the following activities took place during that **science lesson**? *(CIRCLE ALL THAT APPLY.)*

a.	Lecture	1
b.	Students completing textbook/worksheet problems	2
c.	Students reading about science	3
d.	Students working in cooperative learning groups where the entire group receives a single grade	4
e.	Student use of calculators	5
f.	Student use of computers	6
g.	Student use of other technologies	7
h.	Test or quiz	8

36. Did that lesson take place on the most recent day your school was in session? *(CIRCLE ONE.)*

Yes	1
No	2

SECTION E: DEMOGRAPHIC INFORMATION

37. Indicate your sex: *(CIRCLE ONE.)*

Male	1
Female	2

38. Are you: *(CIRCLE ONE.)*

White (not of Hispanic origin)	1
Black (not of Hispanic origin)	2
Hispanic (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	3
American Indian or Alaskan Native	4
Asian or Pacific Islander	5

39. In what year were you born?

19____

40. How many years have you taught prior to this school year?

_____ YEARS

41. How many years have you taught **science** prior to this school year?

_________ YEARS

42. When did you complete this questionnaire?

_________/_________/_________
MONTH DAY YEAR

Thank you for your assistance!

Please return the questionnaire to us in the postage-paid envelope:

1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

Form Approval
OMB No: 3145-0142
Expires: Dec. 31, 1993

NATIONAL SCIENCE FOUNDATION
1993 National Survey of Science and Mathematics Education

Mathematics Questionnaire

You have been selected to answer questions about your mathematics instruction. If you do not currently teach mathematics, please call us toll-free at 1-800-598-2888.

How to Complete the Questionnaire

Most of the questions instruct you to "circle one" answer or "circle all that apply". For a few questions, you are asked to write in your answer on the line provided.

Class Selection

Part of the questionnaire (sections C and D) asks you to provide information about instruction in a particular class. If you teach mathematics to more than one class, use the label at right to determine the mathematics class that has been randomly selected for you to answer about. (If your teaching schedule varies by day, use today's schedule, or if today is not a school day, use the most recent school day.)

If You Have Questions

Please see the inside cover of this questionnaire for more information about this study. If you have questions about the study or any items in the questionnaire, call us toll-free at 1-800-598-2888.

Thank you very much. Your participation is greatly appreciated. Please return the questionnaire to us in the postage-paid envelope:

1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

1993 National Survey of Science and Mathematics Education

The 1993 National Survey of Science and Mathematics Education is supported by the National Science Foundation and is the third in a series. It is being conducted by Horizon Research, Inc., under the direction of Dr. Iris R. Weiss. Data collection is the responsibility of CODA, a survey research organization in Silver Spring, Maryland. The study has received endorsements from the following organizations:

American Federation of Teachers (AFT)
National Catholic Education Association (NCEA)
National Council of Teachers of Mathematics (NCTM)
National Education Association (NEA)
National Science Teachers Association (NSTA)

INFORMATION ABOUT YOUR PARTICIPATION

Public reporting burden for this collection of information is estimated to average 30 minutes per response. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Herman Fleming, National Science Foundation, 1800 G Street - NW, Washington, DC 20550 and to the Office of Management and Budget, Paperwork Reduction Project, OMB #3145-0142, Washington, DC 20503.

ABOUT THE SURVEY

Approximately 6,000 teachers from 1,200 schools throughout the country have been selected for the 1993 National Survey of Science and Mathematics Education. The survey is designed to collect information about science and mathematics education in grades 1 - 12. Its purpose is to provide the education community with current information about science and mathematics education and to identify trends in the areas of teacher education and experience, course offerings, curriculum and instruction, and the availability and use of equipment.

The 1,200 schools were randomly selected for the survey from the Quality Education Data (QED) database. In June of last year, Chief State School Officers and district superintendents were notified about the survey. In September, school principals were sent a pre-survey information booklet, requesting the names of all science and mathematics teachers. From these lists, a national sample of teachers was selected to receive science or mathematics questionnaires. In addition, program questionnaires are being sent to science and mathematics department representatives at each school. Teacher questionnaires are also being sent to all winners (1983 - 1992) of the National Science Foundation's Presidential Awards for Excellence in Science and Mathematics Teaching.

All survey data received will be kept strictly confidential and will be reported only in aggregate form, such as by grade level or region of the country. No information identifying individual states, districts, schools or teachers will be released. No identifying information whatsoever will be included in the dataset.

Each participating school will receive a copy of the study's results in the spring of 1994.

SECTION A: TEACHER OPINIONS

1. Please provide your opinion about each of the following statements.

(CIRCLE ONE ON EACH LINE.)

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
a.	Students learn best when they study mathematics in the context of a personal or social application	1	2	3	4	5
b.	Students learn mathematics best in classes with students of similar abilities	1	2	3	4	5
c.	Students need to master arithmetic computation before going on to algebra	1	2	3	4	5
d.	Students should be able to use calculators most of the time	1	2	3	4	5
e.	Virtually all students can learn to think mathematically	1	2	3	4	5
f.	The testing program in my state/district dictates what mathematics I teach	1	2	3	4	5
g.	I enjoy teaching mathematics	1	2	3	4	5
h.	I consider myself a "master" mathematics teacher	1	2	3	4	5
i.	I feel supported by colleagues to try out new ideas in teaching mathematics.................	1	2	3	4	5
j.	I receive little support from the school administration for teaching mathematics	1	2	3	4	5
k.	Mathematics teachers in this school regularly share ideas and materials	1	2	3	4	5
l.	Mathematics teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	1	2	3	4	5
m.	Activity-based mathematics experiences aren't worth the time and expense for what students learn	1	2	3	4	5
n.	I feel that I have many opportunities to learn new things in my present job	1	2	3	4	5

1. (continued)

(CIRCLE ONE ON EACH LINE.)

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
o.	I am required to follow rules at this school that conflict with my best professional judgment	1	2	3	4	5
p.	Most mathematics teachers in this school contribute actively to making decisions about the mathematics curriculum	1	2	3	4	5
q.	Our guidance department does a good job of assisting students in selecting their mathematics courses	1	2	3	4	5
r.	I have time during the regular school week to work with my peers on mathematics curriculum and instruction	1	2	3	4	5

2. In your opinion, how great a problem is each of the following for **mathematics** instruction **in your school as a whole?**

(CIRCLE ONE ON EACH LINE.)

		Not a significant problem	Somewhat of a problem	Serious problem
a.	Facilities	1	2	3
b.	Funds for purchasing equipment and supplies	1	2	3
c.	Materials for individualizing instruction	1	2	3
d.	Access to computers	1	2	3
e.	Appropriate computer software	1	2	3
f.	Student interest in mathematics	1	2	3
g.	Student reading abilities	1	2	3
h.	Student absences	1	2	3
i.	Teacher interest in mathematics	1	2	3
j.	Teacher preparation to teach mathematics	1	2	3
k.	Time to teach mathematics	1	2	3
l.	Opportunities for teachers to share ideas	1	2	3
m.	In-service education opportunities	1	2	3
n.	Interruptions for announcements, assemblies, other school activities	1	2	3
o.	Large classes	1	2	3
p.	Maintaining discipline	1	2	3
q.	Parental support	1	2	3
r.	State/district testing policies	1	2	3

3. Please rate each of the following in terms of its importance for effective **mathematics** teaching **at the grade levels you teach.**

(CIRCLE ONE ON EACH LINE.)

		Definitely should not be a part of math instruction		Makes no difference		Definitely should be a part of math instruction
a.	Concrete experience before abstract treatments	1	2	3	4	5
b.	Students working in cooperative learning groups	1	2	3	4	5
c.	Emphasis on connections among concepts	1	2	3	4	5
d.	Deeper coverage of fewer mathematics ideas	1	2	3	4	5
e.	Hands-on/manipulative activities	1	2	3	4	5
f.	Applications of mathematics in daily life	1	2	3	4	5
g.	Emphasis on arithmetic computation	1	2	3	4	5
h.	Emphasis on solving real problems	1	2	3	4	5
i.	Emphasis on mathematical reasoning	1	2	3	4	5
j.	Emphasis on writing about mathematics	1	2	3	4	5
k.	Integration of mathematics subjects (e.g., algebra, probability, geometry, etc.) all taught together each year	1	2	3	4	5
l.	Coordination of mathematics with **science**	1	2	3	4	5
m.	Coordination of mathematics with **vocational/ technology education**	1	2	3	4	5
n.	Every student studying mathematics each year	1	2	3	4	5
o.	Taking student preconceptions about a topic into account when planning curriculum and instruction	1	2	3	4	5
p.	Inclusion of performance-based assessment	1	2	3	4	5
q.	Use of computers	1	2	3	4	5
r.	Use of calculators	1	2	3	4	5

SECTION B: TEACHER BACKGROUND

4. Many teachers feel better qualified to teach some subject areas than others. How well qualified do you feel to teach each of the following subjects **at the grade levels you teach**, whether or not they are currently included in your curriculum?

(CIRCLE ONE ON EACH LINE.)

		Not well qualified	Adequately qualified	Very well qualified
a.	Estimation	1	2	3
b.	Number sense and numeration	1	2	3
c.	Number systems and number theory	1	2	3
d.	Measurement	1	2	3
e.	Fractions and decimals	1	2	3
f.	Geometry and spatial sense	1	2	3
g.	Functions	1	2	3
h.	Patterns and relationships	1	2	3
i.	Algebra	1	2	3
j.	Trigonometry	1	2	3
k.	Probability and statistics	1	2	3
l.	Discrete mathematics	1	2	3
m.	Conceptual underpinning of calculus	1	2	3
n.	Mathematical structure	1	2	3

5. How well prepared are you to do each of the following?

(CIRCLE ONE ON EACH LINE.)

