Chapter Two

Teacher Background and Beliefs

A. Overview

While various reform efforts may focus initially on different parts of the science and mathematics education system, e.g., curriculum, assessment, or in-service teacher education, there is a consensus that having a well-prepared teaching force is essential for effective science and mathematics education. The 2000 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 K–4 are female. In grades 5–8, approximately three-fourths of the science and mathematics teachers are female, compared to about half in grades 9–12.

Blacks, Hispanics, and other minority groups continue to be underrepresented in the science and mathematics teaching force; at a time when minorities constitute roughly 40 percent of the student enrollment,[2] only 9–14 percent of the science and mathematics teachers, depending on subject and grade range, are members of minority groups.

As can also be seen in Table 2.1, the majority of the science and mathematics teaching force is older than 40. 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 about 3 in 10 science and mathematics teachers in each grade range are 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.

[2] Horizon Research, Inc. tabulations of the 1999 Common Core of Data. Original data are available from the National Center for Education Statistics.

Table 2.1
Characteristics of the Science and Mathematics Teaching Force, by Grade Range

	Percent of Teachers											
	Science						Mathematics					
	Grades K–4		Grades 5–8		Grades 9–12		Grades K–4		Grades 5–8		Grades 9–12	
Sex												
Male	8	(1.2)	23	(3.1)	50	(2.1)	4	(1.0)	24	(3.3)	45	(2.0)
Female	92	(1.2)	77	(3.1)	50	(2.1)	96	(1.0)	76	(3.3)	55	(2.0)
Race												
White	88	(1.9)	87	(1.8)	90	(1.2)	90	(1.5)	86	(2.1)	91	(1.1)
Black or African-American	5	(0.9)	5	(1.1)	4	(0.8)	4	(0.8)	8	(1.6)	4	(0.8)
Hispanic or Latino	4	(1.1)	3	(1.0)	3	(0.5)	5	(1.2)	6	(1.4)	2	(0.4)
American Indian or Alaskan Native	1	(0.3)	1	(0.5)	2	(0.5)	1	(0.2)	1	(0.3)	1	(0.3)
Native Hawaiian or Other Pacific Islander	0	(0.1)	0	(0.1)	0	(0.1)	0	(0.1)	0	(0.3)	0	(0.2)
Asian	1	(1.0)	1	(0.6)	2	(0.6)	0	(0.2)	1	(0.6)	1	(0.3)
Age												
≤ 30	20	(2.0)	19	(2.8)	20	(2.5)	21	(2.0)	21	(2.6)	16	(1.4)
31–40	19	(1.8)	22	(3.1)	23	(1.7)	21	(1.9)	23	(2.6)	24	(1.5)
41–50	34	(2.1)	30	(3.1)	29	(1.9)	31	(2.4)	27	(3.0)	29	(2.0)
51 +	27	(1.9)	29	(3.7)	28	(1.7)	27	(2.4)	30	(3.4)	30	(1.7)
Experience												
0–2 years	14	(1.6)	16	(2.7)	16	(2.2)	18	(1.9)	20	(3.2)	13	(1.4)
3–5 years	17	(1.6)	9	(1.5)	16	(1.7)	13	(1.5)	12	(1.8)	15	(1.6)
6–10 years	16	(1.8)	19	(2.6)	18	(1.4)	14	(1.6)	16	(2.4)	14	(1.5)
11–20 years	27	(1.9)	24	(3.3)	21	(1.6)	26	(2.0)	21	(2.5)	24	(1.7)
≥ 21 years	26	(2.4)	32	(3.1)	29	(1.7)	29	(2.4)	31	(3.3)	34	(2.0)
Master's Degree												
Yes	41	(2.7)	50	(3.0)	57	(2.3)	41	(2.6)	44	(3.7)	51	(2.2)
No	59	(2.7)	50	(3.0)	43	(2.3)	59	(2.6)	56	(3.7)	49	(2.2)

About 40 percent of the teachers in grades K–4 have earned a degree beyond the Bachelor's, increasing to roughly 45 percent in grades 5–8 and 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 2.2, only 19 percent of the grade K–12 science teachers with two or fewer years prior teaching experience have Master's Degrees, compared to 64 percent of those with more than 20 years prior teaching experience.

Table 2.2
Science and Mathematics Teachers with Degrees Beyond the Bachelor's, by Prior Years Teaching Experience

	Percent of Teachers			
	Science		Mathematics	
0–2 Years	19	(3.6)	20	(4.2)
3–5 Years	30	(4.4)	36	(4.4)
6–10 Years	42	(4.6)	41	(4.1)
11–20 Years	46	(3.5)	45	(3.6)
≥ 21 Years	64	(3.8)	58	(3.1)

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.

Since 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 2.3 shows that very few grade K–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 K–4 colleagues to have undergraduate majors in science or mathematics, a majority still had majors in education.

Table 2.3
Teachers' Undergraduate Majors in Science and Mathematics, by Grade Range*

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Science Teachers						
Science	2	(0.7)	11	(1.4)	81	(2.0)
Science Education	2	(0.6)	5	(1.1)	6	(0.9)
Other Education	86	(1.9)	74	(3.1)	6	(1.5)
Other Fields	11	(1.7)	10	(2.5)	7	(1.0)
Mathematics Teachers						
Mathematics	0	(0.1)	9	(1.3)	58	(2.1)
Mathematics Education	0	(0.2)	6	(0.9)	21	(2.0)
Other Education	91	(1.6)	72	(2.7)	10	(1.4)
Other Fields	9	(1.6)	14	(2.5)	10	(1.2)

* These data should be interpreted with caution. When asked to specify the subject(s) of their degrees, approximately 10 percent of teachers indicated they had undergraduate majors in three or more fields. These teachers were excluded from these analyses.

Grade 9–12 science teachers were much more likely to have majored in a science discipline (81 percent) than in science education (6 percent). The comparable figures for mathematics teachers were 58 percent mathematics majors and 21 percent mathematics education majors. While the percentages of teachers with major in field are greater for grades 9–12 than for the lower grades, roughly 1 out of 10 high school science teachers and 2 out of 10 high school mathematics teachers did not major in their fields.

Tables 2.4, 2.5, and 2.6 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 2.4 shows the percentages of grade K–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 6.1 for grades K–4 to 18.2 for grades 9–12.

Table 2.4
Number of Semesters* of College Coursework in Science, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Fewer than 6 Semesters	56	(2.2)	41	(3.9)	0	(0.2)
6–10 Semesters	30	(2.3)	33	(3.8)	8	(1.9)
11–14 Semesters	6	(1.6)	10	(1.7)	17	(1.4)
15–20 Semesters	5	(1.1)	10	(1.5)	46	(2.2)
More than 20 Semesters	2	(0.5)	5	(1.0)	29	(1.9)
Average Number of Semesters	6.1	(0.2)	8.5	(0.3)	18.2	(0.3)

* The highest number of courses a teacher could indicate for each of the four categories—life science, chemistry, physics/physical science, and earth/space science—was "> 8," and 9 was used as the number of courses in those cases. As a result, these figures underestimate the total for any teacher who completed more than eight courses in a particular category.

