Teacher Background and Beliefs

Overview

A well-prepared teaching force is essential for an effective education system. This chapter provides data about the nation's science, mathematics, and computer science teachers, including their age, gender, race/ethnicity, teaching experience, course backgrounds, beliefs about teaching and learning, and perceptions of preparedness.

Teacher Characteristics

As can be seen in Table 2.1, the vast majority of science teachers at the elementary level are female. The proportion of science teachers who are female decreases as grade level increases, to about 60 percent at the high school level. Science teachers' experience teaching any subject at the K–12 level is similar across grade ranges, though middle school science teachers tend to be less experienced teaching science and more likely to be new to their school. In addition, the majority of the science teaching force is older than 40, with roughly 25 percent of science teachers in each grade range being older than 50. Fewer than 20 percent are age 30 or younger.

Black, Hispanic, and Asian teachers continue to be underrepresented in the science teaching force. At a time when only about half the K–12 student enrollment is White and non-Hispanic, the vast majority of science teachers in each grade range characterize themselves that way.

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

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Sex			
Female	94 (0.7)	71 (1.8)	57 (1.9)
Male	6 (0.7)	28 (1.8)	43 (1.9)
Other	0 (0.1)	0 (0.2)	0 (0.0)
Hispanic or Latino			
Yes	9 (1.6)	7 (1.2)	6 (0.8)
No	91 (1.6)	93 (1.2)	94 (0.8)
Race			
White	88 (1.5)	91 (1.5)	91 (1.2)
Black or African American	8 (1.2)	8 (1.5)	5 (0.9)
Asian	2 (0.6)	2 (0.5)	5 (0.9)
American Indian or Alaskan Native	1 (0.6)	2 (0.6)	2 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.4)	0 (0.2)	0 (0.1)
Age			
≤ 30	19 (1.6)	17 (2.1)	14 (0.9)
31–40	28 (1.6)	29 (2.5)	31 (1.5)
41–50	29 (1.8)	26 (1.9)	28 (1.3)
51–60	20 (1.4)	20 (2.0)	20 (1.1)
61 +	5 (0.8)	8 (1.4)	8 (0.9)
Experience Teaching any Subject at the K–12 Level			
0–2 years	12 (1.3)	15 (1.9)	12 (1.1)
3–5 years	16 (1.4)	13 (1.9)	14 (1.3)
6–10 years	18 (1.6)	18 (1.7)	17 (1.4)
11–20 years	34 (2.1)	35 (2.4)	37 (2.1)
≥ 21 years	20 (1.3)	19 (2.4)	20 (1.2)
Experience Teaching Science at the K–12 Level			
0–2 years	15 (1.3)	21 (2.0)	15 (1.1)
3–5 years	19 (1.4)	15 (1.7)	13 (0.9)
6–10 years	19 (1.6)	18 (1.3)	17 (1.4)
11–20 years	31 (2.0)	34 (2.2)	35 (1.9)
≥ 21 years	16 (1.2)	12 (1.5)	20 (1.2)
Experience Teaching at Their School, any Subject			
0–2 years	24 (1.7)	34 (2.4)	25 (1.4)
3–5 years	24 (1.7)	18 (1.8)	21 (1.6)
6–10 years	18 (1.3)	20 (2.1)	18 (1.3)
11–20 years	24 (1.7)	21 (1.6)	25 (1.8)
≥ 21 years	9 (1.2)	8 (1.2)	8 (0.8)

Table 2.2 shows characteristics of the mathematics teaching force, which overall, are quite similar to those of the science teaching force. For example, elementary mathematics teachers are also predominantly female, and the proportion who are female decreases as grade level increases. Mathematics teacher experience data are also strikingly similar to those of science teachers. As

is the case in science, the typical mathematics teacher in each grade range is White, non-Hispanic, and older than 40.

Table 2.2
Characteristics of the Mathematics Teaching Force, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Sex			
Female	94 (1.0)	70 (2.2)	60 (1.5)
Male	6 (1.0)	30 (2.2)	40 (1.5)
Other	0 (0.1)	0 ---†	0 (0.1)
Hispanic or Latino			
Yes	10 (1.4)	8 (1.5)	7 (1.1)
No	90 (1.4)	92 (1.5)	93 (1.1)
Race			
White	89 (1.3)	89 (1.4)	91 (1.0)
Black or African American	7 (1.0)	8 (1.2)	5 (0.8)
Asian	3 (0.7)	3 (0.8)	4 (0.6)
American Indian or Alaskan Native	1 (0.5)	1 (0.5)	2 (0.3)
Native Hawaiian or Other Pacific Islander	0 (0.3)	1 (0.8)	1 (0.3)
Age			
≤ 30	20 (1.6)	17 (1.7)	20 (1.5)
31–40	27 (1.8)	31 (2.2)	27 (1.3)
41–50	29 (2.1)	29 (2.4)	28 (1.5)
51–60	18 (1.3)	18 (1.7)	19 (1.2)
61 +	5 (0.7)	4 (0.8)	6 (0.7)
Experience Teaching any Subject at the K–12 Level			
0–2 years	12 (1.2)	13 (2.1)	10 (1.1)
3–5 years	17 (1.5)	17 (2.0)	19 (1.7)
6–10 years	17 (1.3)	20 (2.1)	17 (1.1)
11–20 years	35 (1.8)	35 (2.5)	33 (1.6)
≥ 21 years	20 (1.9)	15 (1.6)	21 (1.4)
Experience Teaching Mathematics at the K–12 Level			
0–2 years	14 (1.4)	18 (2.2)	11 (1.0)
3–5 years	17 (1.4)	19 (2.1)	18 (1.6)
6–10 years	18 (1.4)	20 (1.9)	17 (1.2)
11–20 years	33 (1.8)	32 (2.3)	34 (1.6)
≥ 21 years	17 (1.7)	11 (1.1)	20 (1.3)
Experience Teaching at Their School, any Subject			
0–2 years	27 (1.8)	37 (2.5)	30 (1.7)
3–5 years	22 (1.5)	19 (2.0)	22 (1.9)
6–10 years	19 (1.4)	19 (2.1)	19 (1.3)
11–20 years	26 (1.5)	19 (1.8)	22 (1.7)
≥ 21 years	6 (0.9)	6 (0.9)	8 (0.8)

† No middle school mathematics teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

The characteristics of high school computer science teachers, shown in Table 2.3, are similar to those of high school science and mathematics teachers in some areas and markedly different in others. Similar to science and mathematics teachers, nearly all high school computer science teachers characterize themselves as White, and most are older than 40. In contrast, the majority are male. In addition, although nearly half have more than 10 years of experience teaching at the K–12 level, many are novice teachers of computer science, with 35 percent having 0–2 years of experience teaching the subject.

Table 2.3
Characteristics of the High School Computer Science Teaching Force

	PERCENT OF TEACHERS
Sex	
Female	40 (3.6)
Male	60 (3.6)
Other	0 ---†
Hispanic or Latino	
Yes	8 (2.2)
No	92 (2.2)
Race	
White	94 (1.7)
Asian	4 (1.4)
Black or African American	3 (1.3)
American Indian or Alaskan Native	2 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.6)
Age	
≤ 30	12 (2.9)
31–40	31 (3.8)
41–50	25 (3.3)
51–60	21 (2.8)
61 +	11 (2.8)
Experience Teaching any Subject at the K–12 Level	
0–2 years	10 (2.2)
3–5 years	19 (3.2)
6–10 years	23 (3.0)
11–20 years	32 (3.4)
≥ 21 years	15 (2.6)
Experience Teaching Computer Science at the K–12 Level	
0–2 years	35 (3.8)
3–5 years	28 (2.8)
6–10 years	16 (2.7)
11–20 years	18 (2.6)
≥ 21 years	3 (1.2)
Experience Teaching at Their School, any Subject	
0–2 years	28 (3.4)
3–5 years	18 (3.1)
6–10 years	25 (3.2)
11–20 years	21 (3.0)
≥ 21 years	8 (1.9)

† No high school computer science teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

Analyses were conducted to examine how teachers are distributed among schools—for example, whether teachers with the least experience are concentrated in high-poverty schools (i.e., schools with high proportions of students eligible for free/reduced-price lunch). As can be seen in Table 2.4, science classes in high-poverty schools are more likely than those in low-poverty schools to be taught by teachers with five or fewer years of experience. In addition, a majority of computer science classes in high-poverty schools are taught by those with only 0–2 years of experience teaching the subject.