		Not well prepared	Somewhat prepared	Fairly well prepared	Very well prepared
a.	Present the applications of mathematics concepts	1	2	3	4
b.	Use cooperative learning groups	1	2	3	4
c.	Take into account students' prior conceptions about mathematics when planning curriculum and instruction	1	2	3	4
d.	Use computers as an integral part of mathematics instruction	1	2	3	4
e.	Integrate mathematics with other subject areas	1	2	3	4
f.	Manage a class of students who are using manipulatives	1	2	3	4
g.	Use a variety of assessment strategies	1	2	3	4
h.	Use the textbook as a resource rather than as the primary instructional tool	1	2	3	4
i.	Use calculators as an integral part of mathematics instruction	1	2	3	4

5. (continued)

(CIRCLE ONE ON EACH LINE.)

		Not well prepared	Somewhat prepared	Fairly well prepared	Very well prepared
j.	Use performance-based assessment	1	2	3	4
k.	Teach groups that are heterogeneous in ability	1	2	3	4
l.	Teach students from a variety of cultural backgrounds	1	2	3	4
m.	Teach students who have limited English proficiency	1	2	3	4
n.	Teach students who have learning disabilities	1	2	3	4
o.	Encourage participation of females in mathematics	1	2	3	4
p.	Encourage participation of minorities in mathematics	1	2	3	4
q.	Involve parents in the mathematics education of their children	1	2	3	4

6. Which of the following college courses have you completed? Include both **semester hour and quarter hour courses**, whether graduate or undergraduate level. *(CIRCLE ALL THAT APPLY.)*

MATHEMATICS

Mathematics for elementary school teachers	1
Mathematics for middle school teachers	2
Geometry for elementary/middle school teachers	3
College algebra/trigonometry/elementary functions	4
Calculus	5
Advanced Calculus	6
Differential Equations	7
Geometry	8
Probability and statistics	9
Abstract algebra/number theory	10
Linear algebra	11
Applications of mathematics/problem solving	12
History of mathematics	13
Discrete Mathematics	14
Other upper division mathematics	15

SCIENCES/COMPUTER SCIENCES

Biological sciences	16
Chemistry	17
Physics	18
Physical science	19
Earth/space science	20
Engineering (any)	21
Computer programming	22
Other computer science	23

EDUCATION

Supervised student teaching in mathematics	24
Instructional use of computers/ other technologies	25

7. For each of the following subject areas, indicate the number of college **semester and quarter courses** you have completed. Count each course you have taken, regardless of whether it was a graduate or undergraduate course. If your transcripts are not available, provide your best estimates.

NUMBER OF COURSES COMPLETED

		(CIRCLE ONE NUMBER ON EACH LINE.) Semester Courses	*(CIRCLE ONE NUMBER ON EACH LIN* Quarter Courses
a.	Mathematics education	0 1 2 3 4 5 6 7 $\geq$8	0 1 2 3 4 5 6 7 $\geq$8
b.	Calculus	0 1 2 3 4 5 6 7 $\geq$8	0 1 2 3 4 5 6 7 $\geq$8
c.	All other mathematics courses	0 1 2 3 4 5 6 7 $\geq$8	0 1 2 3 4 5 6 7 $\geq$8
d.	Computer science...........................	0 1 2 3 4 5 6 7 $\geq$8	0 1 2 3 4 5 6 7 $\geq$8
e.	Science	0 1 2 3 4 5 6 7 $\geq$8	0 1 2 3 4 5 6 7 $\geq$8

8. Please check the box(es) next to the degree(s) you hold. Use the list of code numbers on the right to indicate your major and minor fields of study for each degree. (If you do not have a second major or minor field, please enter "00.")

		Major field code	Second major or minor field code
Bachelor's Degree	☐	______	______
Master's Degree	☐	______	______
Doctorate Degree	☐	______	______
Other Degree(s)	☐ Specify below:		
1) ________________		______	______
2) ________________		______	______

MAJOR & MINOR FIELD CODES

Education
- 11 Elementary Education
- 12 Middle School Education
- 13 Secondary Education
- 14 Mathematics Education
- 15 Science Education
- 16 Other Education

Mathematics/Computer Science
- 21 Mathematics
- 22 Computer Science

Science
- 31 Biology, Life Science
- 32 Chemistry
- 33 Physics
- 34 Physical Science
- 35 Earth/Space Sciences
- 36 Other Science

Other Disciplines
- 41 History, English Foreign Language, etc.

9. a. In what year did you last take a course for college credit in **mathematics**?

19 ________

b. In what year did you last take a course for college credit in the **teaching of mathematics**?

19 ________

10. What is the **total** amount of time you have spent on in-service education in **mathematics** or **the teaching of mathematics** in the last 12 months? in the last 3 years? (Include attendance at professional meetings, workshops, and conferences, but **do not** include formal courses for which you received college credit.)

(CIRCLE ONE NUMBER IN EACH COLUMN.)

Hours of In-service Education	Last 12 months	Last 3 years
None	1	1
Less than 6 hours	2	2
6 - 15 hours	3	3
16 - 35 hours	4	4
More than 35 hours	5	5

11. In the past twelve months, have you: *(CIRCLE ONE ON EACH LINE.)*

		No	Yes
a.	Attended any national or state mathematics teacher association meetings?	1	2
b.	Taught any in-service workshops or courses in mathematics or mathematics teaching?	1	2
c.	Received any local, state, or national grants or awards for mathematics teaching?	1	2
d.	Served on a school or district mathematics curriculum committee?	1	2
e.	Served on a school or district mathematics textbook selection committee?	1	2

12. For each of the materials listed below, please mark one of the following categories: (1) have never heard of, (2) have heard of but not seen, (3) have seen but not used, or (4) have used in teaching.

(CIRCLE ONE ON EACH LINE.)

		Have never heard of	Have heard of but not seen	Have seen but not used	Have used in teaching
a.	Calculators and Mathematics Project - Los Angeles (CAMP-LA)	1	2	3	4
b.	Computer - Intensive Algebra	1	2	3	4
c.	Elementary Mathematician	1	2	3	4
d.	Futures with Jaime Escalante	1	2	3	4
e.	Geometer's Sketchpad	1	2	3	4
f.	Geometry and Measurement, K-6	1	2	3	4
g.	Getting Ready for Algebra	1	2	3	4
h.	High School Mathematics and Its Applications Project (HIMAP)	1	2	3	4
i.	Jasper Series	1	2	3	4
j.	Journeys in Mathematics	1	2	3	4
k.	Logo Geometry	1	2	3	4
l.	Math and the Mind's Eye	1	2	3	4
m.	Middle Grades Mathematics Project	1	2	3	4
n.	Project Mathematics!	1	2	3	4
o.	Quantitative Literacy Series	1	2	3	4
p.	Used Numbers: Collecting and Analyzing Real Data	1	2	3	4

13. a. The National Council of Teachers of Mathematics has prepared *Curriculum and Evaluation Standards*, generally called the NCTM Standards, for mathematics instruction. Which of the statements below best describes your familiarity with the NCTM Standards? *(CIRCLE ONE.)*

Well aware of the NCTM Standards	1	*(CONTINUE WITH QUESTION 13.b.)*
Heard of the NCTM Standards but don't know much about them	2	*(SKIP TO 14.)*
Not aware of the NCTM Standards	3	*(SKIP TO 14.)*
Not sure	4	*(SKIP TO 14.)*

b. Please indicate the extent to which you agree with each of the following statements.

(CIRCLE ONE ON EACH LINE.)

	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
I am well informed about the NCTM Standards for the grades I teach	1	2	3	4	5
I am prepared to explain the NCTM Standards to my colleagues	1	2	3	4	5

14. a. The National Council of Teachers of Mathematics has prepared *Professional Standards for Teaching Mathematics*, generally called the NCTM Teaching Standards, for mathematics instruction. Which best describes your familiarity with the NCTM Teaching Standards? *(CIRCLE ONE.)*

Well aware of the NCTM Teaching Standards.	1	*(CONTINUE WITH QUESTION 14.b.)*
Heard of the NCTM Teaching Standards but don't know much about them	2	*(SKIP TO 15.)*
Not aware of the NCTM Teaching Standards..	3	*(SKIP TO 15.)*
Not sure..	4	*(SKIP TO 15.)*

b. Please indicate the extent to which you agree with each of the following statements.

(CIRCLE ONE ON EACH LINE.)

	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
I am well informed about the NCTM Teaching Standards for the grades I teach	1	2	3	4	5
I am prepared to explain the NCTM Teaching Standards to my colleagues	1	2	3	4	5

15. Do you teach in a self-contained classroom, i.e., are you responsible for teaching all or most academic subjects to one class?

Yes .... 1 *(COMPLETE 16.a., THEN GO TO 17.)*

No .... 2 *(COMPLETE 16.b., THEN GO TO 17.)*

16. a. **For Teachers of Self-Contained Classes:** We are interested in knowing how much time your students spend studying various subjects. In a typical week, how many days do you have lessons on each of the following subjects, and how many minutes long is an average lesson? (Please write "0" if you do not teach a particular subject to this class.)

	Number of days per week	Approximate number of minutes per day
Mathematics	______	______
Science	______	______
Social Studies	______	______
Reading	______	______

NOW GO TO Q17.

b. **For Teachers of Non Self-Contained Classes:** For each class period you are currently teaching, regardless of subject, give the course title, the code number from the enclosed blue "List of Course Titles" that best describes the content of each course, number of students, and the grade level of most of the students in that class.

Class	Course Title	Code No.	No. of Students	Predominant Grade Level
1	______	______	______	______
2	______	______	______	______
3	______	______	______	______
4	______	______	______	______
5	______	______	______	______
6	______	______	______	______
7	______	______	______	______
8	______	______	______	______

SECTION C: YOUR MATHEMATICS TEACHING IN A PARTICULAR CLASS

The questions in this section are about a particular **mathematics class** you teach. If you teach more than one class per day, please think about the mathematics classes you are teaching today (or the most recent school day). Then consult the label on the front of this questionnaire to determine which mathematics class to consider when answering these questions.