As can be seen in Table 2.5, 91 percent of the grade K–4 science teachers have had at least one college course in the life sciences. Most have had coursework in earth science (83 percent), science education (77 percent), and physics/physical science (61 percent), while roughly 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 (96 percent), earth sciences (84 percent), science education (79 percent), physics/physical science (69 percent), and chemistry (67 percent).

Table 2.5
Number of Semesters Completed by Science Teachers in Various Course Categories

	Percent of Teachers							
	Zero Semesters		1–2 Semesters		3–5 Semesters		6 or More Semesters	
Grades K–4								
Life sciences	9	(1.5)	62	(2.6)	20	(2.1)	9	(1.5)
Chemistry	49	(2.3)	42	(2.3)	7	(1.2)	2	(0.5)
Physics/physical science	39	(2.4)	50	(2.6)	10	(1.6)	1	(0.6)
Earth/space science	17	(1.6)	53	(2.3)	25	(1.8)	4	(1.0)
Science education	23	(2.6)	55	(2.9)	16	(1.7)	6	(1.1)
Grades 5–8								
Life sciences	4	(1.1)	53	(3.4)	23	(2.7)	20	(2.3)
Chemistry	33	(3.7)	47	(3.6)	15	(1.6)	5	(1.0)
Physics/physical science	31	(2.7)	54	(2.8)	11	(1.8)	4	(0.8)
Earth/space science	16	(2.4)	48	(3.5)	28	(3.1)	7	(1.3)
Science education	21	(2.7)	51	(3.8)	19	(2.6)	10	(1.5)
Grades 9–12								
Life sciences	7	(1.0)	13	(2.0)	13	(1.1)	67	(2.1)
Chemistry	3	(0.5)	18	(1.7)	39	(2.1)	41	(2.1)
Physics/physical science	7	(0.9)	40	(2.2)	26	(1.7)	28	(1.9)
Earth/space science	23	(2.6)	32	(1.6)	26	(1.7)	18	(1.5)
Science education	20	(2.3)	31	(2.1)	24	(1.6)	25	(1.6)

Almost all high school science teachers have had at least one course in chemistry (97 percent), biology/life science (93 percent), and physics or physical science (93 percent). Somewhat fewer have had coursework in earth/space science (77 percent) or science education (80 percent). The most frequently cited courses, each completed by a majority of high school science teachers are general chemistry, introductory biology, general physics, botany, cell biology, ecology, zoology, organic chemistry, anatomy/physiology, genetics, life science, and microbiology. (See Table 2.6.)

Table 2.6
Middle and High School Science Teachers
Completing Various College Courses, by Grade Range

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
General methods of teaching	98	(0.6)	90	(2.0)
Methods of teaching science	78	(2.9)	76	(2.6)
Instructional uses of computers/other technologies	49	(3.8)	48	(2.3)
Supervised student teaching in science	41	(3.9)	69	(2.4)
General/introductory chemistry	64	(3.8)	95	(0.9)
Analytical chemistry	5	(0.9)	43	(2.0)
Organic chemistry	13	(1.6)	73	(1.8)
Physical chemistry	7	(1.3)	31	(1.9)
Quantum chemistry	0	(0.2)	7	(0.7)
Biochemistry	8	(1.4)	39	(2.0)
Other chemistry	7	(1.5)	25	(1.6)
Introductory earth science	59	(2.8)	36	(2.2)
Astronomy	24	(3.1)	34	(1.8)
Geology	32	(2.8)	45	(2.3)
Meteorology	8	(1.3)	20	(1.7)
Oceanography	9	(1.7)	18	(1.5)
Physical geography	28	(3.2)	18	(1.6)
Environmental science	30	(3.1)	41	(2.2)
Agricultural science	3	(0.7)	7	(0.9)
Introductory biology/life science	88	(1.9)	85	(1.6)
Botany, plant physiology	25	(2.6)	62	(2.3)
Cell biology	15	(2.0)	52	(2.3)
Ecology	20	(2.4)	53	(2.3)
Entomology	6	(1.5	19	(1.5)
Genetics, evolution	12	(1.4)	61	(2.2)
Microbiology	15	(2.0)	51	(2.2)
Anatomy/Physiology	22	(2.6)	60	(2.1)
Zoology, animal behavior	20	(2.2)	56	(2.3)
Other life science	21	(2.9)	53	(2.1)
Physical science	47	(3.2)	45	(2.4)
General/introductory physics	32	(3.3)	82	(1.6)
Electricity and magnetism	6	(1.1)	29	(2.4)
Heat and thermodynamics	5	(1.1)	23	(2.1)
Mechanics	2	(0.5)	26	(2.4)
Modern or quantum physics	1	(0.2)	14	(1.3)
Nuclear physics	1	(0.4)	11	(1.1)
Optics	1	(0.4)	15	(2.0)
Solid state physics	2	(0.9)	6	(0.9)
Other physics	3	(0.8)	17	(1.4)
History of science	6	(1.5)	17	(1.6)
Philosophy of science	4	(1.0)	14	(1.3)
Science and society	7	(1.7)	15	(1.3)
Electronics	1	(0.4)	7	(1.0)
Engineering (any)	1	(0.3)	9	(1.1)
Integrated science	7	(1.5)	5	(0.8)
Computer programming	15	(3.0)	28	(2.2)
Other computer science	19	(3.2)	20	(1.6)

The National Science Teachers Association (NSTA) has recommended that for the preparation of elementary and middle school science teachers in addition to coursework in science education, "conceptual content should be balanced among life, earth/space, physical, and environmental science, including natural resources" (National Science Teachers Association, 1998). Using completion of a college course as a proxy for competency, Table 2.7 shows that 52 percent of the science teachers in grades K–4, and 63 percent in grades 5–8 meet those standards, while another 11 percent meet the science coursework standard, but lack a course in science education.

Table 2.7
Science Teachers Meeting NSTA
Course-Background Standards, by Grade Range

	Percent of Teachers			
	Grades K–4		Grades 5–8	
Coursework in each science discipline plus science education	52	(3.0)	63	(2.5)
Lack science education only	11	(1.9)	11	(1.9)
Lack one science discipline	25	(2.2)	17	(2.1)
Lack two science disciplines	9	(1.4)	9	(2.2)
Lack three science disciplines	3	(0.7)	0	(0.2)

At the high school level, NSTA's recommendations are very detailed and extensive, including lists of specific concepts in which teachers of each discipline should be competent. Because very few teachers, even those with considerable coursework in the field, meet the very specific NSTA requirements, analyses of data from the 2000 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 2.8, there is considerable variation in extent of teacher preparation for the various science subjects taught at the secondary level. For example, 85 percent of secondary life science classes are taught by teachers who have taken six or more semesters of college biology, but only 39 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 90 percent or more of 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 grade 7–12 earth science and physical science classes are taught by teachers who have not had in-depth preparation in any science discipline.