Table 2.4
Equity Analyses of Classes Taught by Teachers With Varying Experience Teaching Subject, by Proportion of Students Eligible for Free/Reduced-Price Lunch

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Experience Teaching Science				
0–2 years	11 (1.4)	13 (1.3)	22 (2.4)	19 (2.2)
3–5 years	16 (1.9)	13 (1.6)	20 (3.0)	19 (1.9)
6–10 years	18 (2.1)	22 (2.2)	16 (1.9)	21 (2.1)
11–20 years	40 (2.3)	33 (2.6)	27 (2.3)	27 (2.3)
≥ 21 years	15 (1.4)	19 (2.0)	16 (2.0)	13 (2.1)
Experience Teaching Mathematics				
0–2 years	12 (1.8)	11 (1.4)	17 (1.7)	15 (2.1)
3–5 years	17 (2.0)	18 (1.9)	14 (1.9)	18 (2.0)
6–10 years	19 (1.8)	18 (1.8)	18 (1.5)	19 (1.8)
11–20 years	34 (2.2)	36 (2.2)	33 (2.7)	32 (2.7)
≥ 21 years	18 (1.5)	17 (1.6)	17 (2.0)	15 (2.0)
Experience Teaching Computer Science				
0–2 years	28 (5.0)	31 (8.3)	23 (8.2)	56 (9.8)
3–5 years	30 (5.3)	29 (7.1)	36 (12.1)	12 (6.7)
6–10 years	16 (3.6)	17 (5.9)	8 (3.5)	21 (5.3)
11–20 years	24 (4.9)	22 (6.5)	33 (11.4)	3 (2.8)
≥ 21 years	2 (1.4)	2 (1.9)	1 (0.7)	8 (4.9)

Table 2.5 shows the percentage of classes taught by teachers from race/ethnicity groups historically underrepresented in STEM by the proportion of students from these groups in the class. Note that across all three subjects, classes in the highest quartile in terms of students from these groups are more likely than those in the lowest quartile to be taught by teachers from these groups.

Table 2.5
Equity Analysis of Classes Taught by Teachers From Race/Ethnicity Groups Historically Underrepresented in STEM, by Subject

	PERCENT OF CLASSES		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Percent of Historically Underrepresented Students in Class			
Lowest Quartile	2 (0.7)	3 (0.7)	5 (3.0)
Second Quartile	6 (1.1)	5 (0.9)	7 (3.6)
Third Quartile	13 (1.4)	12 (1.4)	3 (2.3)
Highest Quartile	42 (4.1)	45 (3.4)	47 (11.1)

Teacher Preparation

In order to help students learn, teachers must themselves have a firm grasp of important ideas in the discipline they are teaching. Because direct measures of teachers' content knowledge were not feasible in this study, the survey used a number of proxy measures, including teachers' major areas of study and courses completed.

As can be seen in Table 2.6, very few elementary teachers have college or graduate degrees in science or mathematics. The percentage of teachers with one or more degrees in science or mathematics increases with increasing grade range, with 79 percent of high school science teachers and 55 percent of high school mathematics teachers having a major in their discipline. If the definition of degree in discipline is expanded to include degrees in science/mathematics education, these figures increase to 91 percent of high school science teachers and 79 percent of high school mathematics teachers. Only about 1 in 4 computer science teachers have a degree in computer engineering, computer science, or information science, and very few have a degree in computer science education.

Table 2.6
Teacher Degrees, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science Teachers			
Science/Engineering	3 (0.5)	42 (2.2)	79 (1.4)
Science Education	1 (0.3)	36 (2.8)	57 (2.1)
Science/Engineering or Science Education	3 (0.7)	54 (2.9)	91 (1.1)
Mathematics Teachers			
Mathematics	1 (0.4)	26 (2.0)	55 (1.6)
Mathematics Education	2 (0.7)	28 (2.4)	53 (2.0)
Mathematics or Mathematics Education	3 (0.9)	45 (2.7)	79 (1.7)
Computer Science Teachers			
Computer Engineering, Computer Science, or Information Science	n/a	n/a	24 (3.3)
Computer Science Education	n/a	n/a	4 (2.1)
Computer Engineering, Computer Science, Information Science, or Computer Science Education	n/a	n/a	25 (3.2)

Table 2.7 shows the percentage of science teachers in each grade range with at least one college course in each of a number of science disciplines. Note that the vast majority of science teachers at each level have had coursework in the life sciences, and 59–72 percent have had coursework in Earth/space science. In contrast, in chemistry and physics, the percentage of teachers with at least one college course in the discipline increases substantially with increasing grade range. Few teachers at any grade level have had coursework in engineering.

Table 2.7
Science Teachers With College Coursework in Various Disciplines, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Chemistry	45 (1.8)	80 (2.2)	95 (0.6)
Biology/Life Science	89 (1.2)	91 (1.5)	93 (0.7)
Physics	31 (1.7)	69 (2.4)	85 (1.4)
Earth/Space Science	66 (1.5)	72 (2.4)	59 (1.6)
Environmental Science	40 (1.8)	58 (2.3)	53 (1.3)
Engineering	3 (0.5)	10 (1.7)	13 (1.1)

Tables 2.8–2.12 provide additional information about secondary science teacher coursework in biology, chemistry, physics, Earth/space science, and environmental science, respectively, in each case showing the percentage of middle and high school teachers who have had one or more courses beyond the introductory level, as well as the percentage who have completed each of a number of individual courses. Typically, high school teachers are substantially more likely than their middle grades counterparts to have taken coursework beyond the introductory level in a given discipline. Teachers were also asked whether they have had one or more teaching methods courses in a given discipline. About half of teachers at each level have had a methods course focused on biology/life science. Far fewer (14–22 percent of middle school teachers and 7–23 percent of high school teachers) have had methods courses in the other disciplines.

Table 2.8
Secondary Science Teachers Completing Various Biology/Life Science Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Introductory Biology/Life Science	**88 (2.0)**	**92 (0.8)**
One or More Biology/Life Science Courses Beyond the Introductory Level	**65 (2.3)**	**79 (1.5)**
Genetics	33 (2.2)	56 (1.7)
Anatomy/physiology	37 (2.1)	51 (1.8)
Cell biology	34 (2.3)	50 (1.7)
Ecology	34 (2.6)	50 (1.8)
Microbiology	28 (1.7)	48 (1.7)
Biochemistry	22 (2.0)	43 (1.9)
Botany	27 (2.1)	40 (1.7)
Zoology	24 (1.9)	37 (1.6)
Evolution	21 (2.1)	32 (1.8)
Other biology/life science beyond the general/introductory level	33 (2.3)	45 (1.9)
Biology/Life Science Teaching Methods Course	**52 (2.2)**	**52 (1.7)**

Table 2.9
Secondary Science Teachers Completing Various Chemistry Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Introductory Chemistry	**79 (2.2)**	**95 (0.6)**
One or More Chemistry Courses Beyond the Introductory Level	**41 (2.3)**	**72 (1.7)**
Organic chemistry	32 (2.1)	64 (1.7)
Inorganic chemistry	18 (1.7)	42 (1.8)
Biochemistry	20 (2.0)	40 (1.7)
Physical chemistry	12 (1.4)	26 (1.3)
Analytic chemistry	7 (1.2)	25 (1.2)
Quantum chemistry	2 (0.4)	7 (0.6)
Other chemistry beyond the general/introductory level	8 (1.0)	17 (1.5)
Chemistry Teaching Methods Course	**15 (1.9)**	**23 (1.3)**

Table 2.10
Secondary Science Teachers Completing Various Physics Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Introductory Physics	**67 (2.4)**	**84 (1.4)**
One or More Physics Courses Beyond the Introductory Level	**19 (1.8)**	**31 (1.6)**
Mechanics	6 (1.3)	19 (1.3)
Electricity and magnetism	6 (1.0)	17 (1.1)
Heat and thermodynamics	6 (1.3)	14 (1.2)
Astronomy/astrophysics	10 (1.4)	13 (1.1)
Modern or quantum physics	3 (0.7)	13 (1.0)
Optics	2 (0.7)	9 (1.2)
Nuclear physics	1 (0.3)	6 (0.7)
Other physics beyond the general/introductory level	8 (0.9)	13 (1.2)
Physics Teaching Methods Course	**16 (1.9)**	**15 (1.3)**

Table 2.11
Secondary Science Teachers Completing Various Earth/Space Science Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Introductory Earth/Space Science	**68 (2.6)**	**58 (1.6)**
One or More Earth/Space Science Courses Beyond the Introductory Level	**29 (2.1)**	**24 (1.4)**
Geology	22 (1.8)	19 (1.3)
Astronomy/astrophysics	15 (1.7)	13 (1.2)
Physical geography	13 (1.6)	9 (1.0)
Meteorology	9 (1.4)	9 (1.0)
Oceanography	8 (0.9)	8 (0.9)
Other Earth/space science beyond the general/introductory level	11 (1.3)	11 (1.1)
Earth/Space Science Teaching Methods Course	**22 (1.8)**	**11 (1.1)**

Table 2.12
Secondary Science Teachers Completing Various Environmental Science Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Introductory Environmental Science	**55 (2.4)**	**52 (1.2)**
One or More Environmental Science Courses Beyond the Introductory Level	**19 (1.7)**	**26 (1.4)**
Ecology	15 (1.4)	22 (1.3)
Conservation biology	8 (1.2)	11 (0.9)
Oceanography	5 (0.6)	8 (1.0)
Forestry	4 (1.3)	5 (1.0)
Hydrology	3 (0.6)	4 (0.6)
Toxicology	2 (0.4)	3 (0.5)
Other environmental science beyond the general/introductory level	8 (1.2)	13 (1.1)
Environmental Science Teaching Methods Course	**14 (1.9)**	**7 (0.6)**

Teachers of science in the elementary grades are typically responsible for instruction across science disciplines. Accordingly, the National Science Teachers Association (NSTA) has recommended that rather than studying a single science discipline in depth, elementary science teachers be prepared to teach life science, Earth science, and physical science.[7] As a proxy for the competencies outlined by NSTA in these different areas, teachers were asked about their coursework in each. As can be seen in Table 2.13, 34 percent of elementary science teachers have had courses in all three of those areas, and another 36 percent have had coursework in 2 of the 3 areas. At the other end of the spectrum, 7 percent of elementary science teachers have not had any college science courses in these areas.