17. a. Please provide the complete title of the course you will be describing:

____
COURSE TITLE

b. Using the blue "List of Course Titles," indicate the code number that best describes this course:

____
COURSE CODE

(If "Other Mathematics" [Code 299], briefly describe content of course: ______________________
____)

18. What is the duration of this course? *(CIRCLE ONE.)*

a. Year 1
b. Semester 2
c. Quarter 3
d. Other *(PLEASE SPECIFY)* 4

____

19. How many of the students <u>in this mathematics class</u> are in each of the following grades?

1	2	3	4	5	6	7	8	9	10	11	12	TOTAL

20. Please indicate the number of students in this mathematics class in each race/sex category.

	Male	Female
a. White (not of Hispanic origin)	____	____
b. Black (not of Hispanic origin)	____	____
c. Hispanic .... (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	____	____
d. American Indian or Alaskan Native	____	____
e. Asian or Pacific Islander	____	____
TOTAL	____	____

(NOTE: The total number of males and females should be the same as the total number of students in question 19.)

21. How many of the students in this mathematics class are **formally** classified as:

a. Limited English Proficiency ________ students

b. Learning Disabled ________ students

c. Mentally Handicapped ________ students

d. Physically Handicapped, please specify handicaps:

1) ______________________ ________ students

2) ______________________ ________ students

22. Are students assigned to this mathematics class by level of ability? *(CIRCLE ONE.)*

Yes	1
No	2

23. Which of the following best describes the ability of the students in this mathematics class? *(CIRCLE ONE.)*

Fairly homogeneous and low in ability	1
Fairly homogeneous and average in ability	2
Fairly homogeneous and high in ability	3
Heterogeneous, with a mixture of two or more ability levels	4

24. Think about your plans for this mathematics class for the entire course. How much emphasis will each of the following **student objectives** receive?

(CIRCLE ONE ON EACH LINE.)

		None	Minimal emphasis		Moderate emphasis		Very heavy emphasis
a.	Increase interest in mathematics	0	1	2	3	4	5
b.	Learn mathematical concepts	0	1	2	3	4	5
c.	Learn mathematical algorithms	0	1	2	3	4	5
d.	Learn how to solve problems	0	1	2	3	4	5
e.	Learn to reason mathematically	0	1	2	3	4	5
f.	Learn how mathematical ideas connect with one another	0	1	2	3	4	5
g.	Prepare for further study in mathematics	0	1	2	3	4	5
h.	Understand the logical structure of mathematics	0	1	2	3	4	5
i.	Learn about the history of mathematics	0	1	2	3	4	5
j.	Learn to explain ideas in mathematics effectively	0	1	2	3	4	5
k.	Increase awareness of the importance of mathematics in daily life	0	1	2	3	4	5
l.	Learn about the applications of mathematics in science	0	1	2	3	4	5
m.	Learn about the applications of mathematics in business and industry	0	1	2	3	4	5
n.	Learn to perform computations with speed and accuracy	0	1	2	3	4	5
o.	Prepare for standardized tests	0	1	2	3	4	5

25. How much does each of the following influence what you teach in this mathematics class?

(CIRCLE ONE ON EACH LINE.)

		No influence			Extensive influence	Not applicable
a.	Your state's curriculum framework/course of study	1	2	3	4	8
b.	Your district's curriculum framework/course of study	1	2	3	4	8
c.	State test	1	2	3	4	8
d.	District test	1	2	3	4	8
e.	Textbook	1	2	3	4	8
f.	NCTM's *Curriculum and Evaluation Standards*	1	2	3	4	8
g.	NCTM's *Professional Standards for Teaching Mathematics*	1	2	3	4	8
h.	*Science for All Americans* (AAAS' Project 2061)	1	2	3	4	8
i.	Your own mathematics content background	1	2	3	4	8
j.	Your understanding of what motivates your students	1	2	3	4	8
k.	Available facilities, equipment, and supplies	1	2	3	4	8
l.	Parents/community	1	2	3	4	8

26. About how often do students in this mathematics class take part in the following types of activities?

(CIRCLE ONE ON EACH LINE.)

		Never	Once or twice semester	Once or twice a month	Once or twice a week	Almost daily
a.	Listen and take notes during presentation by teacher	1	2	3	4	5
b.	Do mathematics problems from textbooks	1	2	3	4	5
c.	Do mathematics problems from worksheets	1	2	3	4	5
d.	Work in small groups	1	2	3	4	5
e.	Work in class on mathematics projects that take a week or more	1	2	3	4	5
f.	Work at home on mathematics projects that take a week or more	1	2	3	4	5
g.	Make conjectures and explore possible methods to solve a mathematical problem	1	2	3	4	5
h.	Learn about mathematics through real-life applications	1	2	3	4	5
i.	Write their reasoning about how to solve a problem	1	2	3	4	5
j.	Use manipulative materials or models	1	2	3	4	5
k.	Use computers/calculators to explore problems	1	2	3	4	5
l.	Use computers/calculators to do computations	1	2	3	4	5

26. (continued)

(CIRCLE ONE ON EACH LINE.)

		Never	Once or twice semester	Once or twice a month	Once or twice a week	Almost daily
m.	Use computers/calculators to develop an understanding of mathematics concepts	1	2	3	4	5
n.	Participate in dialogue with the teacher to develop an idea	1	2	3	4	5
o.	Watch films, filmstrips, or videotapes	1	2	3	4	5
p.	Watch television programs	1	2	3	4	5

27. For the following equipment, please indicate the approximate number of times per semester each is used in this mathematics class. For those not used, circle either 1, Not needed or 2, Needed but not available.

(CIRCLE ONE ON EACH LINE.)

		Not needed	Needed but not available	Number of times used per semester 1-2	3-5	6-10	11+
a.	Overhead projector	1	2	3	4	5	6
b.	Videotape player	1	2	3	4	5	6
c.	Videodisc player	1	2	3	4	5	6
d.	CD-ROM player	1	2	3	4	5	6
e.	Four function calculators	1	2	3	4	5	6
f.	Fraction calculators	1	2	3	4	5	6
g.	Graphing calculators	1	2	3	4	5	6
h.	Scientific calculators	1	2	3	4	5	6
i.	Computers	1	2	3	4	5	6
j.	Computer/lab interfacing devices	1	2	3	4	5	6

28. How much of your own money do you estimate you will spend for supplies for this mathematics class this year?

$ ______________

29. How much control do you have over each of the following for this mathematics class?

(CIRCLE ONE ON EACH LINE.)

		No control				Strong control
a.	Determining goals and objectives	1	2	3	4	5
b.	Selecting textbooks	1	2	3	4	5
c.	Selecting other instructional materials	1	2	3	4	5
d.	Selecting content, topics, and skills to be taught	1	2	3	4	5
e.	Selecting the sequence in which topics are covered	1	2	3	4	5
f.	Setting the pace for covering topics	1	2	3	4	5
g.	Selecting teaching techniques	1	2	3	4	5
h.	Determining the amount of homework to be assigned	1	2	3	4	5
i.	Choosing criteria for grading students	1	2	3	4	5

30. a. Are you using one or more commercially published textbooks or programs for teaching mathematics to this class?

Yes .... 1 *(CONTINUE WITH 30.b.)*

No .... 2 *(SKIP TO 32.)*

b. Indicate the publisher of the one textbook/program used most often by students in this mathematics class. **(CIRCLE ONE.)**

Addison-Wesley 1
Allyn & Bacon 2
Amsco 3
Delta Education 4
Ginn 5
Glencoe 6
Globe 7
Harcourt, Brace, & Jovanovich 8
Harper & Row 9
D.C. Heath 10
Holt, Rinehart, Winston 11
Houghton Mifflin 12
Kendall Hunt 13
Laidlaw Brothers 14
Little, Brown 15
Macmillan 16
McGraw Hill 17
Merrill 18
Prentice Hall 19
Scott, Foresman 20
Silver, Burdett, & Ginn 21
Wiley 22

Other (PLEASE SPECIFY) 23

____

31. What is the title, author, publication year, and edition of this textbook/program?

Title ______________________________

First Author ____________________ Publication Year __________ Edition __________

32. Approximately what percentage of this textbook/program will you cover in this course? *(CIRCLE ONE.)*

Less than 25 percent	1
25 - 49 percent	2
50 - 74 percent	3
75 - 90 percent	4
More than 90 percent	5

33. How would you rate the overall quality of this textbook/program? *(CIRCLE ONE.)*

Very Poor	1
Poor	2
Fair	3
Good	4
Very Good	5
Excellent	6

34. How much homework do you assign in this mathematical class in a typical **week**? *(CIRCLE ONE.)*

0 - 30 minutes	1
31 - 60 minutes	2
61 - 90 minutes	3
91 - 120 minutes	4
2 - 3 hours	5
More than 3 hours	6

35. Indicate the importance you give to each of the following in setting grades for students in this mathematical class.

(CIRCLE ONE ON EACH LINE.)

		Not important			Very important
a.	Objective tests (e.g., multiple choice, true/false)	1	2	3	4
b.	Essay tests	1	2	3	4
c.	Hands-on/performance tasks	1	2	3	4
d.	Systematic observations of students	1	2	3	4
e.	Interviewing students about what they understand	1	2	3	4
f.	Homework assignments	1	2	3	4
g.	Behavior	1	2	3	4
h.	Effort	1	2	3	4
i.	Mathematics projects	1	2	3	4
j.	Class attendance	1	2	3	4
k.	Contribution to small group work	1	2	3	4
l.	Participation in whole class discussion	1	2	3	4
m.	Individual improvement or progress over past performance	1	2	3	4

SECTION D: YOUR MOST RECENT MATHEMATICS LESSON

Use your most recent **mathematical lesson** in this class to answer the following questions. Do not be concerned if this lesson was not typical of instruction in this class.

36. a. How many minutes were allocated to the most recent mathematical lesson?

______ minutes

b. Of these, how many minutes were spent on the following:

(1)	Daily routines, interruptions, and other non-instructional activities	______
(2)	Whole class lecture/discussions	______
(3)	Individual students reading textbooks, completing worksheets, etc.	______
(4)	Working with hands-on/manipulative materials	______
(5)	Non-manipulative small group work	______
	TOTAL MINUTES	______

(SHOULD BE THE SAME AS 36.a.)