Table 2.8
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	85	(2.5)	3	(1.2)	12	(2.2)
Earth science	39	(5.2)	36	(5.5)	24	(5.6)
Physical science	67	(6.8)	11	(2.9)	22	(7.2)
Grades 9–12						
Biology	94	(1.8)	1	(0.8)	4	(1.6)
Chemistry	74	(4.2)	17	(3.3)	9	(2.8)
Physics	64	(5.8)	26	(5.4)	10	(3.7)
Earth science	58	(6.1)	34	(5.4)	8	(3.7)

Most prospective secondary school science teachers are prepared to teach one discipline, typically 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 2.9, this situation is particularly prevalent in rural schools, where 48 percent of the teachers teach courses in two or more science disciplines.

Table 2.9
Grade 7–12 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	67	(2.4)	73	(4.7)	70	(3.0)	52	(6.0)
Two Subjects	28	(2.3)	21	(3.7)	27	(2.8)	39	(5.9)
Three or More Subjects	5	(1.6)	5	(4.5)	3	(1.8)	9	(3.0)

Turning to mathematics, the 2000 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 backgrounds in mathematics than do their colleagues in the lower grades. For example, as can be seen in Table 2.10, 94 percent of grade 9–12 mathematics teachers have had at least eight semesters of coursework in mathematics, compared to 29 percent of those teaching in grades K–4. It is interesting to note that while only 52 percent of grade 5–8 mathematics teachers have had eight or more semesters of college mathematics, 67 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 2.10
Number of Semesters* of College Coursework in Mathematics, by Teachers and Classes, and by Grade Range

	Percent of Teachers						Percent of Classes					
	Grades K–4		Grades 5–8		Grades 9–12		Grades K–4		Grades 5–8		Grades 9–12	
Fewer than 4 Semesters	24	(2.0)	13	(2.5)	2	(0.8)	24	(1.9)	8	(1.5)	1	(0.4)
4–7 Semesters	46	(2.4)	35	(2.7)	4	(0.8)	45	(2.4)	26	(2.2)	4	(0.9)
8–11 Semesters	20	(2.0)	26	(2.8)	12	(1.6)	21	(2.1)	25	(2.3)	12	(1.3)
More than 11 Semesters	9	(1.5)	26	(2.2)	82	(1.8)	10	(1.7)	42	(2.6)	84	(1.5)

* The highest number of courses a teacher could indicate for each of the four categories—calculus, statistics, advanced calculus, and "all other mathematics courses"—was "> 8," and 9 was used as the number of courses in those cases. As a result, these figures underestimate the total for any teacher who completed more than eight courses in a particular category.

As can be seen in Table 2.11, the vast majority of grade K–4 teachers have had college coursework in mathematics for elementary school teachers and in mathematics education. Far fewer have had college coursework in algebra, probability and statistics, or geometry, areas that the National Council of Teachers of Mathematics suggests should be addressed beginning in the primary grades (National Council of Teachers of Mathematics, 2000).

Table 2.11
Grade K–4 Mathematics Teachers Completing Various College Courses

	Percent of Teachers	
Mathematics for elementary school teachers	96	(1.0)
Mathematics education	94	(1.1)
College algebra/trigonometry/elementary functions	42	(2.2)
Probability and statistics	33	(2.5)
Applications of mathematics/problem solving	21	(1.9)
Geometry for elementary/middle school teachers	21	(1.5)
Calculus	12	(1.7)

Table 2.12 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, applications of mathematics/problem solving, and history of mathematics (National Council of Teachers of Mathematics, 1998). Percentages of grade 5–8 teachers having completed these courses range from 51 percent for probability and statistics to 11 percent for history of mathematics.

In contrast, the 2000 Survey found that high school mathematics teachers have relatively strong content backgrounds. The majority has had college coursework in calculus (96 percent); college algebra (80 percent); geometry (82 percent); probability and statistics (86 percent); linear algebra

(81 percent); abstract algebra (64 percent); advanced calculus (70 percent); differential equations (65 percent); other upper division mathematics (59 percent); and number theory (56 percent). The only three NCTM-recommended areas where fewer than half of high school mathematics teachers had coursework were applications of mathematics/problem-solving (37 percent), discrete mathematics (37 percent) and history of mathematics (42 percent).

Table 2.12
Middle and High School Mathematics Teachers
Completing Various College Courses, by Grade Range

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
Mathematics for middle school teachers	28	(2.8)	26	(1.9)
Geometry for elementary/middle school teachers	28	(2.4)	17	(1.6)
College algebra/trigonometry/elementary functions	56	(3.5)	80	(1.5)
Calculus	31	(2.5)	96	(0.9)
Advanced calculus	13	(1.5)	70	(2.0)
Real analysis	6	(1.0)	38	(2.0)
Differential equations	12	(1.5)	65	(2.0)
Geometry	37	(3.2)	82	(1.3)
Probability and statistics	51	(3.5)	86	(1.7)
Abstract algebra	12	(1.3)	64	(2.0)
Number theory	20	(2.6)	56	(2.1)
Linear algebra	16	(1.8)	81	(1.6)
Applications of mathematics/problem solving	23	(2.2)	37	(1.7)
History of mathematics	11	(1.5)	42	(1.9)
Discrete mathematics	7	(0.9)	37	(1.7)
Other upper division mathematics	17	(2.0)	59	(1.9)
Biological sciences	71	(2.9)	49	(2.1)
Chemistry	40	(3.3)	47	(2.0)
Physics	26	(2.8)	52	(2.1)
Physical science	49	(3.4)	23	(2.0)
Earth/space science	42	(3.6)	20	(1.8)
Engineering (any)	4	(0.9)	15	(1.5)
Computer programming	29	(2.8)	63	(2.1)
Other computer science	28	(3.2)	28	(2.1)
Computer programming/other computer science	47	(3.1)	68	(2.0)
General methods of teaching	93	(1.5)	90	(1.2)
Methods of teaching mathematics	80	(2.6)	77	(2.2)
Instructional uses of computers/other technologies	44	(3.8)	43	(2.2)
Supervised student teaching in mathematics	42	(3.8)	70	(2.0)

As can be seen in Table 2.13, 28 percent of grade 5–8 mathematics teachers have not had any of the 6 recommended mathematics courses; only 6 percent have had at least 5 of the 6. Just over a third of all high school mathematics teachers had completed at least 9 of the 11 recommended courses; another 45 percent had completed 6, 7, or 8 of these courses.