[7] National Science Teachers Association. (2012). NSTA science content analysis form: Elementary science specialists or middle school science teachers. Arlington, VA: NSTA.

Table 2.13
Elementary Science Teachers' Coursework Related to NSTA Preparation Standards

	PERCENT OF TEACHERS
Courses in Earth, life, and physical science†	34 (1.5)
Courses in 2 of the 3 areas	36 (1.6)
Course in 1 of the 3 areas	23 (1.5)
Courses in 0 of the 3 areas	7 (1.0)

† Physical science is defined as a course in either chemistry or physics.

Forty-nine percent of middle grades teachers of general or integrated science have had at least one college course in chemistry, Earth science, life science, and physics. An additional 29 percent have had coursework in 3 of the 4 areas (see Table 2.14).

Table 2.14
Middle School Teachers of General/Integrated Science Coursework Related to NSTA Preparation Standards

	PERCENT OF TEACHERS
Courses in chemistry, Earth science, life science, and physics	49 (2.8)
Courses in 3 of the 4 areas	29 (3.0)
Courses in 2 of the 4 areas	12 (1.9)
Course in 1 of the 4 areas	4 (0.9)
Courses in 0 of the 4 areas	6 (2.3)

Many secondary science classes, especially at the high school level, focus on a single area of science, such as biology or chemistry. Table 2.15 provides information about the course background of those teaching these courses. Middle school life science/biology teachers are far more likely to have a degree in their discipline (40 percent) than those teaching Earth science (5 percent) or physical science (7 percent). In addition, a majority of middle school Earth science and physical science teachers have had either no coursework in the field or only an introductory course. High school biology teachers also tend to have particularly strong backgrounds in their discipline, with 63 percent having a degree in biology, and another 25 percent with at least three college courses beyond introductory biology. In contrast, about one-third of high school environmental science teachers and roughly one-quarter of Earth science teachers in each grade range have not had any college coursework in their field.

Table 2.15
Secondary Science Teachers With Varying Levels of Background in Subject†

	PERCENT OF TEACHERS				
	DEGREE IN FIELD	NO DEGREE IN FIELD BUT 3+ COURSES BEYOND INTRODUCTORY	NO DEGREE IN FIELD BUT 1–2 COURSES BEYOND INTRODUCTORY	NO DEGREE IN FIELD OR COURSES BEYOND INTRODUCTORY	NO COURSEWORK IN FIELD
Middle					
Life science/biology	40 (4.5)	26 (3.9)	10 (2.3)	18 (3.1)	6 (2.0)
Physical science	7 (3.3)	10 (3.3)	9 (3.3)	64 (5.4)	9 (2.2)
Earth science	5 (1.3)	22 (6.0)	17 (4.0)	31 (5.5)	26 (5.3)
High					
Life science/biology	63 (2.5)	25 (2.6)	6 (1.1)	5 (1.4)	1 (0.5)
Chemistry	42 (2.7)	28 (2.2)	20 (2.1)	9 (1.9)	1 (0.6)
Physics	24 (2.6)	27 (3.1)	15 (2.6)	30 (3.7)	4 (1.2)
Earth science	15 (2.9)	18 (3.4)	11 (2.6)	31 (5.0)	26 (5.7)
Environmental science	11 (3.4)	21 (3.0)	17 (2.9)	20 (5.3)	31 (4.4)

† Teachers assigned to teach classes in more than one subject area are included in each category.

Additional analyses were conducted to examine the extent to which teachers with the strongest background in their field are equitably distributed; results are shown in Table 2.16. Secondary science classes with different proportions of students from race/ethnicity groups historically underrepresented in STEM are about equally likely to be taught by teachers who have had at least three courses in the subject beyond the introductory level. In contrast, classes composed of high-achieving students are significantly more likely to be taught by teachers with strong content background than those with low levels of prior achievement. In addition, classes in schools with the highest proportion of students eligible for free/reduced-price lunch are less likely to be taught by teachers with substantial background in the subject than classes in schools in the lowest quartile. There also appear to be regional differences, as classes in the Northeast and Midwest are more likely to be taught by teachers who have a degree or at least three advanced courses in the subject.

Table 2.16
Equity Analyses of Secondary Science Classes With Teachers With Substantial Background† in Subject of Selected Class

	PERCENT OF CLASSES
Prior Achievement Level of Class	
Mostly High	72 (2.5)
Average/Mixed	61 (2.2)
Mostly Low	43 (5.1)
Percent of Historically Underrepresented Students in Class	
Lowest Quartile	63 (3.0)
Second Quartile	67 (3.1)
Third Quartile	57 (2.9)
Highest Quartile	56 (5.0)
Percent of Students in School Eligible for FRL	
Lowest Quartile	66 (2.7)
Second Quartile	64 (3.1)
Third Quartile	62 (3.6)
Highest Quartile	52 (4.2)
Region	
Midwest	69 (2.9)
Northeast	71 (4.0)
South	58 (2.7)
West	50 (4.3)

† Defined as having either a degree or at least three advanced courses in the subject of their selected class.

Turning to elementary grades mathematics, as can be seen in Table 2.17, nearly all teachers have completed college coursework in mathematics for elementary school teachers. Roughly half of elementary mathematics teachers have had college courses in each of a number of areas of mathematics, including algebra and statistics. About 1 in 4 elementary mathematics teachers have had a course in computer science, though very few have taken a course in engineering.

Table 2.17
Elementary Mathematics Teachers Completing Various College Courses

	PERCENT OF TEACHERS
Mathematics	
Mathematics content for elementary school teachers	92 (1.1)
College algebra/trigonometry/functions	49 (2.1)
Statistics	47 (1.9)
Integrated mathematics	34 (1.6)
College geometry	32 (2.1)
Probability	25 (1.6)
Calculus	18 (1.4)
Discrete mathematics	6 (0.8)
Other upper division mathematics	14 (1.3)
Other	
Computer science	27 (1.7)
Engineering	2 (0.5)

The National Council of Teachers of Mathematics (NCTM) has recommended that elementary mathematics teachers take college coursework in a number of different areas, including number and operations (for which "mathematics content for elementary teachers" can serve as a proxy), algebra, geometry, probability, and statistics.[8] As can be seen in Table 2.18, only 7 percent of elementary mathematics teachers have had courses in each of these areas; the typical elementary teacher has had coursework in only 1 or 2 of these 5 areas.

Table 2.18
Elementary Mathematics Teachers' Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS
Courses in algebra, geometry, number and operations, probability, and statistics	7 (0.9)
Courses in 3–4 of the 5 areas	39 (1.9)
Courses in 1–2 of the 5 areas	53 (2.0)
Courses in 0 of the 5 areas	2 (0.5)

Table 2.19 shows the percentage of middle and high school mathematics teachers with coursework in each of a number of areas. Nearly all high school mathematics teachers have completed a calculus course, and 85 percent have taken a course in advanced calculus. Similar proportions have had college coursework in linear algebra and in statistics. Other college courses completed by a majority of high school mathematics teachers include abstract algebra, differential equations, axiomatic geometry, analytic geometry, probability, number theory, and discrete mathematics. Substantially fewer teachers at the middle grades have had college coursework in each of these areas though about three-quarters have had a course in statistics and two-thirds in calculus.

[8] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for elementary mathematics specialist. Reston, VA: NCTM.