37. Which of the following activities took place during that **mathematical lesson**? *(CIRCLE ALL THAT APPLY.)*

a. Lecture 1

b. Students completing textbook/worksheet problems 2

c. Students reading about mathematical 3

d. Students working in cooperative learning groups where the entire group receives a single grade 4

e. Student use of calculators 5

f. Student use of computers 6

g. Student use of other technologies 7

h. Test or quiz 8

38. Did that lesson take place on the most recent day your school was in session? *(CIRCLE ONE.)*

Yes 1

No 2

SECTION E: BACKGROUND INFORMATION

39. Indicate your sex: *(CIRCLE ONE.)*

Male	1
Female	2

40. Are you: *(CIRCLE ONE.)*

White (not of Hispanic origin)	1
Black (not of Hispanic origin)	2
Hispanic (Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)	3
American Indian or Alaska Native	4
Asian or Pacific Islander	5

41. In what year were you born?

19____

42. How many years have you taught prior to this school year?

______ YEARS

43. How many years have you taught **mathematical** prior to this school year?

______ YEARS

44. When did you complete this questionnaire?

________/________/________
MONTH DAY YEAR

Thank you for your assistance!

Please return the questionnaire to us in the postage-paid envelope:

1993 National Survey of Science and Mathematics Education
c/o CODA
1400 Spring Street - Suite 150
Silver Spring, MD 20910

LIST OF COURSE TITLES

A. SCIENCE COURSES

CODE	Course Category
	Grades 1 - 6
101	Science, Grade 1
102	Science, Grade 2
103	Science, Grade 3
104	Science, Grade 4
105	Science, Grade 5
106	Science, Grade 6
107	Other Elementary Science

CODE	Course Category
	Grades 7 - 8
108	Life Science
109	Earth Science
110	Physical Science
111	General Science
112	Coordinated Science: Includes content from more than one science discipline, e.g., life and physical science, but keeps the disciplines separate.
113	Integrated Science: Includes science from various science disciplines, but blurs the distinctions among them.

CODE	Course Category	Sample Course Titles
	Grades 9 - 12	
	Biology	
114	1st Year	Biology I; General Biology; College Prep Biology; Regents Biology; Introductory Biology; BSCS I
115	1st Year, Applied	Basic Biology; Applied Biology; Life Science; Biomedical Education; Animal Science; Horticulture; Biology Science; Health Science; Nutrition; Man and Disease; Agriculture Science; Fundamentals of Biology
116	2nd Year, AP	Advanced Placement Biology
117	2nd Year, Advanced	Biology II; Advanced Biology; College Biology; Psychobiology; Physiology; Anatomy; Microbiology; Genetics; Cell Biology; Embryology; Molecular Biology; Invertebrate/Vertebrate Biology; BSCS II
118	2nd Year, Other	Zoology; Botany; Bio-Medical Careers; Field Biology; Marine Biology; Other Biological Sciences
	Chemistry	
119	1st Year	Chemistry I; General Chemistry; Introductory Chemistry; Regents Chemistry
120	1st Year, Applied	Applied Chemistry; Consumer Chemistry; Technical Chemistry; Practical Chemistry
121	2nd Year, AP	Advanced Placement Chemistry
122	2nd Year, Advanced	Chemistry II; Advanced Chemistry; College Chemistry; Organic Chemistry; Inorganic Chemistry; Physical Chemistry; Biochemistry; Analytical Chemistry
	Physics	
123	1st Year	Physics I; General Physics; Regents Physics; Introductory Physics
124	1st Year, Applied	Applied Physics; Electronics; Radiation Physics; Practical Physics
125	2nd Year, AP	Advanced Placement Physics
126	2nd Year, Advanced	Physics II; Advanced Physics; College Physics; Nuclear Physics; Atomic Physics
127	Physical Science	Physical Science; Interaction of Matter and Energy; Applied Physical Science
	Earth Science	
128	Astronomy/Space Science *	
129	Geology *	
130	Meteorology *	
131	Oceanography/Marine Science *	
132	1st Year	Earth Science; Earth/Space Science; Regents Earth Science
133	1st Year, Applied	Applied Earth Science; Fundamentals of Earth Science; Soil Science
134	2nd Year, Advanced	Advanced Earth Science; Earth Science II
135	Other Earth Science	
	Other Science	
136	General Science	General Science; Basic Science; Consumer Science; Introductory Science; Investigations in Science
137	Environmental Science	Ecology, Environmental Science
138	Science, Technology, Society	Science, Technology, Society; Science and Society
139	Coordinated Science	Includes content from more than one science discipline, e.g., life and physical science, but keeps the disciplines separate
140	Integrated Science	Includes content from the various science disciplines, but blurs the distinctions among them.
199	Other Science	Research Topics; science integrated with other disciplines, e.g., technology, engineering, mathematics.

* NOTE: A course that includes substantial content from two or more of the earth sciences should be listed under code 132, 133, 134, or 135.

B. MATHEMATICS COURSES

CODE	Course Category	Sample Course Titles
Grades 1 - 6		
201	Mathematics, Grade 1	
202	Mathematics, Grade 2	
203	Mathematics, Grade 3	
204	Mathematics, Grade 4	
205	Mathematics, Grade 5	
206	Mathematics, Grade 6	
207	Other Elementary Mathematics	
Grades 7 - 8		
208	Remedial Math, 7	Remedial Math 7
209	Math 7, Regular	Math 7
210	Math 7, Accelerated	Accelerated Math 7; Pre-Algebra; Introductory Algebra; Enriched Math 7; Transitional Math 7
211	Remedial Math, 8	Remedial Math 8
212	Math 8, Regular	Math 8
213	Math 8, Enriched	Pre-Algebra; Accelerated Math 8; Honors Math 8; Transitional Math 8
214	Math, 8, Algebra I	Algebra I; Beginning Algebra; Elementary Algebra
Grades 9 - 12		
Review Mathematics		
215	Level 1	General Math 1; Basic Math; Math 9; Developmental Math; High School Arithmetic; Comprehensive Math Transitional Math
216	Level 2	General Math 2; Vocational Math; Applied Math; Consumer Math; Technical Math; Business Math; Math 10 Career Math; Practical Math; Essential Math; Cultural Math
217	Level 3	General Math 3; Math 11, Intermediate Math; Applied Math II
218	Level 4	General Math 4, Math 12
Informal Mathematics		
219	Level 1	Pre-Algebra; Introductory Algebra; Basic Algebra; Applications; Algebra 1A; Non-College Algebra; Math A
220	Level 2	Basic Geometry; Informal Geometry; Practical Geometry; Core Geometry
221	Level 3	Basic Algebra 2; Mathematics of Consumer Economics
Formal Mathematics		
222	Level 1	Algebra I; Elementary Algebra; Beginning Algebra; Unified Math I; Integrated Math 1; Algebra 1B; Math B
223	Level 2	Geometry; Plane Geometry; Solid Geometry; Integrated Math 2; Unified Math II; Math C
224	Level 3	Algebra II, Intermediate Algebra; Algebra and Trigonometry; Algebra and Analytic Geometry; Integrated Math 3 Unified Math III
225	Level 4	Algebra III; Trigonometry; Advanced Algebra; College Algebra; Pre-Calculus; Analytic/Advanced Geometry Trigonometry and Analytic/Solid Geometry; Math Topics; Introduction to College Math; Number Theory Math IV; College Prep Senior Math; Elementary Functions; Finite Math; Numerical Analysis; Discrete Math
226	Level 5	Calculus and Analytic Geometry; Calculus; Abstract Algebra; Differential Equations; Multivariate Calculus; Linea Algebra; Theory of Equations; Vectors/Matrix Algebra; Math Analysis
227	Level 5, AP	Advanced Placement Calculus AB; Advanced Placement Calculus BC.
Other Mathematics		
228	Probability and Statistics	
229	Mathematics integrated with other subjects	
299	Other Mathematics	

C. OTHER COURSES

CODE	Course Category
301	Computer Science
302	Social Studies/History
303	English/Language Arts/Reading
304	Business Education
305	Vocational Education
306	Technology Education
307	Foreign Language
308	Health/Physical Education
309	Art/Music/Drama
399	Other subject

Appendix C

Pre-Survey Mailout

National Science Foundation Letter

Principal Letter

Fact Sheet

Information Needed Before the Survey

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
WASHINGTON, D.C. 20550

Division of Research, Evaluation and Dissemination

January 1993

Dear Colleague:

The National Science Foundation (NSF) requests your participation in the 1993 National Survey of Science and Mathematics Education. NSF supports the development of curriculum materials, workshops for teachers, and a variety of other activities aimed at improving science and mathematics education. The 1993 Survey, third in a series begun in 1977, will provide information about current practices and teachers' perceptions of their needs. Your response will allow NSF to learn about important changes in teaching practices.

This study has been endorsed by the American Federation of Teachers, the National Catholic Education Association, the National Council of Teachers of Mathematics, the National Education Association, and the National Science Teachers Association.

Horizon Research, Inc. and CODA are conducting the survey for the National Science Foundation by the authority of the NSF Act of 1950 as amended. Participation in the survey is voluntary. Your response is very valuable because it represents the responses of many others. The information you provide will be kept strictly confidential and will be reported only in statistical summary form such as by grade level. No information identifying teachers, schools, districts or states will be released.

More details about your participation in the survey are contained in the accompanying letter. Thank you for your cooperation in this very important effort.

Sincerely,

Kenneth J. Travers
Director
Division of Research,
Evaluation and Dissemination

1993 NATIONAL SURVEY OF SCIENCE AND MATHEMATICS EDUCATION

FACT SHEET

Overview

Approximately 1,250 schools in more than 950 school districts throughout the United States have been selected to participate in the 1993 National Survey of Science and Mathematics Education. The survey has been designed to collect information about science and mathematics education in grades K-12. It is being conducted by Horizon Research, Inc., under the direction of Dr. Iris R. Weiss. Data collection is the responsibility of CODA, Inc., in Silver Spring, Md. The study is supported by the National Science Foundation. The survey previously was conducted in 1977 and 1985.

Background and Purpose

The purpose of the survey is to provide the education community with accurate and current information about science and mathematics education and trends in the following areas.