Table 2.13
Mathematics Teachers Completing NCTM-Recommended College Mathematics Courses, by Grade Range

	Percent of Teachers			
	Grades 5–8		Grades 9–12	
Recommended for Middle/Junior High School Teachers				
No Courses	28	(3.1)	1	(0.7)
1–2 Courses	47	(3.6)	10	(1.4)
3–4 Courses	20	(1.9)	48	(2.1)
5-6 Courses	6	(0.9)	40	(2.0)
Recommended for High School Teachers				
0–1 Courses	40	(3.2)	2	(0.8)
2–5 Courses	45	(3.2)	17	(1.9)
6–8 Courses	11	(1.4)	45	(2.1)
9–10 Courses	4	(0.6)	28	(1.8)
11 Courses	1	(0.1)	7	(1.3)

There is evidence, however, that students who take lower-level mathematics classes at the high school level are not as likely to get the benefits of having well-prepared teachers. For example, Table 2.14 shows the percentage of high school mathematics teachers who have completed each of a number of college mathematics classes, comparing those who do and do not teach advanced mathematics courses (Algebra II or higher). Note that much larger percentages of teachers who are assigned to advanced classes have taken coursework in a number of these areas. For example, among high school teachers assigned only to lower-level mathematics courses, 54 percent have had coursework in abstract algebra, compared to 72 percent of those who teach at least one advanced mathematics course.

Table 2.14
Grade 9–12 Mathematics Teachers Completing Various College Courses, by Teaching Assignment

	Percent of Teachers			
	Teaching No Advanced Courses		Teaching One or More Advanced Courses	
Calculus	92	(1.9)	99	(0.6)
Advanced calculus	57	(3.3)	79	(2.2)
Differential equations	58	(3.2)	70	(2.5)
Geometry	80	(2.4)	84	(1.6)
Probability and statistics	82	(3.3)	89	(1.3)
Abstract algebra	54	(3.1)	72	(2.7)
Number theory	51	(3.5)	60	(2.3)
Linear algebra	75	(3.2)	86	(1.7)
Applications of mathematics/problem solving	35	(3.0)	38	(2.6)
History of mathematics	39	(3.0)	44	(2.5)
Discrete mathematics	31	(2.8)	42	(2.1)
Other upper division mathematics	52	(2.7)	65	(2.6)
Computer programming	57	(3.1)	67	(2.4)
Instructional uses of computers/other technologies	40	(3.0)	46	(3.1)

Policymakers have begun to include two-year community colleges in their thinking about improving pre-service teacher preparation. Accordingly, the 2000 National Survey asked teachers to indicate where they had taken their science and mathematics courses. Roughly one-fourth of the teachers in each subject/grade range took one or more of these courses at a two-year college. At the same time, as shown in Table 2.15, most teachers completed a majority of their undergraduate science/mathematics courses at a four-year college or university. On the average, grade K–4 and 5–8 science teachers took nearly 90 percent of their undergraduate science courses at a four-year college or university. Grade 9–12 science teachers took 95 percent of their undergraduate science courses at a four-year institution. The pattern is nearly identical for mathematics teachers.

Table 2.15
Average Percentage of Undergraduate Science/Mathematics Courses Teachers Completed in Their Field at Two- and Four-Year Institutions, by Grade Range

	Average Percent of Courses in Field					
	Grades K–4		Grades 5–8		Grades 9–12	
Science Teachers						
Two-year college/community college/technical school	12	(1.4)	13	(2.6)	5	(0.5)
Four-year college/university	88	(1.4)	87	(2.6)	95	(0.5)
Mathematics Teachers						
Two-year college/community college/technical school	12	(1.2)	12	(1.9)	6	(0.8)
Four-year college/university	88	(1.2)	88	(1.9)	94	(0.8)

D. Teacher Pedagogical Beliefs

The National Council of Teachers of Mathematics (NCTM) originally published *Curriculum and Evaluation Standards* in 1989, followed by *Principles and Standards for School Mathematics* in 2000. In science, the National Research Council (NRC) released the *National Science Education Standards* in 1996. As one measure of the influence of the *Standards*, teachers in the 2000 National Survey of Science and Mathematics Education were asked the extent of their familiarity with each of these documents. Science teachers as a whole are much less likely to be familiar with the NRC *Standards* than mathematics teachers are with the NCTM *Standards*. As can be seen in Table 2.16, high school and middle school science teachers (62 and 58 percent, respectively) are more likely to be familiar with the *Standards* than are elementary school science teachers (33 percent). In each grade range, roughly 70 percent of the science teachers familiar with the national standards agree with their vision and indicate that they are implementing their recommendations at least to a moderate extent.

Table 2.16
Science Teachers' Familiarity with, Agreement with, and Implementation of the NRC *Standards*, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Familiarity with NRC *Standards*						
Not at all familiar	67	(2.2)	42	(3.7)	37	(2.0)
Somewhat familiar	22	(1.8)	31	(3.0)	34	(2.2)
Fairly familiar	9	(1.3)	19	(2.4)	18	(1.4)
Very familiar	2	(0.5)	8	(1.6)	10	(1.1)
Extent of agreement with NRC *Standards***						
Strongly disagree	0	(0.4)	0	--*	0	(0.2)
Disagree	4	(2.0)	5	(2.3)	7	(1.6)
No Opinion	26	(3.7)	27	(4.1)	22	(2.3)
Agree	61	(4.1)	62	(4.4)	65	(2.9)
Strongly Agree	8	(2.4)	6	(2.0)	5	(0.9)
Extent to which recommendations have been implemented**						
Not at all	5	(1.9)	4	(2.1)	4	(1.1)
To a minimal extent	26	(3.9)	22	(5.1)	28	(2.3)
To a moderate extent	57	(4.1)	51	(5.3)	56	(2.5)
To a great extent	12	(2.5)	23	(4.5)	12	(1.6)

* No teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.
** These analyses included only those teachers indicating they were at least somewhat familiar with the *Standards.*

As can be seen in Table 2.17, 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 NCTM *Standards*. Sixty-two percent of elementary mathematics teachers, 73 percent of the middle grade mathematics teachers, and 85 percent of the high school mathematics teachers indicated they were at least "somewhat familiar" with the *Standards*.

Table 2.17
Mathematics Teachers' Familiarity with, Agreement with, and Implementation of the NCTM *Standards*, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Familiarity with NCTM *Standards*						
Not at all familiar	38	(2.9)	27	(3.0)	15	(1.5)
Somewhat familiar	31	(2.4)	24	(3.1)	31	(1.8)
Fairly familiar	21	(2.0)	30	(2.7)	35	(1.8)
Very familiar	10	(1.5)	19	(2.1)	19	(1.3)
Extent of agreement with NCTM *Standards**						
Strongly Disagree	0	(0.2)	0	(0.2)	0	(0.2)
Disagree	1	(0.4)	3	(0.9)	6	(1.0)
No Opinion	20	(2.2)	20	(3.4)	19	(2.0)
Agree	69	(2.7)	61	(3.7)	66	(2.5)
Strongly Agree	10	(1.9)	16	(3.7)	8	(1.1)
Extent to which recommendations have been implemented*						
Not at all	2	(1.0)	0	(0.1)	3	(1.0)
To a minimal extent	16	(2.1)	17	(3.0)	23	(2.2)
To a moderate extent	56	(3.5)	59	(3.1)	57	(2.6)
To a great extent	26	(2.8)	25	(3.1)	17	(1.8)

* These analyses included only those teachers indicating they were at least somewhat familiar with the *Standards.*

Further, those teachers who indicated they were familiar with the *Standards* were asked to indicate the extent to which they agreed with the national standards and the extent to which they have implemented the *Standards* in their teaching. Regardless of grade level, approximately 75 percent of the mathematics teachers familiar with the NCTM *Standards* indicated they agreed with that vision of mathematics education. Similarly, roughly three-fourths of the mathematics teachers at each grade level who were familiar with the NCTM *Standards* indicated they have implemented the *Standards* at least to a moderate extent.