Table 2.19
Secondary Mathematics Teachers
Completing Various College Courses, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
Mathematics		
Calculus	65 (2.3)	92 (1.4)
Statistics	74 (1.9)	89 (1.1)
Advanced calculus	47 (2.0)	85 (1.4)
Linear algebra (e.g., vectors, matrices, eigenvalues)	42 (2.0)	84 (1.5)
Probability	52 (2.5)	75 (1.3)
Abstract algebra (e.g., groups, rings, ideals, fields)	31 (1.7)	73 (1.5)
Mathematics content for middle/high school teachers	62 (2.6)	69 (1.9)
Differential equations	36 (1.9)	68 (1.6)
Analytic/coordinate geometry (e.g., transformations or isometries, conic sections)	33 (2.0)	66 (1.8)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)	31 (2.4)	61 (1.6)
Axiomatic geometry (Euclidean or non-Euclidean)	24 (1.9)	59 (1.9)
Number theory (e.g., divisibility theorems, properties of prime numbers)	41 (2.4)	58 (1.7)
Real analysis	19 (1.7)	49 (1.6)
Integrated mathematics	50 (2.5)	47 (1.8)
Other upper division mathematics	28 (2.2)	58 (1.9)
Other		
Computer science	42 (2.2)	62 (1.7)
Engineering	9 (1.1)	18 (1.3)

At the middle grades level, NCTM recommends that teachers have more extensive college coursework, including courses in number theory (for which "mathematics for middle school teachers" can serve as a proxy), algebra, geometry, probability, statistics, and calculus.[9] As can be seen in Table 2.20, more than half of middle grades mathematics teachers have had college courses in all or nearly all of these areas, having completed at least 4 of the 6 recommended courses.

Table 2.20
Middle School Mathematics Teachers'
Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS
Courses in algebra, calculus, geometry, number theory, probability, and statistics	21 (2.0)
Courses in 4–5 of the 6 areas	37 (2.4)
Courses in 2–3 of the 6 areas	27 (1.9)
Course in 1 of the 6 areas	9 (1.3)
Courses in 0 of the 6 areas	6 (1.6)

Table 2.21 provides analogous data for high school mathematics teachers, in this case based on a total of seven courses, including number theory and discrete mathematics and omitting

[9] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for middle grades. Reston, VA: NCTM.

mathematics coursework specifically aimed at teachers.[10] Approximately three-quarters of high school teachers meet or come close to having taken courses in all seven areas, completing at least five.

Table 2.21
High School Mathematics Teachers' Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS
Courses in algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics	36 (1.6)
Courses in 5–6 of the 7 areas	40 (1.6)
Courses in 3–4 of the 7 areas	16 (1.7)
Courses in 1–2 of the 7 areas	6 (0.9)
Courses in 0 of the 7 areas	1 (0.5)

Table 2.22 shows the percentage of high school computer science teachers with coursework in each of a number of areas. A large majority of computer science teachers have taken an introduction to programming or an introduction to computer science course. Substantially fewer have taken other, more specific, courses related to computer science such as algorithms, computer networks, or artificial intelligence. However, a large majority of computer science teachers also have taken mathematics coursework often used in computer science, either in statistics or linear algebra.

[10] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for secondary. Reston, VA: NCTM.

Table 2.22
High School Computer Science Teachers Completing Various College Courses

	PERCENT OF TEACHERS
Computer Science/Engineering	
Introduction to computer science/programming	84 (2.5)
Algorithms (e.g., sorting; search trees, heaps, and hashing; divide-and-conquer)	50 (3.8)
Operating systems/computer systems	45 (3.5)
Database systems (e.g., the relational model, relational algebra, SQL)	38 (3.7)
Software design/engineering	35 (3.1)
Computer networks (e.g., application layer protocols, Internet protocols, network interfaces)	32 (3.7)
Computer graphics (e.g., ray tracing, the graphics pipeline, transformations, texture mapping)	22 (3.6)
Computer engineering	19 (2.9)
Electrical/electronics engineering	19 (3.3)
Human-computer interaction (e.g., human information processing subsystems; libraries of standard graphical user interface objects; methodologies to measure the usability of software)	17 (3.2)
Artificial intelligence (e.g., machine learning, robotics, computer vision)	14 (2.7)
Other upper division computer science	39 (3.9)
Other types of engineering courses	23 (3.6)
Mathematics	
Statistics	84 (2.7)
Linear algebra	72 (3.0)
Probability	59 (3.3)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)	44 (4.1)
Number theory (e.g., divisibility theorems, properties of prime numbers)	44 (3.6)

The Computer Science Teachers Association (CSTA) has published recommendations for computer science teacher certification,[11] and the International Society for Technology in Education (ISTE) has published standards for computer science educators.[12] Although there is not perfect agreement between these lists from CSTA and ISTE, they are reasonably consistent. Taken together, they suggest computer science teachers have coursework in the following four areas: programming, algorithms, data structures, and some element of computer systems or networks. As can be seen in Table 2.23, 1 in 4 computer science teachers have taken courses in all four recommended areas. Including those with coursework in at least 3 of the 4 recommended areas increases the percentage of teachers to nearly half.

[11] Ericson, B., Armoni, M., Gal-Ezer, J., Seehorn, D., Stephenson, C., & Trees, F. (2008). Ensuring exemplary teaching in an essential discipline. Addressing the crisis in computer science teacher certification. *Final Report of the CSTA Teacher Certification Task Force. ACM.*

[12] International Society for Technology in Education. (2011). *Standards for computer science educators.* Retrieved from https://www.iste.org/standards.

Table 2.23
High School Computer Science Teachers' Coursework Related to CSTA/ISTE Course-Background Standards

	PERCENT OF TEACHERS
Courses in algorithms, computer systems/networks, data structures, and programming	25 (3.3)
Courses in 3 of the 4 areas	21 (3.2)
Courses in 2 of the 4 areas	20 (2.7)
Course in 1 of the 4 areas	21 (2.6)
Courses in 0 of the 4 areas	13 (2.1)

Teachers were also asked about their path to certification. As can be seen in Table 2.24, elementary science teachers are more likely than those at the high school level to have had an undergraduate program leading to a bachelor's degree and a teaching credential, and high school science teachers are more likely than their elementary school counterparts to have completed a post-baccalaureate credentialing program that did not include a master's degree. Similar patterns are seen among mathematics teachers' paths to certification across grade ranges, though the differences are not as striking. Seven percent of high school mathematics teachers and the same proportion of high school science teachers have not earned a teaching credential. Thirty-eight percent of high school computer science teachers have earned a teaching credential through an undergraduate program leading to a bachelor's degree, and 24 percent through a post-baccalaureate credentialing program that did not include a master's degree. Sixteen percent of computer science teachers have not earned a teaching credential.

Table 2.24
Teachers' Paths to Certification, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science			
An undergraduate program leading to a bachelor's degree and a teaching credential	65 (1.9)	53 (2.8)	40 (1.9)
A post-baccalaureate credentialing program (no master's degree awarded)	11 (1.5)	20 (2.3)	25 (1.7)
A master's program that also led to a teaching credential	22 (1.8)	24 (2.7)	28 (2.2)
Has not earned a teaching credential	1 (0.5)	4 (1.3)	7 (1.0)
Mathematics			
An undergraduate program leading to a bachelor's degree and a teaching credential	65 (2.2)	61 (2.6)	57 (2.3)
A post-baccalaureate credentialing program (no master's degree awarded)	10 (1.5)	14 (1.9)	16 (1.2)
A master's program that also led to a teaching credential	23 (2.1)	20 (1.6)	21 (1.6)
Has not earned a teaching credential	2 (0.6)	4 (1.1)	7 (1.5)
Computer Science			
An undergraduate program leading to a bachelor's degree and a teaching credential	n/a	n/a	38 (3.7)
A post-baccalaureate credentialing program (no master's degree awarded)	n/a	n/a	24 (3.2)
A master's program that also led to a teaching credential	n/a	n/a	22 (2.8)
Has not earned a teaching credential	n/a	n/a	16 (2.7)

Table 2.25 shows the content areas high school science teachers are certified to teach (i.e., have a credential, endorsement, or license in that area). Nearly all are certified in at least one science

area, with the most common areas being biology/life science (71 percent) and chemistry (51 percent). About one-third are certified to teach Earth/space science, physics, or ecology/environmental science. About 1 in 6 are certified to teach all science content areas.

Table 2.25
High School Science Teachers' Areas of Certification

	PERCENT OF TEACHERS
Certified in One or More Science Areas	**91 (1.1)**
Biology/life science	71 (1.6)
Chemistry	51 (2.2)
Earth/space science	37 (2.1)
Physics	33 (1.6)
Ecology/environmental science	32 (2.0)
Certified in All Science Areas	**18 (1.4)**
Not Certified in Any Science Area	**9 (1.1)**

High school computer science teachers were asked a similar item about their areas of certification (see Table 2.26). Forty-four percent have a certification in computer science, and 34 percent are certified to teach mathematics. About one-quarter are certified to teach business.