<u>Experience of Teachers:</u>

- How many years of experience do today's science and mathematics teachers have?
- What proportion of the science and mathematics teachers are minority? How has this changed since 1985?
- What is the extent of out-of-field teaching in the nation's science and mathematics classes?
- In what areas do science and mathematics teachers feel a need for additional assistance?

<u>Course Offerings:</u>

- What are the current course offerings?
- How have offerings changed over the last 15 years?
- How do course offerings relate to other factors, such as school size or community type?

<u>Curriculum and Instruction:</u>

- How much time is spent by teachers on science and mathematics in the elementary grades?
- What are the teachers' objectives for science and mathematics instruction?
- What textbooks are most commonly used?

<u>Availability and Use of Equipment:</u>

- What types of equipment (e.g., calculators) are available and to what extent?
- How are computers used for instruction?

The study has been coordinated with the data collection efforts of the Department of Education (including the National Assessment of Educational Progress, the National Educational Longitudinal Study, and the Schools and Staffing Surveys) to avoid unnecessary duplication.

How Schools Were Selected

A total of 1,250 schools were randomly selected, using the Quality Education Data (QED) database as a sampling frame. To ensure adequate representation for national and regional estimates, all schools in the country were stratified as follows before the sample was drawn:

- Grade span
- Region of the country

(SEE OTHER SIDE)

- Metropolitan status
- Public versus private
- Orshansky percentile

District superintendents were notified of the schools in their district selected for the survey. Approximately 6000 teachers will be selected for the survey from lists of mathematics and science teachers provided by school principals. On average, five teachers will be selected from each school.

Survey Schedule

The survey is being conducted according to the following schedule:

CSSO's notified	June 1992
District offices with sampled schools notified	June 1992
Mail to schools for list of teachers	Sept. 1992
Mail questionnaires to sampled teachers	Jan. 1993
Study results available	Spring 1994

Survey Questionnaires

In January 1993, we will mail questionnaires for all sampled teachers and department heads to the individual the principal has designated as the survey coordinator for the school. The coordinator will be asked to distribute the questionnaires within the school.

Each sampled teacher will receive one of the following types of questionnaires:

- Elementary Science Teacher Questionnaire;
- Elementary Mathematics Teacher Questionnaire;
- Secondary Science Teacher Questionnaire; or
- Secondary Mathematics Teacher Questionnaire.

Questionnaires will take about 25 minutes to complete. If the teacher has been categorized as a "mathematics and science" teacher, the assignment of questionnaire type will be randomized.

Also included in the packet will be a short questionnaire (10 minutes) for each department head: the School Science Program Questionnaire and the School Mathematics Program Questionnaire.

Respondents who have any questions about items in the questionnaire can call us toll-free at 1-800-598-2888 for assistance. A postage-paid return envelope will be included with each questionnaire. Once the questionnaire is completed, the teacher may simply seal it and drop it in the mail.

Confidentiality

All survey data received by CODA will be kept strictly confidential and will be reported only in aggregate form, such as by grade level or region of the country. No information identifying individual districts, schools, or teachers will be released. No identifying information whatsoever will be included in the dataset.

In Appreciation for Participation

While every school and teacher's cooperation is important to obtain accurate results, participation is voluntary. To compensate participants for their time, the study has arranged to give each school a voucher to be used in purchasing science and mathematics education materials. The amount of the voucher will depend on the degree each school participates. Each school completing the teacher listing phase and program head questions will receive a $25 voucher. Additionally, $10 will be given for each responding teacher. At the conclusion of the study, each school will receive a copy of the results of the survey.

1993 NATIONAL SURVEY OF SCIENCE AND MATHEMATICS EDUCATION
CODA, Inc. 1400 Spring Street, Suite 150 Silver Spring MD 20910 (800) 598-2888 (301) 588-0177 *FAX: (301) 588-0417*

September 1, 1992

Dear Principal,

The purpose of this letter is to inform you that your school has been selected for the 1993 National Survey of Science and Mathematics Education. A total of 1,250 public and private schools and 6,000 K-12 teachers throughout the United States will be involved in the 1993 survey. The survey is supported by the National Science Foundation and is the third in a series of national surveys of science and mathematics education (the others were in 1977 and 1985-86). The enclosed Fact Sheet provides more information.

The 1993 survey will help determine how well-prepared schools and teachers are for effective science and mathematics education, what would help them do a better job, and how the National Science Foundation can best use its resources and prestige to improve science and mathematics education. The survey is being conducted by Horizon Research, Inc., under the direction of Dr. Iris R. Weiss. Data collection is the responsibility of CODA, Inc., in Silver Spring, Maryland.

As explained in the enclosed Fact Sheet, the topics to be covered in this study include science and mathematics course offerings and enrollments, availability of facilities and equipment, instructional techniques, textbook usage, teacher background, and needs for in-service education. Information will be collected from selected teachers by printed questionnaire only -- no classroom visits will be involved. Data will be kept strictly confidential and will be reported only in aggregate form, such as by grade level. No individually identifying information will be released.

The survey has two stages.

1. At this time, we ask that you complete the enclosed booklet and return it to us in the enclosed postage-paid envelope. The booklet requests that you:

   Part 1: Designate individuals, such as department heads, to receive the science and mathematics program questionnaires. We also request that you designate someone to serve as our contact point for the survey.

   Part 2: List all teachers of science or mathematics at your school. Instructions for creating the list have been included in the booklet.

   Part 3: Provide some basic background information about your school.

   When all booklets have been received, CODA will draw a sample of teachers at each school. On average, we will sample five teachers for each school.

2. In January 1993, we will mail teacher questionnaires and the two program questionnaires to the attention of the individual you designated as our contact point. Teacher questionnaires will take an average of 20-30 minutes to complete. The science and mathematics program questionnaires will take about 10 minutes. Respondents will be asked to return questionnaires directly to us, using the postage-paid envelopes provided.

To compensate participants for their time, the study has arranged to give each school a voucher to be used in purchasing science and mathematics education materials, such as the NCTM's Curriculum and Education Standards, Project 2061's Science for All Americans, and NSTA's Scope, Sequence, and Coordination Content Core. (The amount of the voucher will depend on response rates, with each participating school receiving $25, plus $10 for each responding teacher.) In addition, each school will receive a copy of the results of the survey.

Your cooperation is greatly appreciated. Please return the completed booklet for your school within the next 10 days so that we can begin the teacher selection process. If you have any questions about any of the items in the booklet or the study in general, please call us toll-free at 1-800-598-2888. Ask for the Science and Mathematics Survey specialist.

Thank you for your cooperation.

Sincerely,

Jacki Smith
Data Collection Coordinator

JS:pr
Enclosures

1993 NATIONAL SURVEY OF SCIENCE AND MATHEMATICS EDUCATION

INFORMATION NEEDED BEFORE THE SURVEY

LABEL

Please complete the following items in this booklet and return it to us in the enclosed envelope. There are three parts:

Part 1: Designation of department heads and school contact

Part 2: Names of science and mathematics teachers for sampling purposes

Part 3: School background information

Part 1: Designations

1. To whom should we address the School Science Program Questionnaire? This should be completed by the science department head or other staff member who is most knowledgeable about the science curriculum for all grades at your school. (The questionnaire takes about 10 minutes.)

______________________________ ____________________
Name of individual to receive Science Program Questionnaire — *Title*

2. To whom should we address the School Mathematics Program Questionnaire? This should be completed by the mathematics department head or other staff member most knowledgeable about the mathematics curriculum for all grades at your school. (The questionnaire takes about 10 minutes.)

______________________________ ____________________
Name of individual to receive Mathematics Program Questionnaire — *Title*

3. We would like you to designate someone to serve as our contact point at the school. (We will send all questionnaires to this person for distribution to teachers/department heads.)

____
Name of contact

(______)____________________
Telephone number

Part 2: Listing of Science and Mathematics Teachers

Instructions

On the following sheets, please list every teacher in this school who is responsible for science and/or mathematics instruction. (While most schools will need only one sheet, three have been provided to accommodate extremely large schools.) We will use this list to randomly select a sample of approximately five teachers to receive questionnaires.

1. List all teachers who will be teaching science/mathematics at this school in the 1992 - 1993 school year. (If a teacher has been designated to receive the science or mathematics program questionnaire, the teacher should still be listed.)

2. Do not include teacher aides or teachers responsible only for special education, e.g., self-contained classes for the educable mentally handicapped or "pull-out" classes for remediation or enrichment of students who also receive science/mathematics instruction from the regular classroom teacher.

3. For each teacher you list, circle the grades or subjects taught.

   - If the teacher has a self-contained class, such as in the elementary grades, circle the grade(s).

   - If the teacher has classes that are not self-contained, circle all of the categories that apply for that teacher. (See the examples below.)

4. If you have a listing of teachers for this school, you may send that back instead. Please make sure the list includes all teachers of science and mathematics and provides the other information we will need (i.e., "grades taught" for teachers of self-contained classes, subject categories for block and departmentalized teachers.)

5. If you have any questions, please call us toll-free at (800) 598-2888.

How to Categorize Science and Mathematics Classes

Here are some examples of science and mathematics courses in middle and high school grades, classified according to the four categories on the listing form:

High School Physics or Chemistry: *Chemistry (1st year), Advanced Chemistry, Advanced Placement Chemistry, Physics I, Advanced Physics.*

Other Science: *Biology, Earth Science, Physical Science, Integrated Science, General Science.*

High School Calculus or Advanced Math: *Calculus, Pre-calculus, Algebra 3, Analytic Geometry, Trigonometry, Math IV, College Prep/Senior Math.*

Other Math: *General Math, Basic Math, Algebra I, Algebra 2, Geometry, Integrated Math I - III, Unified Math I - III.*

For the purposes of this survey, the following are **not** considered science or mathematics courses: Computer Science, Health, Hygiene, Technology Education, Business.

Example of a Completed Teacher Listing Form

At the bottom of this page is an example of how the listing form would be completed for a K - 12 school with the teachers listed below. At this school, there are self-contained classes in grades K - 5, block teaching in grades 6 - 8, and departmentalized teaching in grades 9 - 12.