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 all of these subjects. Table 2.18 shows self-contained elementary (grade K–6) teachers' perceptions of their qualifications to teach reading/language arts, social studies, mathematics, and science. Seventy-six percent of the elementary teachers assigned to teach all four subjects indicated they felt very well qualified to teach reading/language arts, compared to 60 percent for mathematics and 52 percent for social studies. Only 18–29 percent of the elementary teachers feel very well qualified to teach physical science, earth science, and life science.

Table 2.18
Elementary Teachers' Perceptions of
Their Qualifications to Teach Each Subject

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Life Science	10	(0.9)	61	(1.7)	29	(1.7)
Earth Science	11	(1.1)	64	(1.5)	25	(1.4)
Physical Science	21	(1.6)	61	(1.7)	18	(1.1)
Mathematics	1	(0.4)	39	(1.5)	60	(1.6)
Reading/Language Arts	1	(0.3)	23	(1.5)	76	(1.6)
Social Studies	4	(0.6)	44	(1.8)	52	(1.8)

Tables 2.19 and 2.20 provide more detailed data on middle and high school science teachers' perceptions of their qualifications to teach each of a number of subjects in their particular grade levels. Middle school teachers (defined here as those in non-self-contained classes in grades 5–8) tend to feel more qualified to teach science process and inquiry skills and topics related to earth science, environmental science, and biology at their grade level and less well qualified to teach topics in chemistry and physics.

Table 2.19
Middle School Science Teachers' Perceptions of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Qualified		Adequately Qualified		Very Well Qualified	
Earth science						
Earth's features and physical processes	10	(2.4)	51	(3.8)	38	(3.8)
The solar system and the universe	11	(2.2)	52	(4.0)	37	(3.9)
Climate and weather	15	(3.3)	53	(4.2)	32	(3.7)
Biology						
Structure and function of human systems	9	(2.1)	41	(3.8)	50	(3.9)
Plant biology	11	(2.5)	44	(3.8)	45	(3.5)
Animal behavior	11	(2.5)	45	(4.1)	45	(3.8)
Interactions of living things/ecology	6	(1.9)	41	(3.9)	53	(4.0)
Genetics and evolution	27	(3.9)	45	(3.9)	28	(2.7)
Chemistry						
Structure of matter and chemical bonding	26	(3.5)	45	(4.0)	29	(3.4)
Properties and states of matter	16	(3.4)	38	(3.7)	45	(3.7)
Chemical reactions	24	(3.6)	48	(4.2)	28	(3.5)
Energy and chemical change	24	(3.7)	50	(4.0)	26	(3.1)
Physics						
Forces and motion	24	(3.9)	51	(4.0)	25	(3.2)
Energy	19	(3.2)	56	(3.8)	25	(3.2)
Light and sound	30	(3.7)	48	(3.9)	22	(3.2)
Electricity and magnetism	28	(3.3)	52	(4.1)	20	(3.1)
Modern physics (e.g., special relativity)	63	(3.6)	30	(3.2)	7	(2.1)
Environmental and resource issues						
Pollution, acid rain, global warming	10	(2.0)	46	(3.7)	44	(3.6)
Population, food supply and production	14	(2.9)	46	(3.6)	40	(3.8)
Science process/inquiry skills						
Formulating hypotheses, drawing conclusions, making generalizations	5	(2.1)	38	(4.3)	57	(4.5)
Experimental design	15	(3.3)	43	(3.9)	42	(4.1)
Describing, graphing, and interpreting data	7	(2.2)	40	(4.1)	53	(4.1)

High school science teachers (defined here as those in non-self-contained classes in grades 9–12) show more variation in their preparedness to teach different subjects, most likely attributable to the fact that most high school science teachers specialize in one subject. As with middle school teachers, high school science teachers are most likely to feel at least adequately qualified to teach science process and inquiry skills.

Table 2.20
High School Science Teachers' Perceptions of
Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Qualified		Adequately Qualified		Very Well Qualified	
Earth science						
Earth's features and physical processes	26	(1.8)	50	(2.5)	24	(1.9)
The solar system and the universe	32	(2.0)	42	(2.4)	26	(1.9)
Climate and weather	29	(1.7)	51	(2.1)	20	(1.5)
Biology						
Structure and function of human systems	20	(1.7)	22	(1.9)	58	(2.4)
Plant biology	24	(1.8)	30	(2.2)	46	(2.4)
Animal behavior	24	(1.9)	28	(2.0)	49	(2.4)
Interactions of living things/ecology	18	(1.6)	24	(2.0)	58	(2.3)
Genetics and evolution	20	(1.7)	24	(1.8)	55	(2.3)
Chemistry						
Structure of matter and chemical bonding	7	(0.9)	37	(2.0)	55	(2.0)
Properties and states of matter	6	(0.8)	33	(1.9)	61	(2.0)
Chemical reactions	12	(1.2)	37	(2.0)	51	(2.1)
Energy and chemical change	13	(1.2)	36	(2.0)	52	(2.0)
Physics						
Forces and motion	24	(1.8)	39	(1.7)	37	(2.1)
Energy	23	(1.7)	41	(1.8)	36	(2.2)
Light and sound	30	(1.9)	38	(2.1)	32	(2.1)
Electricity and magnetism	40	(1.7)	34	(1.8)	26	(2.1)
Modern physics (e.g., special relativity)	56	(2.0)	28	(1.9)	16	(2.2)
Environmental and resource issues						
Pollution, acid rain, global warming	10	(1.1)	45	(2.5)	45	(2.3)
Population, food supply and production	15	(1.4)	42	(2.1)	43	(2.1)
Science process/inquiry skills						
Formulating hypotheses, drawing conclusions, making generalizations	1	(0.6)	24	(1.8)	74	(1.9)
Experimental design	6	(1.2)	33	(1.9)	61	(1.8)
Describing, graphing, and interpreting data	3	(0.8)	26	(1.9)	72	(2.0)

Based on the results of a factor analysis, the items in Tables 2.20 were combined into seven content preparedness composite variables. (Definitions of all composite variables, descriptions of how they were created, and reliability information are included in Appendix E.) Each composite has a minimum possible score of 0 and a maximum possible score of 100. Table 2.21 shows the mean content composite scores for all high school science teachers, for those responsible for teaching that subject, and for those not teaching that subject.