Table 2.26
High School Computer Science Teachers' Areas of Certification

	PERCENT OF TEACHERS
Certified in One or More Areas	**84 (2.7)**
Computer Science	44 (3.6)
Mathematics	34 (3.4)
Business	28 (2.4)
Engineering	10 (2.4)
Science	9 (2.3)
Not Certified	**16 (2.7)**

Recognizing that teaching is not always an individual's first career, the survey also included an item asking whether teachers had a full-time job in their designated field after completing their undergraduate degree and prior to teaching. Science teachers were asked whether they had full-time job experience in a science- or engineering-related field. Mathematics and computer science teachers were asked about experience in a mathematics-related field (e.g., accounting, engineering, computer programming) and computer programming or computer/software engineering, respectively. As can be seen in Table 2.27, the likelihood of science and mathematics teachers having prior career experience in their field substantially increases with increasing grade range. In addition, high school science and computer science teachers are more likely than their mathematics colleagues to have prior job experience in their respective fields (about one-third vs. one-fifth).

Table 2.27
Teachers With Full-Time Job Experience in Their Designated Field Prior to Teaching, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science	3 (0.7)	23 (2.8)	36 (2.1)
Mathematics	7 (1.1)	12 (1.4)	19 (1.4)
Computer Science	n/a	n/a	35 (4.3)

Teacher Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning. Table 2.28 shows the percentage of science teachers in each grade range agreeing with each of the statements; data for mathematics teachers and computer science teachers are shown in Table 2.30 and Table 2.32, respectively.

It is interesting to note that elementary, middle, and high school science teachers have similar views about a number of elements of science instruction. At least 90 percent of teachers in each grade range agree that: (1) teachers should ask students to support their conclusions about a science concept with evidence; (2) students learn best when instruction is connected to their everyday lives; (3) students should learn science by doing science; and (4) most class periods should provide opportunities for students to apply scientific ideas to real-world contexts. A similarly large proportion of science teachers in each grade range believe that most class periods should provide opportunities for students to share their thinking and reasoning. In contrast, teacher opinions about ability grouping vary considerably by grade range, with 60 percent of high school science teachers, 48 percent of those in the middle grades, and 25 percent at the elementary level believing that students learn science best in classes with students of similar abilities.

There are also inconsistent views in relation to a number of elements of effective science instruction, with teachers agreeing with statements associated with both traditional and reform-oriented beliefs. Approximately three-fourths of teachers at each grade range agree that it is better to focus on ideas in depth, even if it means covering fewer topics, one of the central tenets of calls for reform in science instruction. At the same time, despite research on learning that suggests otherwise,[13] roughly one-third of science teachers at each grade level agree that teachers should explain an idea to students before having them consider evidence for that idea, and more than half that laboratory activities should be used primarily to reinforce ideas that the students have already learned. And despite recommendations that students develop understanding of concepts first and learn the scientific language later, 66–77 percent of science teachers at the various grade ranges think that students should be given definitions for new vocabulary at the beginning of instruction on a science idea.

[13] National Research Council. (2005). *How students learn: History, mathematics, and science in the classroom.* M. S. Donovan & J. D. Bransford, (Eds.) Washington, DC: National Academy Press.

Table 2.28
Science Teachers Agreeing† With Various Statements About Teaching and Learning, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Reform-Oriented Beliefs			
Teachers should ask students to support their conclusions about a science concept with evidence.	95 (1.1)	97 (0.9)	99 (0.3)
Students learn best when instruction is connected to their everyday lives.	95 (1.0)	97 (0.7)	96 (0.7)
Students should learn science by doing science (e.g., developing scientific questions; designing and conducting investigations; analyzing data; developing models, explanations, and scientific arguments).	95 (1.0)	93 (1.7)	93 (1.2)
Most class periods should provide opportunities for students to apply scientific ideas to real-world contexts.	93 (1.2)	90 (2.0)	91 (1.4)
Most class periods should provide opportunities for students to share their thinking and reasoning.	96 (0.9)	92 (1.9)	89 (1.4)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	75 (2.1)	74 (2.9)	77 (2.0)
Traditional Beliefs			
At the beginning of instruction on a science idea, students should be provided with definitions for new scientific vocabulary that will be used.	77 (2.1)	72 (2.3)	66 (2.1)
Students learn science best in classes with students of similar abilities.	25 (1.9)	48 (3.6)	60 (1.7)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	56 (2.4)	57 (2.6)	52 (2.0)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.	33 (2.1)	30 (2.6)	37 (2.3)

† Includes teachers indicating "strongly agree" or "agree" on a five-point scale ranging from 1 "strongly disagree" to 5 "strongly agree."

These items (and the analogous items for mathematics and computer science) were combined into two composite variables: Traditional Teaching Beliefs and Reform-Oriented Teaching Beliefs. The composite scores shown in Table 2.29 suggest that elementary, middle, and high school science teachers have relatively strong reform-oriented beliefs. However, traditional beliefs are also fairly prevalent across all grades.

Table 2.29
Mean Scores for Science Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Elementary	55 (0.9)	86 (0.6)
Middle	57 (1.1)	87 (0.7)
High	59 (0.7)	85 (0.5)

As can be seen in Table 2.30, mathematics teachers share many of the reform-oriented beliefs of science teachers, with at least 85 percent of teachers in each grade range agreeing that (1) teachers should ask students to justify their mathematical thinking, (2) students should learn mathematics by doing mathematics, (3) most class periods should provide students opportunities to share their thinking and reasoning, and (4) students learn best when instruction is connected to their everyday lives. At the same time, 49 percent of elementary mathematics teachers, increasing to 66 percent in the middle grades and 70 percent at the high school level, believe that students learn mathematics best in classes with students of similar abilities.

As is the case in science, most mathematics teachers agree with the notion of covering fewer ideas in greater depth, but sizeable proportions do not agree with other recommendations for improving mathematics teaching and learning. For example, 43–53 percent of mathematics teachers, depending on grade range, believe that hands-on activities/manipulatives should be used primarily to reinforce ideas the students have already learned, despite recommendations that these be used to help students develop their initial understanding of key concepts. And even larger proportions of mathematics teachers, from 78 percent at the high school level to 82 percent at the elementary level, believe that students should be given definitions of new vocabulary at the beginning of instruction on a mathematical idea.

Table 2.30
Mathematics Teachers Agreeing† With Various Statements About Teaching and Learning, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Reform-Oriented Beliefs			
Teachers should ask students to justify their mathematical thinking.	97 (0.6)	99 (0.4)	98 (0.6)
Students should learn mathematics by doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models).	97 (0.7)	97 (0.6)	96 (0.8)
Most class periods should provide opportunities for students to share their thinking and reasoning.	96 (0.9)	95 (0.7)	94 (0.9)
Students learn best when instruction is connected to their everyday lives.	97 (0.6)	93 (1.8)	85 (1.7)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	77 (2.0)	89 (1.5)	83 (1.7)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts.	93 (1.1)	92 (1.1)	78 (1.6)
Traditional Beliefs			
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	82 (1.6)	78 (3.1)	78 (1.8)
Students learn mathematics best in classes with students of similar abilities.	49 (2.3)	66 (2.7)	70 (1.8)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	53 (2.5)	43 (2.7)	44 (2.1)
Teachers should explain an idea to students before having them investigate the idea.	34 (2.1)	31 (2.9)	32 (2.3)

† Includes teachers indicating “strongly agree” or “agree” on a five-point scale ranging from 1 “strongly disagree” to 5 “strongly agree.”

Similar to science teachers, mathematics teachers also have relatively strong reform-oriented beliefs (see Table 2.31). Traditional beliefs are also fairly common among mathematics teachers at all grade levels.

Table 2.31
Mean Scores for Mathematics Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Elementary	59 (0.9)	84 (0.6)
Middle	60 (1.1)	84 (0.8)
High	61 (0.9)	79 (0.5)

Computer science teachers' views also echo those of science and mathematics teachers, as at least 90 percent agree that students should learn computer science by doing computer science and learn best when instruction is connected to their everyday lives, that teachers should ask students to justify their solutions, and that most class periods should provide opportunities for students to share their thinking and reasoning (see Table 2.32).

Although most computer science teachers agree with statements characteristic of reform-oriented instruction, a majority still hold beliefs aligned with more traditional instruction. For example, 71 percent agree that hands-on/manipulatives/programming activities should be used primarily to reinforce a computer science idea that the students have already learned. Similar to their mathematics counterparts, 3 out of 4 high school computer science teachers agree that at the beginning of instruction on a computer science idea, students should be provided with definitions for new vocabulary that will be used.