Teacher	Grade/Subject
Carol Linstrom	Kindergarten, self-contained
Mary Wilson	1st grade, self-contained
Lorraine Thomas	2nd grade, self-contained
Lucy Mathieu	3rd grade, self-contained
Allison Scott	3rd/4th grades combined, self-contained
Sarah Anderson	5th grade, self-contained
Bill Madigan	6th grade block: science, social studies
Karen Renwick	6th grade block: math, english
John Kilgore	basic algebra, geometry, general science
Louise Gaines	trigonometry
Barney Kessel	biology, physical science
Lillian Foster	geometry, pre-calculus
Angela White	high school chemistry
Tom Lancer	high school physics, earth science

PAGE 1

SCIENCE AND MATHEMATICS TEACHERS AT THIS SCHOOL

Please list all teachers who teach science and/or mathematics at this school. For teachers who teach:

- Self-contained classes, circle each grade taught.
- Classes that are not self-contained, circle each subject taught. (See examples.)

IF YOU NEED ASSISTANCE, CALL:
1-800-598-2888

#	TEACHER NAME First	Last	SELF-CONTAINED (CIRCLE ALL GRADES TAUGHT)	NOT SELF-CONTAINED (CIRCLE ALL SUBJECTS TAUGHT) SCIENCE: High School Physics or Chemistry	SCIENCE: Other Science	MATH: High School Calculus or Advanced Math	MATH: Other Math
01	Carol	Linstrom	(K) 1 2 3 4 5 6 7 8	1	2	3	4
02	Mary	Wilson	K (1) 2 3 4 5 6 7 8	1	2	3	4
03	Lorraine	Thomas	K 1 (2) 3 4 5 6 7 8	1	2	3	4
04	Lucy	Mathieu	K 1 2 (3) 4 5 6 7 8	1	2	3	4
05	Allison	Scott	K 1 2 (3) (4) 5 6 7 8	1	2	3	4
06	Sara	Anderson	K 1 2 3 4 (5) 6 7 8	1	2	3	4
07	Bill	Madigan	K 1 2 3 4 5 6 7 8	1	(2)	3	4
08	Karen	Renwick	K 1 2 3 4 5 6 7 8	1	2	3	(4)
09	John	Kilgore	K 1 2 3 4 5 6 7 8	1	(2)	3	(4)
10	Louise	Gaines	K 1 2 3 4 5 6 7 8	1	2	(3)	4
11	Barney	Kessel	K 1 2 3 4 5 6 7 8	1	(2)	3	4
12	Lillian	Foster	K 1 2 3 4 5 6 7 8	1	2	(3)	(4)
13	Angela	White	K 1 2 3 4 5 6 7 8	(1)	2	3	4
14	Tom	Lancer	K 1 2 3 4 5 6 7 8	(1)	(2)	3	4
15			K 1 2 3 4 5 6 7 8	1	2	3	4

PAGE 1

SCIENCE AND MATHEMATICS TEACHERS AT THIS SCHOOL

Please list all teachers who teach science and/or mathematics at this school. For teachers who teach:

- Self-contained classes, circle each grade taught.
- Classes that are not self-contained, circle each subject taught. (See examples.)

IF YOU NEED ASSISTANCE, CALL:
1-800-598-2888

#	TEACHER NAME First	Last	SELF-CONTAINED (CIRCLE ALL GRADES TAUGHT)	OR NOT SELF-CONTAINED (CIRCLE ALL SUBJECTS TAUGHT): SCIENCE — High School Physics or Chemistry	SCIENCE — Other Science	MATH — High School Calculus or Advanced Math	MATH — Other Math
01			K 1 2 3 4 5 6 7 8	1	2	3	4
02			K 1 2 3 4 5 6 7 8	1	2	3	4
03			K 1 2 3 4 5 6 7 8	1	2	3	4
04			K 1 2 3 4 5 6 7 8	1	2	3	4
05			K 1 2 3 4 5 6 7 8	1	2	3	4
06			K 1 2 3 4 5 6 7 8	1	2	3	4
07			K 1 2 3 4 5 6 7 8	1	2	3	4
08			K 1 2 3 4 5 6 7 8	1	2	3	4
09			K 1 2 3 4 5 6 7 8	1	2	3	4
10			K 1 2 3 4 5 6 7 8	1	2	3	4
11			K 1 2 3 4 5 6 7 8	1	2	3	4
12			K 1 2 3 4 5 6 7 8	1	2	3	4
13			K 1 2 3 4 5 6 7 8	1	2	3	4
14			K 1 2 3 4 5 6 7 8	1	2	3	4
15			K 1 2 3 4 5 6 7 8	1	2	3	4
16			K 1 2 3 4 5 6 7 8	1	2	3	4
17			K 1 2 3 4 5 6 7 8	1	2	3	4
18			K 1 2 3 4 5 6 7 8	1	2	3	4
19			K 1 2 3 4 5 6 7 8	1	2	3	4
20			K 1 2 3 4 5 6 7 8	1	2	3	4
21			K 1 2 3 4 5 6 7 8	1	2	3	4
22			K 1 2 3 4 5 6 7 8	1	2	3	4
23			K 1 2 3 4 5 6 7 8	1	2	3	4
24			K 1 2 3 4 5 6 7 8	1	2	3	4
25			K 1 2 3 4 5 6 7 8	1	2	3	4

SCIENCE AND MATHEMATICS TEACHERS AT THIS SCHOOL (CONTINUED)

IF YOU NEED ASSISTANCE, CALL:
1-800-598-2888

#	TEACHER NAME First	Last	SELF-CONTAINED (CIRCLE ALL GRADES TAUGHT) — OR —	NOT SELF-CONTAINED (CIRCLE ALL SUBJECTS TAUGHT): SCIENCE — High School Physics or Chemistry	SCIENCE — Other Science	MATH — High School Calculus or Advanced Math	MATH — Other Math
26			K 1 2 3 4 5 6 7 8	1	2	3	4
27			K 1 2 3 4 5 6 7 8	1	2	3	4
28			K 1 2 3 4 5 6 7 8	1	2	3	4
29			K 1 2 3 4 5 6 7 8	1	2	3	4
30			K 1 2 3 4 5 6 7 8	1	2	3	4
31			K 1 2 3 4 5 6 7 8	1	2	3	4
32			K 1 2 3 4 5 6 7 8	1	2	3	4
33			K 1 2 3 4 5 6 7 8	1	2	3	4
34			K 1 2 3 4 5 6 7 8	1	2	3	4
35			K 1 2 3 4 5 6 7 8	1	2	3	4
36			K 1 2 3 4 5 6 7 8	1	2	3	4
37			K 1 2 3 4 5 6 7 8	1	2	3	4
38			K 1 2 3 4 5 6 7 8	1	2	3	4
39			K 1 2 3 4 5 6 7 8	1	2	3	4
40			K 1 2 3 4 5 6 7 8	1	2	3	4
41			K 1 2 3 4 5 6 7 8	1	2	3	4
42			K 1 2 3 4 5 6 7 8	1	2	3	4
43			K 1 2 3 4 5 6 7 8	1	2	3	4
44			K 1 2 3 4 5 6 7 8	1	2	3	4
45			K 1 2 3 4 5 6 7 8	1	2	3	4
46			K 1 2 3 4 5 6 7 8	1	2	3	4
47			K 1 2 3 4 5 6 7 8	1	2	3	4
48			K 1 2 3 4 5 6 7 8	1	2	3	4
49			K 1 2 3 4 5 6 7 8	1	2	3	4
50			K 1 2 3 4 5 6 7 8	1	2	3	4
51			K 1 2 3 4 5 6 7 8	1	2	3	4
52			K 1 2 3 4 5 6 7 8	1	2	3	4
53			K 1 2 3 4 5 6 7 8	1	2	3	4
54			K 1 2 3 4 5 6 7 8	1	2	3	4
55			K 1 2 3 4 5 6 7 8	1	2	3	4

SCIENCE AND MATHEMATICS TEACHERS AT THIS SCHOOL (CONTINUED)

IF YOU NEED ASSISTANCE, CALL:
1-800-598-2888

#	TEACHER NAME First	Last	SELF-CONTAINED (CIRCLE ALL GRADES TAUGHT) — OR —	NOT SELF-CONTAINED (CIRCLE ALL SUBJECTS TAUGHT): SCIENCE: High School Physics or Chemistry	SCIENCE: Other Science	MATH: High School Calculus or Advanced Math	MATH: Other Math
56			K 1 2 3 4 5 6 7 8	1	2	3	4
57			K 1 2 3 4 5 6 7 8	1	2	3	4
58			K 1 2 3 4 5 6 7 8	1	2	3	4
59			K 1 2 3 4 5 6 7 8	1	2	3	4
60			K 1 2 3 4 5 6 7 8	1	2	3	4
61			K 1 2 3 4 5 6 7 8	1	2	3	4
62			K 1 2 3 4 5 6 7 8	1	2	3	4
63			K 1 2 3 4 5 6 7 8	1	2	3	4
64			K 1 2 3 4 5 6 7 8	1	2	3	4
65			K 1 2 3 4 5 6 7 8	1	2	3	4
66			K 1 2 3 4 5 6 7 8	1	2	3	4
67			K 1 2 3 4 5 6 7 8	1	2	3	4
68			K 1 2 3 4 5 6 7 8	1	2	3	4
69			K 1 2 3 4 5 6 7 8	1	2	3	4
70			K 1 2 3 4 5 6 7 8	1	2	3	4
71			K 1 2 3 4 5 6 7 8	1	2	3	4
72			K 1 2 3 4 5 6 7 8	1	2	3	4
73			K 1 2 3 4 5 6 7 8	1	2	3	4
74			K 1 2 3 4 5 6 7 8	1	2	3	4
75			K 1 2 3 4 5 6 7 8	1	2	3	4
76			K 1 2 3 4 5 6 7 8	1	2	3	4
77			K 1 2 3 4 5 6 7 8	1	2	3	4
78			K 1 2 3 4 5 6 7 8	1	2	3	4
79			K 1 2 3 4 5 6 7 8	1	2	3	4
80			K 1 2 3 4 5 6 7 8	1	2	3	4
81			K 1 2 3 4 5 6 7 8	1	2	3	4
82			K 1 2 3 4 5 6 7 8	1	2	3	4
83			K 1 2 3 4 5 6 7 8	1	2	3	4
84			K 1 2 3 4 5 6 7 8	1	2	3	4
85			K 1 2 3 4 5 6 7 8	1	2	3	4

Part 3: Background Information About this School

1. How many K - 12 students are there in this school at the present time?

____
 # K - 12 students

2. Indicate the grades included in this school. **(Circle all that apply.)**

K 1 2 3 4 5 6 7 8 9 10 11 12

3. Which of the following best describes the community in which this school is located? **(Circle the best answer.)**

a. A rural or farming community 01

b. A small city or town of fewer than 50,000 that is not a suburb of a larger city 02

c. A medium-sized city (50,000 to 100,000 people)......................... 03

d. A suburb of a medium-sized city 04

e. A large city (100,000 to 500,000 people) 05

f. A suburb of a large city 06

g. A very large city (over 500,000 people) 07

h. A suburb of a very large city 08

i. A military base or station 09

j. An Indian reservation.. 10

4. Does this school provide Chapter 1 services under the Elementary and Secondary Education Act as amended (i.e., federal funds for the special educational needs of disadvantaged children)?