Not surprisingly, those assigned to teach physics feel much more qualified to teach physics topics than those not assigned to this course (with mean composite scores of 82 and 55, respectively). The same pattern holds true for most of the science areas, including biology, chemistry, and earth science. In contrast, teachers of environmental science, integrated science, and physical science do not feel more qualified to teach their subject than science teachers as a whole.

Table 2.21
Content Preparedness Composite
Scores of High School Science Teachers

	Mean Score			
	Teach Subject		Do Not Teach Subject	
Chemistry	90	(1.2)	70	(1.1)
Biology/Life science	84	(1.4)	60	(1.6)
Physics	82	(3.1)	55	(1.1)
Earth science	81	(1.5)	63	(0.9)
Environmental science	73	(2.8)	68	(0.9)
Physical science	66	(3.3)	60	(1.0)
Integrated/general science	64	(1.4)	62	(0.9)

Mathematics teachers were also given a list of 16 mathematics topics recommended by the NCTM *Principles and Standards for School Mathematics* (NCTM, 2000), the updated version of the mathematics standards, 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 2.22, a majority of middle school teachers feel very well qualified to teach each of eight topics: computation (90 percent); estimation (83 percent); measurement (81 percent); numeration and number theory (76 percent); pre-algebra (75 percent); patterns and relationships (73 percent); geometry and spatial sense (57 percent); and data collection and analysis (56 percent). Nearly that many feel very well qualified to teach algebra (49 percent) and probability (46 percent). Relatively few feel very well qualified to teach functions and pre-calculus concepts (19 percent); statistics (18 percent); technology in support of mathematics (18 percent); topics from discrete mathematics (8 percent); mathematical structures (6 percent); or calculus (4 percent).

As can be seen in Table 2.23, a majority of the high school mathematics teachers feel very well qualified to teach each of 9 out of the 16 topics listed, ranging from 94 percent for algebra and pre-algebra to 61 percent for functions and pre-calculus concepts. In contrast, only about one-quarter of the high school mathematics teachers feel very well qualified to teach statistics; calculus; and technology in support of mathematics. Even fewer feel very well qualified to teach mathematical structures or topics from discrete mathematics (12 and 16 percent, respectively).

Table 2.22
Middle School Mathematics Teachers' Perceptions of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Numeration and number theory	1	(0.5)	23	(3.4)	76	(3.5)
Computation	0	(0.1)	10	(1.9)	90	(1.9)
Estimation	0	(0.1)	17	(2.8)	83	(2.8)
Measurement	1	(0.5)	18	(2.9)	81	(2.9)
Pre-algebra	2	(0.9)	22	(3.8)	75	(3.9)
Algebra	11	(2.1)	40	(3.9)	49	(3.6)
Patterns and relationships	1	(0.5)	26	(3.7)	73	(3.7)
Geometry and spatial sense	3	(0.8)	41	(4.2)	57	(4.3)
Functions (including trigonometric functions) and pre-calculus concepts	50	(3.9)	32	(3.4)	19	(2.2)
Data collection and analysis	3	(0.7)	41	(3.4)	56	(3.5)
Probability	5	(1.2)	50	(3.1)	46	(2.9)
Statistics (e.g., hypothesis tests, curve fitting and regression)	41	(4.1)	41	(4.2)	18	(2.3)
Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)	62	(4.0)	30	(4.1)	8	(1.8)
Mathematical structures (e.g., vector spaces, groups, rings, fields)	68	(4.0)	26	(4.0)	6	(1.6)
Calculus	78	(2.4)	18	(2.4)	4	(0.9)
Technology (calculators, computers) in support of mathematics	34	(3.7)	48	(4.4)	18	(2.5)

Table 2.23
High School Mathematics Teachers' Perceptions of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Numeration and number theory	6	(0.7)	30	(2.1)	64	(2.2)
Computation	1	(0.2)	11	(1.4)	88	(1.5)
Estimation	1	(0.2)	14	(1.6)	85	(1.7)
Measurement	1	(0.2)	14	(1.7)	85	(1.7)
Pre-algebra	1	(0.2)	5	(1.0)	94	(1.1)
Algebra	0	(0.2)	5	(1.1)	94	(1.1)
Patterns and relationships	1	(0.3)	24	(1.9)	75	(2.0)
Geometry and spatial sense	4	(0.8)	26	(2.0)	70	(2.3)
Functions (including trigonometric functions) and pre-calculus concepts	6	(0.9)	34	(2.0)	61	(2.0)
Data collection and analysis	9	(1.1)	45	(2.5)	46	(2.5)
Probability	10	(1.2)	48	(1.9)	42	(2.0)
Statistics (e.g., hypothesis tests, curve fitting and regression)	23	(1.6)	51	(2.2)	26	(2.0)
Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)	43	(1.8)	41	(1.7)	16	(1.5)
Mathematical structures (e.g., vector spaces, groups, rings, fields)	47	(2.1)	41	(1.9)	12	(1.4)
Calculus	39	(1.9)	36	(2.0)	24	(1.8)
Technology (calculators, computers) in support of mathematics	23	(1.9)	48	(2.1)	29	(2.1)

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 2.24, the difference is particularly large for functions and pre-calculus concepts; 73 percent of the teachers assigned to one or more advanced high school mathematics classes, but only 41 percent of those who do not teach advanced classes, feel well qualified to teach this topic.

Table 2.24
High School Mathematics Teachers Considering Themselves Well Qualified to Teach Each of a Number of Subjects, by Teaching Assignment

	Percent of Teachers			
	Teaching No Advanced Courses		Teaching One or More Advanced Courses	
Pre-algebra	94	(1.2)	94	(1.6)
Algebra	92	(1.6)	95	(1.6)
Computation	85	(2.4)	90	(1.8)
Estimation	85	(2.1)	85	(2.0)
Measurement	83	(2.5)	87	(2.0)
Patterns and relationships	69	(3.0)	79	(2.3)
Geometry and spatial sense	67	(3.2)	72	(2.9)
Numeration and number theory	61	(3.1)	67	(2.6)
Data collection and analysis	42	(3.3)	48	(3.1)
Functions (including trigonometric functions) and pre-calculus concepts	41	(3.2)	73	(2.6)
Probability	38	(2.7)	44	(2.7)
Technology (calculators, computers) in support of mathematics	20	(2.4)	35	(2.9)
Statistics (e.g., hypothesis tests, curve fitting and regression)	17	(2.2)	32	(2.9)
Calculus	10	(1.7)	34	(2.6)
Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)	9	(1.5)	20	(2.3)
Mathematical structures (e.g., vector spaces, groups, rings, fields)	9	(2.2)	15	(1.9)

Composite variables were created to gauge mathematics teachers' feelings of qualification to teach both general and advanced mathematics topics. Table 2.25 shows mathematics teachers' scores on the mathematics content composites. Teachers of advanced mathematics courses feel better qualified than teachers of non-advanced courses to teach both advanced mathematics topics (mean composite scores of 63 and 51, respectively) and general mathematics topics (mean composite scores of 91 and 88, respectively).