Table 2.32
High School Computer Science Teachers Agreeing† With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS
Reform-Oriented Beliefs	
Students should learn computer science by doing computer science (e.g., breaking problems into smaller parts, considering the needs of a user, creating computational artifacts).	97 (1.2)
Teachers should ask students to justify their solutions to a computational problem.	92 (1.6)
Most class periods should provide opportunities for students to share their thinking and reasoning.	91 (2.5)
Students learn best when instruction is connected to their everyday lives.	90 (2.0)
Most class periods should provide opportunities for students to apply computer science ideas to real-world contexts.	79 (3.1)
It is better for computer science instruction to focus on ideas in depth, even if that means covering fewer topics.	58 (3.9)
Traditional Beliefs	
At the beginning of instruction on a computer science idea, students should be provided with definitions for new vocabulary that will be used.	75 (2.7)
Hands-on/manipulatives/programming activities should be used primarily to reinforce a computer science idea that the students have already learned.	71 (3.5)
Students learn computer science best in classes with students of similar abilities.	51 (3.3)

† Includes teachers indicating "strongly agree" or "agree" on a five-point scale ranging from 1 "strongly disagree" to 5 "strongly agree."

As can be seen in Table 2.33, high school computer science teachers have relatively strong reform-oriented beliefs. In addition, computer science teachers hold relatively strong traditional beliefs about instruction, even more so than their science and mathematics counterparts.

Table 2.33
Mean Scores for High School Computer Science Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE
Reform-Oriented Beliefs	82 (0.9)
Traditional Beliefs	67 (1.4)

Because beliefs are important mediators of behaviors, it is worth examining whether teachers' beliefs vary by the context in which they teach or the students they serve. Tables 2.34–2.36 display class mean scores for the teacher belief composites by a number of equity factors.

Table 2.34 presents composite scores for science teachers' beliefs about teaching and learning by two equity factors: the prior achievement level of the class and the proportion of students in the school who are eligible for free/reduced-price lunch. Teachers of classes composed of students characterized as mostly low prior achievers are somewhat more likely to hold traditional beliefs and slightly less likely to hold reform-oriented beliefs about science instruction. Science classes in schools with the highest proportions of students eligible for free/reduced-price lunch are more likely to be taught by teachers with more traditional beliefs than those in low-poverty schools, though the difference is small.

Table 2.34
Equity Analyses of Class Mean Scores for Science Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Prior Achievement Level of Class		
Mostly High	57 (1.4)	88 (0.5)
Average/Mixed	55 (0.8)	87 (0.5)
Mostly Low	61 (1.5)	84 (1.1)
Percent of Students in School Eligible for FRL		
Lowest Quartile	54 (1.1)	87 (0.7)
Second Quartile	56 (1.1)	86 (0.8)
Third Quartile	56 (2.4)	87 (0.7)
Highest Quartile	60 (0.9)	86 (0.7)

Data in Table 2.35 suggest weak relationships between mathematics teachers' beliefs and the proportion of students in the class from race/ethnicity groups historically underrepresented in STEM and the proportion of students in the school who are eligible for free/reduced-price lunch. Interestingly, the two factors share the same pattern, with traditional beliefs and reform-oriented beliefs being strongest among teachers of classes with the greatest percentage of students from race/ethnicity groups historically underrepresented in STEM and students eligible for free/ reduced-price lunch.

Table 2.35
Equity Analyses of Class Mean Scores for Mathematics Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	58 (0.9)	81 (0.7)
Second Quartile	60 (1.1)	82 (0.8)
Third Quartile	59 (1.3)	84 (0.6)
Highest Quartile	63 (1.0)	85 (0.7)
Percent of Students in School Eligible for FRL		
Lowest Quartile	57 (0.9)	82 (0.7)
Second Quartile	59 (1.2)	82 (0.7)
Third Quartile	61 (1.1)	84 (0.7)
Highest Quartile	63 (1.0)	85 (0.7)

As can be seen in Table 2.36, there does not appear to be a relationship between computer science teachers' beliefs and the proportion of students in the class from race/ethnicity groups historically underrepresented in STEM. Classes in schools with the highest proportions of students eligible for free/reduced-price lunch are somewhat more likely to be taught by teachers with stronger reform-oriented beliefs than those in low-poverty schools.

Table 2.36
Equity Analyses of Class Mean Scores for High School Computer Science Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	65 (2.1)	80 (1.7)
Second Quartile	72 (4.1)	82 (2.5)
Third Quartile	61 (1.8)	85 (1.8)
Highest Quartile	66 (4.5)	84 (1.8)
Percent of Students in School Eligible for FRL		
Lowest Quartile	65 (1.7)	80 (1.4)
Second Quartile	67 (3.5)	82 (1.6)
Third Quartile	69 (5.2)	86 (2.4)
Highest Quartile	61 (2.8)	85 (2.3)

Teachers' Perceptions of Preparedness

Elementary teachers are typically assigned to teach multiple subjects to a single group of students, including not only science and mathematics, but other areas as well. However, as can be seen in Table 2.37, these teachers do not feel equally well prepared to teach the various subjects. Although 73 percent of elementary teachers of self-contained classes feel very well prepared to teach mathematics—slightly lower than the 77 percent for reading/language arts—only 31 percent feel very well prepared to teach science, and only 6 percent feel very well prepared to teach computer science or programming.

Table 2.37
Elementary Teachers' Perceptions of Their Preparedness to Teach Each Subject

	PERCENT OF TEACHERS†			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
Reading/Language arts	0 (0.1)	3 (0.5)	19 (1.0)	77 (1.2)
Mathematics	0 (0.1)	4 (0.7)	23 (1.6)	73 (1.6)
Social studies	3 (0.5)	15 (1.0)	39 (1.4)	42 (1.3)
Science	4 (0.8)	23 (1.8)	42 (1.9)	31 (1.9)
Computer science/programming	45 (1.8)	35 (1.5)	14 (1.1)	6 (0.7)

† Includes only teachers assigned to teach multiple subjects to a single class of students in grades K–6.

As noted earlier, teachers of self-contained classes were randomly assigned to respond to either the science or mathematics teacher questionnaire. Those who received the science questionnaire were asked about their preparedness to teach each of the major science disciplines to that class, and those receiving the mathematics questionnaire were asked about a number of mathematics areas.

As can be seen in Table 2.38, elementary teachers are more likely to feel very well prepared to teach life science and Earth science than they are to teach physical science. Engineering stands out as the area where elementary teachers feel least prepared, with only 3 percent feeling very well prepared to teach it at their grade level, and 51 percent noting that they are not adequately prepared.

Table 2.38
Elementary Teachers' Perceptions of Their Preparedness to Teach Various Science Disciplines

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
Life science	3 (0.7)	24 (1.8)	49 (1.8)	24 (1.5)
Earth/Space science	6 (0.8)	27 (1.5)	47 (1.7)	20 (1.5)
Physical science	11 (1.3)	35 (1.6)	41 (2.1)	13 (1.1)
Engineering	51 (2.2)	33 (1.8)	14 (1.2)	3 (0.6)

Table 2.39 provides data on elementary teachers' perceptions of their preparedness to teach each of a number of mathematics topics at their assigned grade level. Interestingly, 74 percent of elementary teachers feel very well prepared to teach number and operations, which is about the same proportion that feel very well prepared to teach mathematics in general. The fact that markedly fewer teachers feel very well prepared to teach measurement and data representation, geometry, and early algebra suggests that elementary teachers equate teaching mathematics with teaching number and operations.

Table 2.39
Elementary Teachers' Perceptions of Their Preparedness to Teach Various Mathematics Topics

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
Number and operations	0 (0.1)	2 (0.5)	23 (1.7)	74 (1.7)
Measurement and data representation	3 (0.5)	8 (1.1)	37 (1.8)	53 (1.8)
Geometry	4 (0.7)	12 (1.3)	35 (1.8)	49 (2.2)
Early algebra	6 (0.9)	17 (1.2)	36 (2.1)	41 (1.9)

As noted earlier, the teacher questionnaires included a series of items about a single, randomly selected class. Middle and high school science teachers were shown a list of topics based on the subject of that class and asked how well prepared they felt to teach each of those topics at the grade levels they teach. As can be seen in Table 2.40, high school science teachers are more likely than their middle grades counterparts to feel very well prepared to teach topics within each discipline. In addition, high school chemistry teachers are more likely to feel well prepared than teachers in any other subject/grade level group, with 76–89 percent considering themselves very well prepared to teach the various topics. It is interesting to note the variation among topics within physics, with only 19 percent of high school physics teachers feeling very well prepared to teach modern physics (e.g., relativity) compared to 45–79 percent for the other topics in the list.