YES .... 1 --------> IF YES: How many K -12 students are served?____________
NO 2

5. Are any of the students in this school eligible for free or reduced price lunches that are paid for with public funds (e.g., Federal government or other government)?

YES .... 1 ---------> IF YES: How many K - 12 students receive free or reduced price lunches?____________
NO 2

6. Approximately what percentage of the students attending this school are children of: **(Round to nearest percent.)**

a. Professional or managerial personnel ________ %

b. Sales, clerical, technical, or skilled workers ________ %

c. Factory or other blue collar workers ________ %

d. Farm workers ________ %

e. Persons not regularly employed ________ %

f. Persons on welfare ________ %

TOTAL 100 %

7. Approximately what percentage of the students attending this school are: **(Round to nearest one-tenth percent.)**

a. White (not of Hispanic origin) ________ %

b. Black (not of Hispanic origin) ________ %

c. Hispanic, regardless of race ________ %

(Mexican, Puerto Rican, Cuban, Central or South American, or other Hispanic culture or origin)

d. American Indian or Alaskan Native ________ %

e. Asian or Pacific Islander ________ %

TOTAL 100 %

8. Who completed this booklet:

a. Name: ______________________________

b. Title: ______________________________

c. Phone: (_____) ________________________

PLEASE RETURN THIS BOOKLET TO CODA IN THE ENVELOPE PROVIDED.

QUESTIONNAIRES WILL BE MAILED TO YOUR SCHOOL IN JANUARY, 1993.

THANK YOU FOR YOUR ASSISTANCE

CODA, Inc.
1400 Spring St. - Suite 150
Silver Spring, MD 20910

Appendix D

Description of Data Collection

Description of Data Collection

A. Advance Notification

On May 12, 1992, the Principal Investigator and staff members from CODA, and the data collection subcontractor, met with the Council of Chief State School Officer's Subcommittee on Statistics, the Education Information Advisory Committee (EIAC). The proposed study and survey instruments received a favorable review. Notification letters were mailed to the Chief State School Officers on June 1, 1992. The letters advised the CSSOs of the format and schedule of the study and identified the schools in their states that had been sampled for the survey.

Two weeks later similar information letters were mailed to superintendents of districts in which sampled public schools were located. Letters also were sent to diocesan education offices for the Catholic schools sampled. District officials were asked to contact CODA if they had any questions or concerns, if any sampled schools had closed, or if school address information was incorrect. In response to this mailing, CODA learned about several closed schools and address changes. A total of seven districts refused, accounting for 11 sampled schools. Eight districts required us to submit to an approval process, which usually involved sending an abstract describing the study and submitting samples of the survey instruments.

New York City (NYC), in particular, had a very long approval process. Materials were submitted to the Office of Evaluation, Research and Assessment (OERA). After OERA had granted approval to conduct research, approval forms had to be signed by principals of participating schools and district superintendents. These trickled in over the several months of the data collection period. In several cases sub-districts within the NYC school system also had their own approval process which required the submission of survey materials.

B. Pre-Survey

During the first week in September 1992, pre-survey packets were sent to the principals of each sampled school which had not refused at the district level. Based on information obtained during the initial district contact, packets for a few schools were directed to school district officials, who then forwarded them to the schools.

The pre-survey packet consisted of a cover letter from CODA, a fact sheet about the survey, and an eight-page pre-survey booklet. The booklet was designed to obtain the following information from the school principal, or someone designated by the principal:

- The names of the heads of the science and mathematics departments or, if there were no official departments, individuals who were knowledgeable enough about the science and mathematics programs at their school to fill out Program questionnaires;

- The name of a person to act as our contact point for the survey;

- Names of those who taught science and mathematics at the school; and

- Key characteristics about the school and the population it served which would be useful during the analysis. These were: number of students, grades included in school, community size description, Chapter 1 status, number of students receiving free or reduced price lunches, percentage breakdown of parents' occupational categories, and racial/ethnic breakdown of school population.

As an incentive for schools to participate, schools were offered a voucher redeemable at the end of the year for instructional materials. Schools which completed the pre-survey form were credited $25. (Later, during the questionnaire phase of the study, the value of the voucher increased by $10 for each completed teacher questionnaire and $5 for each completed Program questionnaire.)

Principals from non-responding schools were sent prompting postcards three weeks after the initial mailing. A week later telephone prompts followed to those still not responding. It generally required a series of telephone calls to determine whether anyone had received the pre-survey, to whom the task had been delegated, and whether or not that person was planning to complete it. In many cases, schools requested a remail of the survey materials. For some of the smaller schools, prompters were able to complete the survey form over the telephone. All schools were offered the option to send in teacher "codes" rather than actual teacher names, thereby preserving the anonymity of the respondents. Only two principals exercised this option.

A few school officials directly refused to participate at this stage, citing that the current state of school funding or low teacher salaries would not permit this additional burden. When this occurred, telephone prompters did not attempt to change the respondent's mind. Instead, after a five-day "cool down" period, CODA sent personalized letters which addressed the particular concerns given by the school. If a completed pre-survey was not received soon thereafter, a follow-up telephone call was made. While this method was effective in some cases, most direct refusers were fairly unyielding in their original decision.

Table 1 summarizes the results of the pre-survey by stratum. A total of 18 schools were identified as ineligible. Completed pre-survey forms were received from 1,098 of the remaining 1,234 schools for an overall response rate of 89.1 percent.

Table 1
Results of Pre-Surveys by Stratum

	Stratum 1	Stratum 2	Stratum 3	TOTAL
TOTAL SURVEYS	**660**	**299**	**293**	**1,252**
Completed	**581**	**276**	**241**	**1,098**
Response Rate	89%	93%	85%	89%
Ineligible	**8**	**1**	**9**	**18**
Closed	4	1	1	6
Pre-K, K Only	0	0	7	7
Sampled Twice	1	0	1	2
Home School	1	0	0	1
Job Corps Center	1	0	0	1
School Does Not Exist	1	0	0	1
Non-Response	**71**	**22**	**43**	**136**
District Level	4	2	5	11
School Level	67	20	38	125

Upon receipt, CODA staff reviewed the pre-survey booklets carefully to ensure that school staff had provided the information needed for sampling teachers. In particular, the following checks were made:

- The address was the same as that found on the original sampling frame (QED);
- The school's enrollment (by grade) was consistent with that reported by QED; and
- The number of teachers listed was consistent with the reported enrollment.

Discrepancies in this information were resolved by a call to the local contact.

Of all the problems detected by this review, a discrepancy between QED's grade range and that reported by the school was the most common. This problem can be illustrated by two examples:

1. Wilson Middle School (grades 7–8) and Wilson High School (grades 9–12) are listed separately in the QED sampling frame. Only the middle school, however, is sampled for the survey. The pre-survey form contains information for grades 7–12. To resolve this problem, CODA re-contacted the school and clarified which information pertained only to the middle school.

2. The converse of this situation occurred as well. For example, if the sampled entity from QED was Wilson School, grades 7–12, but the school provided information

only for the middle school, CODA re-contacted the school and requested additional information (i.e. enrollment, teacher names, and background data) for the high school.

In general, schools were asked to report information in a manner consistent with the way QED reported the grade range. If this was not possible because the QED file was in error or there had been a reorganization at the school, the school's revised grade range was used. In a few cases, the new grade range created a change in school stratum. A list of schools changing stratum as a result of corrected grade ranges was maintained and the appropriate adjustments were made to the base sample weights.

The pre-survey resulted in a file of 16,776 teachers. From this frame, a sample of 6,120 science and mathematics teachers was drawn. The number of teachers sampled per school ranged from 1 to 65.1

Teachers were actually sampled in two separate sample draws in order that late responders to the pre-survey would not hold up the main data collection effort. The first sample, consisting of 16,733 teachers, was drawn in January 1993 and included teachers from 1,055 schools. The second selection was made in March 1993. This draw resulted in a sample 186 teachers from 43 schools.

C. Teacher Survey

During the week of February 8, 1993, CODA staff mailed packets of teacher and program head questionnaires by priority mail to local contacts. (Packets were mailed to the second group of schools during the week of March 22, 1993.) When requested, the packets were sent to district officials. The packets contained:

- Cover letters from CODA and from Kenneth Travers, Director, Division of Research, Evaluation and Dissemination, National Science Foundation.

- A catalog of school supplies available through the redemption of the incentive voucher.

- A School Summary Sheet. This sheet listed the school name, address, ID number, grade range, local contact, program heads, sampled teachers and their subjects, and the potential value of the school's incentive voucher. It provided an area for the local contact to keep track of which individuals had responded to the survey.

- Individual sealed envelopes for each sampled teacher, the science program representative, and the mathematics program representative. Each packet contained:

    - Cover letters from CODA and Kenneth Travers of the National Science Foundation.