Table 2.25
Content Preparedness Composite Scores of High School Mathematics Teachers for General and Advanced Mathematics

	Mean Score					
	All Teachers		Teach One or More Advanced Courses		Teach No Advanced Courses	
General Mathematics	89	(0.7)	91	(0.8)	88	(0.9)
Advanced Mathematics	59	(0.9)	63	(1.2)	51	(1.1)

Teachers were also 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 2.26, 88 percent of the grade K–4 teachers, 89 percent of the grade 5–8 teachers, and 98 percent of the grade 9–12 teachers reported that they enjoy teaching science. Ninety-four percent or more of the mathematics teachers in each grade range reported that they enjoy teaching that subject.

In grades K–4 and grades 5–8, mathematics teachers are more likely than science teachers to consider themselves "master" teachers. Nearly forty percent of the grade K–4 teachers consider themselves "master" teachers of mathematics compared to 20 percent in science. In grades 5–8, 57 percent of the mathematics teachers consider themselves "master" teachers, compared to 39 percent of the science teachers. In grades 9–12, science and mathematics teachers are more similar, with 64 percent and 69 percent, respectively, considering themselves "master" teachers of their subject.

Table 2.26
Teachers' Opinions About Their Science and Mathematics Teaching, by Grade Range

	Percent of Teachers Agreeing*					
	Grades K–4		Grades 5–8		Grades 9–12	
Enjoy teaching subject						
Science	88	(1.9)	89	(2.7)	98	(0.8)
Mathematics	94	(1.2)	96	(1.8)	98	(0.7)
Consider themselves "master" teacher of subject						
Science	20	(2.1)	39	(3.5)	64	(2.4)
Mathematics	40	(2.3)	57	(3.6)	69	(1.9)

* Includes teachers indicating "strongly agree" or "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 2.27 shows the percentage of grade K–4, 5–8, and 9–12 science teachers indicating they were either "fairly well prepared" or "very well prepared" for each task; analogous results for mathematics teachers are presented in Table 2.28.

Table 2.27
Science Teachers Considering Themselves Well Prepared* for Each of a Number of Tasks, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Take students' prior understanding into account when planning curriculum and instruction	71	(2.4)	76	(3.3)	77	(1.5)
Develop students' conceptual understanding of science	73	(2.4)	84	(3.1)	92	(0.9)
Provide deeper coverage of fewer science concepts	60	(2.3)	76	(3.1)	88	(1.2)
Make connections between science and other disciplines	77	(1.8)	78	(3.4)	89	(1.3)
Lead a class of students using investigative strategies	62	(2.3)	77	(2.9)	82	(1.7)
Manage a class of students engaged in hands-on/project-based work	79	(2.3)	87	(2.7)	92	(1.2)
Have students work in cooperative learning groups	83	(2.0)	92	(1.5)	86	(1.5)
Listen/ask questions as students work in order to gauge their understanding	88	(1.5)	92	(1.8)	96	(0.8)
Use the textbook as a resource rather than the primary instructional tool	76	(2.4)	81	(3.1)	85	(1.5)
Teach groups that are heterogeneous in ability	87	(1.9)	85	(2.7)	80	(1.9)
Teach students who have limited English proficiency	30	(2.3)	27	(3.1)	21	(1.8)
Recognize and respond to student cultural diversity	65	(2.4)	68	(3.3)	61	(2.1)
Encourage students' interest in science	89	(1.5)	92	(2.3)	95	(1.1)
Encourage participation of females in science	92	(1.3)	93	(2.1)	95	(0.7)
Encourage participation of minorities in science	87	(1.6)	87	(2.6)	89	(1.3)
Involve parents in the science education of their children	47	(2.4)	51	(3.7)	44	(2.1)
Use calculators/computers for drill and practice	45	(2.5)	56	(3.9)	68	(1.9)
Use calculators/computers for science learning games	36	(2.4)	47	(3.5)	48	(2.1)
Use calculators/computers to collect and/or analyze data	29	(2.3)	51	(3.9)	67	(1.9)
Use computers to demonstrate scientific principles	18	(1.9)	35	(2.9)	51	(2.4)
Use computers for laboratory simulations	12	(1.6)	24	(2.8)	45	(2.2)
Use the Internet in your science teaching for general reference	39	(2.7)	53	(3.9)	65	(2.1)
Use the Internet in your science teaching for data acquisition	29	(2.5)	46	(3.6)	57	(2.1)
Use the Internet in your science teaching for collaborative projects with classes/individuals in other schools	15	(1.8)	29	(3.2)	30	(2.2)

* Includes teachers responding "very well prepared" or "fairly well prepared" to each statement.

While there have been calls for increased technology use in America's classrooms, data from the 2000 National Survey of Science and Mathematics Education highlight the need for professional development opportunities for teachers if that goal is to be achieved. For example, in science, while 45 percent of K–4 teachers indicate feeling at least fairly well prepared to use calculators/computers for drill and practice, only 18 percent indicated that level of comfort with using computers to demonstrate scientific principles. Feelings of preparedness increased with increasing grade range, but even at the high school level, only about half of teachers indicated they were at least fairly well prepared to use computers to demonstrate scientific principles or for laboratory simulations.

Teachers of mathematics generally indicated higher levels of preparedness to use calculators and computers. For example, 66 percent of the grade K–4 teachers, rising to 86 percent at the high

school level, indicated feeling at least fairly well prepared to use calculators/computers for drill and practice. Similarly, the percentages of teachers indicating comfort with using these technologies to demonstrate mathematics principles ranged from 43 percent in grades K–4 to 75 percent in grades 9–12.