Table 2.40
Secondary Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Grade Range

	PERCENT OF TEACHERS†	
	MIDDLE	HIGH
Earth/Space Science		
Earth's features and physical processes	42 (2.2)	64 (7.0)
The solar system and the universe	32 (2.0)	60 (7.0)
Climate and weather	31 (2.3)	60 (7.0)
Biology/Life Science		
Cell biology	50 (2.6)	74 (2.6)
Structures and functions of organisms	55 (2.7)	70 (3.3)
Genetics	46 (3.0)	70 (3.2)
Ecology/ecosystems	52 (3.0)	65 (2.5)
Evolution	40 (2.8)	63 (2.5)
Chemistry		
The periodic table	47 (3.0)	89 (2.4)
States, classes, and properties of matter	55 (2.6)	88 (2.4)
Atomic structure	46 (3.2)	87 (2.9)
Elements, compounds, and mixtures	45 (2.6)	87 (3.0)
Chemical bonding, equations, nomenclature, and reactions	28 (2.6)	83 (3.3)
Properties of solutions	30 (2.2)	76 (3.1)
Physics		
Forces and motion	44 (3.5)	79 (4.2)
Energy transfers, transformations, and conservation	39 (3.0)	72 (4.6)
Properties and behaviors of waves	21 (2.1)	57 (4.8)
Electricity and magnetism	19 (2.0)	45 (4.4)
Modern physics	7 (1.3)	19 (2.7)
Environmental and Resource Issues (e.g., land and water use, energy resources and consumption, sources and impacts of pollution)	31 (2.8)	63 (6.7)

† Each secondary science teacher was asked about one set of science topics based on the discipline of his/her randomly selected class.

Table 2.41 displays mean scores for the composite variable Perceptions of Content Preparedness, which was defined based on the content of the targeted class. The mean scores indicate that elementary teachers generally do not feel well prepared to teach science. In addition, high school science teachers feel better prepared to teach science than their middle school counterparts.

Table 2.41
Mean Scores for Science Teachers' Perceptions of Content Preparedness Composite

	MEAN SCORE
Elementary	50 (0.8)
Middle	71 (0.8)
High	88 (0.6)

Secondary science teachers were also asked about their preparedness to teach engineering, regardless of the discipline of their designated class. As can be seen in Table 2.42, very few middle and high school science teachers feel very well prepared to teach engineering concepts, and sizeable proportions indicate being not adequately prepared. This finding is not surprising given that few teachers have had college coursework in engineering and engineering has not historically been part of the school curriculum. K–12 teachers will likely need both high-quality curriculum and substantive professional development to be successful at integrating engineering into their science teaching.

Table 2.42
Secondary Science Teachers' Perceptions of Their Preparedness to Teach Engineering

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
Middle				
Developing possible solutions	28 (2.2)	32 (2.2)	26 (1.9)	14 (1.8)
Defining engineering problems	29 (2.1)	35 (2.3)	24 (2.0)	12 (1.6)
Optimizing a design solution	32 (2.2)	33 (2.2)	24 (1.9)	10 (1.6)
High				
Developing possible solutions	34 (1.9)	36 (1.9)	22 (1.4)	8 (0.8)
Defining engineering problems	38 (1.8)	38 (1.7)	18 (1.2)	7 (0.7)
Optimizing a design solution	42 (1.8)	36 (1.7)	16 (1.1)	6 (0.7)

The relatively low scores on the Perceptions of Preparedness to Teach Engineering composite, shown in Table 2.43, indicate that middle and high school science teachers do not feel adequately prepared to teach engineering. Interestingly, middle school science teachers feel significantly more prepared in this area than high school science teachers.

Table 2.43
Mean Scores for Secondary Science Teachers' Perceptions of Preparedness to Teach Engineering Composite

	MEAN SCORE
Middle	43 (1.4)
High	33 (1.0)

Table 2.44 provides data on secondary mathematics teachers' perceptions of preparedness to teach each of a number of mathematics topics. At each grade level, teachers are most likely to feel very well prepared to teach the number system and operations and algebraic thinking, and far less likely to feel that level of preparedness for discrete mathematics. High school mathematics teachers are substantially more likely than middle school teachers to feel very well prepared to teach many of the listed topics. However, in the case of statistics and probability, middle grades teachers are more likely than high school teachers to feel very well prepared. In addition, very few secondary mathematics teachers consider themselves very well prepared to teach computer science/programming ideas.

Table 2.44
Secondary Mathematics Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Grade Range

	PERCENT OF TEACHERS	
	MIDDLE	HIGH
The number system and operations	85 (1.4)	89 (0.9)
Algebraic thinking	78 (1.7)	89 (0.9)
Functions	57 (2.0)	84 (1.4)
Measurement	61 (2.0)	74 (1.3)
Geometry	59 (2.3)	65 (1.4)
Modeling	46 (2.4)	59 (1.8)
Statistics and probability	40 (2.4)	31 (1.7)
Discrete mathematics	12 (1.4)	21 (1.3)
Computer science/programming	4 (0.7)	5 (0.8)

Table 2.45 shows mathematics teachers' scores on the Perceptions of Content Preparedness composite. Similar to science teachers, high school mathematics teachers feel better prepared than middle school mathematics teachers. Elementary teachers feel as prepared to teach mathematics as do middle school mathematics teachers, and substantively more prepared in mathematics than they do in science.

Table 2.45
Mean Scores for Mathematics Teachers' Perceptions of Content Preparedness Composite

	MEAN SCORE
Elementary	79 (0.7)
Middle	78 (0.7)
High	82 (0.6)

High school computer science teachers were also asked about their preparedness to teach each of a number of topics related to computing and programming. As can be seen in Table 2.46, fewer than half consider themselves very well prepared in any of the topics, though they are more likely to feel well prepared to teach about algorithms and programming than about networks and the Internet (47 vs. 23 percent, respectively).

Table 2.46
High School Computer Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF TEACHERS
Algorithms and programming	47 (4.0)
Impacts of computing	35 (3.4)
Computing systems	31 (3.9)
Data and analysis	27 (4.1)
Networks and the Internet	23 (3.4)

These items were combined into a composite variable measuring high school computer science teachers' perceptions of content preparedness (see Table 2.47). Compared to high school science and mathematics teachers, high school computer science teachers perceive themselves to be far less prepared to teach their respective content.

Table 2.47
Mean Scores for High School Computer Science Teachers' Perceptions of Content Preparedness Composite

	MEAN SCORE
Overall	64 (1.5)

Two series of items focused on teacher preparedness for a number of tasks associated with instruction. First, teachers were asked how well prepared they feel to carry out a number of tasks in instruction, including developing students' understanding and abilities, encouraging participation of students, and differentiating their instruction to meet learners' needs. Second, teachers were asked about how well prepared they feel to monitor and address student understanding, focusing on a specific unit in the randomly selected class.

As can be seen in Table 2.48, science teacher preparedness tends to increase with increasing grade range. For example, only 23 percent of elementary teachers feel very well prepared to develop students' conceptual understanding of science ideas, compared to 42 percent of middle grades teachers and 58 percent of high school teachers. A majority of high school teachers also feel very well prepared to use formative assessment to monitor student learning; the proportion of teachers feeling very well prepared increases with increasing grade level. Fewer teachers at all grade levels feel very well prepared to provide science instruction that is based on students' ideas, develop students' awareness of STEM careers, and incorporate students' cultural backgrounds into science instruction.

Table 2.48
Science Teachers Considering Themselves Very Well Prepared for Each of a Number of Tasks, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Develop students' conceptual understanding	23 (1.5)	42 (2.2)	58 (1.5)
Use formative assessment to monitor student learning	28 (1.7)	48 (2.2)	52 (1.6)
Develop students' abilities to do science (e.g., develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	17 (1.5)	38 (1.9)	46 (1.6)
Encourage students' interest in science and/or engineering	26 (1.3)	42 (2.2)	44 (1.6)
Encourage participation of all students in science and/or engineering	31 (1.6)	44 (2.3)	43 (1.6)
Differentiate science instruction to meet the needs of diverse learners	19 (1.3)	33 (2.0)	35 (1.5)
Provide science instruction that is based on students' ideas	12 (1.1)	21 (1.8)	25 (1.4)
Develop students' awareness of STEM careers	9 (0.9)	21 (1.8)	21 (1.2)
Incorporate students' cultural backgrounds into science instruction	11 (1.1)	15 (1.3)	18 (1.4)

The items in Table 2.48 were combined into a composite variable to examine science teachers' overall perceptions of pedagogical preparedness. As can be seen in Table 2.49, secondary science teachers feel more prepared in this area than elementary science teachers.

Table 2.49
Mean Scores for Science Teachers' Perceptions of Pedagogical Preparedness Composite

	MEAN SCORE
Elementary	57 (0.8)
Middle	68 (0.9)
High	71 (0.6)

Table 2.50 shows the percentage of science classes at each grade level taught by teachers who feel very well prepared for each of a number of tasks related to instruction within a particular unit in a designated class. Two findings are notable. First, secondary teachers feel better prepared for these tasks than elementary teachers. Second, science teachers, regardless of grade level, tend to feel less well prepared for finding out what students already know or think about the key science ideas to be addressed, and anticipating what students might find difficult in the unit.