- The appropriate version of the questionnaire. The cover of each questionnaire also contained a label identifying the particular class the teacher should consider when answering Sections C and D of the questionnaire.

- List of course codes.

- A postage-paid return envelope.

Many of the individuals designated to respond for the program questionnaires were teachers and, consequently, had been randomly sampled as teachers as well. While these individuals received copies of both questionnaires, they were given a special cover letter which explained why both questionnaires had been included in the packet. The letter alerted these respondents that a number of questions in the program questionnaire could be skipped because they were identical to questions in the teacher questionnaire.

The 1993 National Survey of Science and Mathematics Education was endorsed by the following groups:

- American Federation of Teachers,
- National Catholic Education Association,
- National Council of Teachers of Mathematics,
- National Education Association, and
- National Science Teachers Association.

The endorsements were noted on the covers of the questionnaires. Copies of the letters of endorsement were sent to districts, schools and teachers when a reluctance to participate was encountered.

D. Presidential Award Winners

In conjunction with the 1993 National Survey of Science and Mathematics Education, 1,390 winners of the Presidential Awards for Excellence in the Teaching of Science and Mathematics (from the years 1983 to 1992) were mailed copies of the same versions of the science and mathematics questionnaires. Awardees were not offered any incentive for taking part in the survey. A small number of awardees had also been sampled as part of the main study. These individuals were sent only one copy of the questionnaire, but the resulting data were included in both datasets. A total of 1,127 out of 1,377 eligible Presidential Awardees completed questionnaires, yielding an overall response rate of 81.8 percent.

E. Prompting Respondents

A series of steps was taken to increase the response rate. Four weeks after the first mail-out, teachers and program heads who had not responded were sent a postcard reminder. If no responses had been received from the school, the local contact was called to ensure that the packet had arrived and its contents had been distributed. As a result of this call, remails were made to a number of schools.

In April, new packets of survey materials were remailed directly to all remaining non-respondents. The cover letter emphasized that the end of the data collection period was approaching and that participation would increase the total voucher amount for the school. This mailout was followed by another series of telephone prompts to the individual teachers and program heads. When contact could not be made, prompters left a toll-free number for the teacher to call.

Telephone prompting resulted in a significant number of remails to sampled teachers. While in a few cases the local contact either misplaced the materials or never distributed them, in most other cases it was a matter of the teacher discarding the survey materials or losing them among other paperwork.

Periodically, local school contacts were sent updated school summary sheets, indicating which teachers had returned completed questionnaires. The summary sheet also showed the current value of the school supply voucher vs. the expected value if all sampled teachers and department heads returned questionnaires.

Cases classified as temporary refusals were sent new copies of questionnaires and support material with personalized cover letters and copies of letters from educational organizations that had endorsed the survey. If a questionnaire was not received within 10 days, office staff called the school and tried to speak directly to the teacher to find out if s/he had received the packet and would be participating. If it was not possible to reach the teacher, the caller would leave a message, asking the teacher to call CODA's toll-free "800" number. A log was kept of all incoming calls on the toll-free line.

F. Response Rates

A total of 5,026 out of 5,990 eligible teachers took part in the survey; the response rate was 84 (83.91) percent. Completed program questionnaires were received from 1,940 out of the 2,196 possible, for a response rate of 88 (88.34) percent. Tables 2 and 3 provide response rate breakdowns for program heads and teachers, respectively.

Table 2
Results of Program Questionnaires, by Stratum and Subject

	Sampled	Non-Response	Ineligible	Completed	Response Rate
Stratum 1	**1,162**	**146**	**0**	**1,016**	**87%**
Science	581	0	0	508	87%
Mathematics	581	0	0	508	87%
Stratum 2	**552**	**58**	**0**	**494**	**90%**
Science	276	32	0	244	88%
Mathematics	276	26	0	250	91%
Stratum 3	**482**	**52**	**0**	**430**	**89%**
Science	241	31	0	210	87%
Mathematics	241	21	0	220	91%
TOTAL	**2,196**	**256**	**0**	**1,940**	**88%**

Table 3
Results of Teacher Questionnaires, by Stratum and Subject

	Sampled	Non-Response	Ineligible	Completed	Response Rate
Stratum 1	**3,034**	**502**	**49**	**2,483**	**84%**
Science	1,509	254	23	1,232	83%
Mathematics	1,525	248	26	1,251	84%
Stratum 2	**1,555**	**260**	**40**	**1,255**	**83%**
Science	775	128	20	627	84%
Mathematics	780	132	20	628	83%
Stratum 3	**1,531**	**202**	**41**	**1,288**	**87%**
Science	756	96	23	637	87%
Mathematics	775	106	18	651	86%
TOTAL	**6,120**	**964**	**130**	**5,026**	**84%**

G. Data Retrieval

Survey respondents did not always complete all items in the questionnaire data. A set of guidelines was developed to determine the course of action for varying degrees of missing data. For the pre-survey, two levels of data retrieval were established, Level 1 and Level 2. Level 1 items were those considered crucial for verifying the correctness of the school sampling and the completeness of the teacher and program head sampling frame. Specifically, these items included:

- School grade range;
- Number of students;
- Names of teachers with either their subject area or the grade number of the self-contained class they taught;
- Names of science and mathematics program representatives; and
- Name of local contact.

Level 1 items were retrieved immediately.

Level 2 items were defined as those which did not impact the second phase of data collection. Included were:

- Type of community;
- Number of children receiving Chapter I services;
- Number of children receiving free or reduced-price lunches;
- Percentage of students whose parents fell into various occupational categories; and
- Percentage of students of various racial/ethnic groups.

These items were usually retrieved easily from the local contact during the second phase of the data collection. Information about a school's ethnic breakdown and the percentage of parents in certain occupational categories was less readily available. Near the end of the teacher data collection period, a mailout was made to schools not responding to these questions, asking them to give us their best estimates of the percentages in each category.

Data retrieval was also conducted when information was missing from the program or teacher questionnaires. The following items were data-retrieved for the program questionnaires:

- Missed pages;
- Unclear or missing information for school course offerings;
- Reported grade ranges discrepant with school grade ranges; and
- Designation of mathematics or science courses that students of low, average and high ability would be likely to take in their first year at the school.

For the teacher questionnaire, the following items were data-retrieved:

- Missing pages or sections
- Incomplete textbook titles
- Teacher's class load (or breakdown of time spent on various subjects for teachers in self-contained classrooms). Discrepancies between the information in this item and the information about a particular class were resolved by data retrieval after the pre-survey information was consulted for possible useful information.
- The size of the class randomly sampled for Sections C and D of the questionnaire.

Because individual teachers were difficult to reach by telephone, those whose questionnaires required data retrieval were first sent forms on which they could check off the correct information or clarify their answers. In some cases it was possible to obtain information about the number of classes taught, course names, and class sizes from school office staff.

H. File Preparation

Completed questionnaires were recorded in CODA's receipt system and given a temporary batch number. Next they were routed to editing and coding. Manual edits were used to identify missing information and obvious out-of-range answers, to identify and, if possible, resolve multiple answers, and to make several consistency checks. For example, if a teacher indicated that s/he was responding for a specific class in seventh grade pre-algebra, the editor would check that the course was in the teacher's list of courses and that the teacher indicated seventh graders among the classes of students that s/he taught.

As questionnaires were processed, codes were created for open-ended questions. Many of the answers needing special codes on both the teacher and program questionnaires involved length of class period, the number of times a class met, and the duration of a course. For instance, many schools are experimenting with varying blocks of instruction time and with rotating schedules. These schools did not fit easily into pre-coded answers about the length of a class period and the number of times a week a class was offered.

Questionnaires requiring data retrieval were turned over to appropriate staff for follow-up. Those that were completely coded were given a final batch number and sent to a data entry firm to be keyed. When the keyed data were returned, they were run by batch through a machine-edit program, which checked for missing data, out-of-range answers, adherence to skip patterns, and logical inconsistencies. Corrections were made in the keyed data and on the hardcopy questionnaires.

After the individual batches of questionnaires had been machine-edited, corrected, and, if necessary, flagged for unresolvable problems, frequencies and cross-tabulations were run on each dataset to detect any inconsistencies not captured by the edit program. At the conclusion of this process, the following datasets were delivered to Horizon Research, Inc.:

- A file containing pre-survey data, receipt system information, and QED background information;
- Science program data;
- Mathematics program data;
- Science teacher data;
- Mathematics teacher data;
- Teacher file with receipt system information and background data from QED;
- Presidential Awardee science teacher data;
- Presidential Awardee mathematics teacher data; and
- Presidential Awardee receipt system.

The teacher sampling algorithm resulted in no teachers sampled in 13 small schools. For these schools, one teacher per school was randomly selected with certainty.

Appendix E

Description of Reporting Variables

Description of Reporting Variables

A. Region

Each sample school and teacher was classified as belonging to one of four census regions.

- Midwest: IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI
- Northeast: CT, MA, ME, NH, NJ, NY, PA, RI, VT
- South: AL, AR, DC, DE, FL, GA, KY, LA, MD, MS, NC, SC, TN, VA, WV
- West: AK, AZ, CA, CO, HI, ID, MT, NM, NV, OK, OR, TX, UT, WA, WY

B. Type of Community

Each sample school and teacher was classified as belonging to one of three types of communities.

- Urban: Central city
- Suburban: Area surrounding central city, but still located within the counties constituting a Metropolitan Statistical Area (MSA)
- Rural: Area outside any MSA

C. Grade Range

Teachers were classified by grade range according to the information they provided about their teaching schedule. Most of the analyses in this report used the grade ranges 1–4, 5–8, and 9–12; a teacher who taught classes in more than one grade range was included in both. In contrast, each class was categorized as either grades 1–4, 5–8, or 9–12 based on the grade range information provided by the teacher.

D. Teach Advanced High School Mathematics

High school mathematics teachers who are assigned to teach Algebra II, Algebra III, Pre-Calculus, and/or Calculus were categorized as teaching "advanced" high school mathematics.

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