Table 2.28
Mathematics Teachers Considering Themselves Well Prepared* for Each of a Number of Tasks, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Take students' prior understanding into account when planning curriculum and instruction	87	(1.8)	86	(2.7)	85	(1.5)
Develop students' conceptual understanding of mathematics	90	(1.7)	88	(1.9)	88	(1.6)
Provide deeper coverage of fewer mathematics concepts	76	(2.3)	82	(2.6)	76	(1.8)
Make connections between mathematics and other disciplines	83	(1.9)	78	(2.8)	68	(1.8)
Lead a class of students using investigative strategies	67	(2.4)	67	(3.3)	61	(2.1)
Manage a class of students engaged in hands-on/project-based work	84	(1.9)	76	(3.2)	69	(2.1)
Have students work in cooperative learning groups	86	(1.9)	85	(2.6)	76	(1.8)
Listen/ask questions as students work in order to gauge their understanding	94	(1.0)	95	(1.6)	92	(1.1)
Use the textbook as a resource rather than the primary instructional tool	81	(1.7)	71	(2.8)	71	(1.9)
Teach groups that are heterogeneous in ability	86	(1.9)	81	(3.1)	73	(2.0)
Teach students who have limited English proficiency	34	(2.5)	26	(3.0)	18	(1.5)
Recognize and respond to student cultural diversity	68	(2.2)	68	(2.8)	56	(2.2)
Encourage students' interest in mathematics	96	(0.8)	89	(1.5)	90	(1.2)
Encourage participation of females in mathematics	98	(0.6)	96	(0.9)	94	(0.9)
Encourage participation of minorities in mathematics	91	(1.4)	88	(2.2)	86	(1.4)
Involve parents in the mathematics education of their children	72	(2.4)	51	(3.0)	37	(2.0)
Use calculators/computers for drill and practice	66	(2.6)	74	(2.6)	86	(1.3)
Use calculators/computers for mathematics learning games	69	(2.6)	69	(2.9)	54	(2.2)
Use calculators/computers to collect and/or analyze data	39	(2.3)	64	(3.2)	66	(2.0)
Use calculators/computers to demonstrate mathematics principles	43	(2.4)	57	(3.1)	75	(1.8)
Use calculators/computers for simulations and applications	39	(2.3)	47	(3.5)	58	(1.9)
Use the Internet in your mathematics teaching for general reference	24	(1.9)	34	(3.0)	30	(1.9)
Use the Internet in your mathematics teaching for data acquisition	20	(1.8)	27	(2.8)	28	(1.8)
Use the Internet in your mathematics teaching for collaborative projects with classes/individuals in other schools	14	(1.5)	18	(2.5)	15	(1.4)

* Includes teachers responding "very well prepared" or "fairly well prepared" to each statement.

The 2000 National Survey of Science and Mathematics Education also provided evidence that many teachers do not feel well prepared to teach the diversity of students in our nation's schools. While the majority of science and mathematics teachers (ranging from 56 to 68 percent, depending on subject and grade range) feel well prepared to recognize and respond to student cultural diversity, only 18–34 percent feel well prepared to teach students who have limited English proficiency. At the same time, the vast majority of science and mathematics teachers

reported feeling at least fairly well prepared to encourage the participation of females (92–98 percent), and to encourage the participation of minorities (86–91 percent).

In science, elementary teachers are less likely than middle and high school teachers to feel prepared to develop students' conceptual understanding of science, provide deeper coverage of fewer science concepts, make connections between science and other disciplines, lead a class of students using investigative strategies, and to manage a class of students engaged in hands-on/project-based work. In contrast, in mathematics, it is the high school teachers who are less likely to feel prepared to make connections between mathematics and other disciplines, and manage a class of students engaged in hands-on/project-based work; most teachers in all three grade ranges feel well prepared to develop students' conceptual understanding of mathematics, and to provide deeper coverage of fewer mathematics concepts. In both science and mathematics, grade 9–12 teachers are less likely than their grade K–8 counterparts to feel well prepared to teach groups that are heterogeneous in ability.

Table 2.29 displays the composite scores related to teachers' pedagogical preparedness by subject and grade range. It is interesting that in science, grade 9–12 teachers feel better prepared to use standards-based teaching practices than teachers of grades K–4 and 5–8, while in mathematics, teachers of grades 9–12 feel less well prepared to use standards-based teaching practices than grade K–4 and 5–8 teachers. A similar pattern exists for teachers' preparedness to teach students from diverse backgrounds. Grade 9–12 science teachers report feeling better prepared than K–4 teachers to handle diversity in the classroom; grade 9–12 mathematics teachers feel less well prepared to teach students from diverse backgrounds.

The composites related to teachers' preparedness to use calculators/computers and the Internet in the classroom indicate that the majority of teachers do not feel well prepared to use technology in their teaching. The exception to this is mathematics teachers' preparedness to use calculators/ computers in their teaching. However, this finding is likely a reflection of the widespread use of calculators in mathematics classes and may not be indicative of computer use.

Table 2.29
Composite Scores of Science and Mathematics Teachers' Pedagogical Preparedness

	Mean Score							
	Use Standards-Based Teaching Practices		Teach Students from Diverse Backgrounds		Use Calculators/ Computers		Use the Internet	
Science								
Grades K–4	66	(0.9)	73	(1.0)	32	(1.4)	29	(1.5)
Grades 5–8	73	(1.4)	75	(1.7)	43	(1.9)	41	(2.3)
Grades9–12	76	(0.7)	77	(0.8)	54	(1.3)	50	(1.3)
Mathematics								
Grades K–4	73	(0.8)	78	(0.8)	50	(1.3)	24	(1.3)
Grades 5–8	73	(1.3)	78	(1.3)	59	(1.7)	31	(2.1)
Grades 9–12	68	(0.8)	73	(0.7)	63	(1.1)	30	(1.1)

F. Summary

Data in this chapter provide insight on teachers' preparation and indicate that science and mathematics teachers, especially in the elementary and middle grades, do not have strong content preparation in their respective subjects. 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 in each area. While roughly 75 percent of the elementary teachers feel very well qualified to teach reading/language arts, approximately 60 percent feel very well qualified to teach mathematics and about 25 percent feel very well qualified to teach science. In part, this may be due to very few grade K–4 science and mathematics teachers having undergraduate majors in these fields, with the majority having majors in education.

While science and mathematics teachers in grades 5–8 were more likely than their grade K–4 colleagues to have undergraduate majors in science or mathematics, a majority still had majors in education. On the other hand, grade 9–12 science and mathematics teachers were much more likely to have majored in their discipline than in education. The number of semesters of college coursework completed by teachers tells a similar story: elementary teachers have less extensive backgrounds than do their middle grade counterparts, who in turn have had less science/ mathematics coursework than their high school counterparts.

Furthermore, there is evidence that students who take lower-level mathematics classes at the high school level are not as likely to get the benefits of having well-prepared teachers. Teachers of lower-level mathematics courses are much less likely than teachers of advanced mathematics courses to have completed coursework in a number of important mathematics topics.

The 2000 National Survey found that science teachers as a whole are much less likely to be familiar with the NRC *Standards* than mathematics teachers are with the NCTM *Standards*. In both subjects, teachers in the higher grades are more likely to be familiar with the respective *Standards* than teachers in the lower grades. Roughly 70 percent of the science and mathematics teachers familiar with the respective S*tandards* agree with their vision and indicate that they are implementing their recommendations at least to a moderate extent.

While the majority of science and mathematics teachers indicate feeling at least fairly well prepared to use many standards-based teaching practices, such as leading a class of students using investigative strategies or teaching groups that are heterogeneous in ability, relatively few feel well prepared to use technology (calculators, computers, or the Internet) in their teaching or to teach students who have limited English proficiency.