Table 2.50
Science Classes in Which Teachers Feel Very Well Prepared for Each of a Number of Tasks in the Most Recent Unit in a Designated Class, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Assess student understanding at the conclusion of this unit	32 (1.8)	58 (2.0)	59 (1.8)
Monitor student understanding during this unit	33 (1.9)	51 (2.1)	53 (1.8)
Implement the instructional materials to be used during this unit	32 (2.0)	45 (2.4)	53 (1.6)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	22 (1.9)	37 (2.1)	45 (1.6)
Find out what students thought or already knew about the key science ideas	31 (2.2)	39 (2.1)	38 (1.6)

The items in Table 2.50 were combined to create a composite variable named Perceptions of Preparedness to Implement Instruction in Particular Unit. As can be seen in Table 2.51, feelings of preparedness increase with increasing grade range.

Table 2.51
Mean Scores for Science Teachers' Perceptions of Preparedness to Implement Instruction in Particular Unit Composite

	MEAN SCORE
Elementary	68 (0.9)
Middle	77 (0.9)
High	80 (0.5)

As can be seen in Table 2.52, mathematics teachers' feelings of pedagogical preparedness differ by grade range. High school teachers tend to feel more prepared than those at the elementary level to carry out tasks related to deepening students' understanding. For example, about two-thirds of high school mathematics teachers feel very well prepared to develop students' abilities to do mathematics and develop students' conceptual understanding, compared to 46 percent of elementary teachers. In contrast, elementary teachers are more likely than their secondary counterparts to feel very well prepared to encourage students' interest and participation in mathematics. As in science, few mathematics teachers at any grade level feel very well prepared to incorporate students' cultural backgrounds into instruction and develop students' awareness of STEM careers.

Table 2.52
Mathematics Teachers Considering Themselves Very Well Prepared for Each of a Number of Tasks, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	46 (1.7)	55 (2.1)	66 (2.0)
Develop students' conceptual understanding	46 (1.6)	49 (2.2)	61 (1.8)
Use formative assessment to monitor student learning	53 (1.7)	57 (2.2)	57 (1.6)
Encourage participation of all students in mathematics	56 (1.6)	49 (2.1)	46 (1.8)
Encourage students' interest in mathematics	42 (1.9)	37 (2.0)	38 (1.5)
Differentiate mathematics instruction to meet the needs of diverse learners	41 (1.9)	36 (2.2)	33 (1.6)
Provide mathematics instruction that is based on students' ideas	19 (1.6)	23 (1.7)	26 (1.5)
Incorporate students' cultural backgrounds into mathematics instruction	15 (1.5)	13 (1.1)	17 (1.3)
Develop students' awareness of STEM careers	8 (1.0)	10 (0.9)	15 (1.1)

In contrast to the pattern in science teachers' perceptions of pedagogical preparedness, mathematics perceptions are fairly consistent across all grade bands (see Table 2.53). In addition, elementary mathematics teachers feel more pedagogically prepared than elementary science teachers, which is not surprising given that self-contained elementary teachers consider themselves far more prepared to teach mathematics than science. Middle and high school teachers' perceptions of pedagogical preparedness are very similar across the two subjects.

Table 2.53
Mean Scores for Mathematics Teachers' Perceptions of Pedagogical Preparedness Composite

	MEAN SCORE
Elementary	69 (0.7)
Middle	69 (0.8)
High	71 (0.5)

Table 2.54 shows the percentage of elementary, middle, and high school mathematics classes taught by teachers who feel very well prepared for each of a number of instructional tasks. As is the case in science, mathematics teachers tend to feel less well prepared to find out what students thought or already knew about the key ideas to be addressed in the unit.

Table 2.54
Mathematics Classes in Which Teachers Feel Very Well Prepared for Various Tasks in the Most Recent Unit, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Assess student understanding at the conclusion of this unit	64 (1.9)	62 (2.3)	68 (1.4)
Implement the instructional materials to be used during this unit	55 (1.8)	55 (2.0)	61 (1.6)
Monitor student understanding during this unit	60 (1.8)	57 (1.9)	60 (1.6)
Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit	43 (1.7)	50 (2.1)	59 (1.6)
Find out what students thought or already knew about the key mathematical ideas	42 (2.1)	38 (2.2)	47 (1.5)

As can be seen in Table 2.55, mathematics teachers feel relatively well prepared to implement instruction in a particular unit. Among the three grade bands, high school teachers feel slightly more prepared than elementary and middle grades teachers.

Table 2.55
Mean Scores for Mathematics Teachers' Perceptions of Preparedness to Implement Instruction in Particular Unit Composite

	MEAN SCORE
Elementary	81 (0.8)
Middle	80 (1.0)
High	83 (0.6)

In high school computer science, roughly half of teachers feel very well prepared to encourage students' interest in computer science, develop students' ability to do computer science, and encourage participation of all students in computer science (see Table 2.56). Fewer than one-quarter feel very well prepared to differentiate computer science instruction to meet the needs of diverse learners or to incorporate students' cultural backgrounds into computer science instruction.

Table 2.56
High School Computer Science Teachers Considering Themselves Very Well Prepared for Each of a Number of Tasks

	PERCENT OF TEACHERS
Encourage students' interest in computer science	49 (3.6)
Develop students' abilities to do computer science (e.g., breaking problems into smaller parts, considering the needs of a user, creating computational artifacts)	48 (3.7)
Encourage participation of all students in computer science	45 (3.8)
Develop students' conceptual understanding	42 (3.6)
Develop students' awareness of STEM careers	36 (4.2)
Use formative assessment to monitor student learning	35 (3.4)
Provide computer science instruction that is based on students' ideas	28 (3.9)
Differentiate computer science instruction to meet the needs of diverse learners	21 (3.3)
Incorporate students' cultural backgrounds into computer science instruction	16 (3.1)

Table 2.57 shows the mean composite score for high school computer science teachers' perceptions of pedagogical preparedness. The mean score of 68 is quite similar to the mean score for high school science and mathematics teachers.

Table 2.57
Mean Scores for High School Computer Science Teachers' Perceptions of Pedagogical Preparedness Composite

	MEAN SCORE
Overall	68 (1.7)

High school computer science teachers were also asked about their preparedness for unit-related tasks. As can be seen in Table 2.58, computer science teachers tend to feel less well prepared for (1) finding out what students thought or already knew about the key ideas to be addressed in the unit and (2) anticipating what difficulties students may have in the unit than they do for monitoring understanding during or assessing understanding at the end of the unit.

Table 2.58
High School Computer Science Classes in Which Teachers Feel Very Well Prepared for Various Tasks in the Most Recent Unit

	PERCENT OF CLASSES
Monitor student understanding during this unit	43 (4.6)
Assess student understanding at the conclusion of this unit	41 (4.0)
Implement the instructional materials to be used during this unit	41 (4.2)
Find out what students thought or already knew about the key computer science ideas	29 (4.6)
Anticipate difficulties that students may have with particular computer science ideas and procedures in this unit	26 (3.9)

High school computer science teachers' perceptions of preparedness to implement instruction in a particular unit are shown in Table 2.59. Their feelings of preparedness in this area are consistent with their perceptions of pedagogical preparedness more broadly (see Table 2.57).

Table 2.59
Mean Scores for High School Computer Science Teachers' Perceptions of Preparedness to Implement Instruction in Particular Unit Composite

	MEAN SCORE
Overall	71 (1.6)

Scores on the teacher perceptions of preparedness composites were analyzed by a number of equity variables. In science, the most striking differences are among classes of students with different levels of prior achievement (see Table 2.60). Compared to classes of mostly low prior achievers, teachers of classes with mostly high prior achievers are more likely to feel well prepared to teach science content, implement pedagogies (e.g., develop students' abilities to do science, encourage students' interest in science and/or engineering), and implement instruction in a particular unit. Although the same pattern appears in teachers' perceptions of preparedness to teach engineering, the difference between classes of mostly high prior achievers and mostly low prior achievers is not statistically significant. In addition, classes containing a higher proportion of students from race/ethnicity groups historically underrepresented in STEM and classes in higher-poverty schools are less likely to be taught by teachers who feel well prepared to teach science content and implement instruction in a particular unit.

Table 2.60
Equity Analyses of Class Mean Scores for Science Teacher Perceptions of Preparedness Composites

	MEAN SCORE			
	SCIENCE CONTENT PREPAREDNESS	PREPAREDNESS TO TEACH ENGINEERING†	PEDAGOGICAL PREPAREDNESS	PREPAREDNESS TO IMPLEMENT INSTRUCTION IN PARTICULAR UNIT
Prior Achievement Level of Class				
Mostly High	81 (1.3)	38 (1.9)	72 (1.1)	82 (0.9)
Average/Mixed	62 (0.8)	38 (1.0)	63 (0.7)	73 (0.6)
Mostly Low	61 (1.7)	33 (2.6)	60 (1.3)	69 (1.4)
Percent of Historically Underrepresented Students in Class				
Lowest Quartile	67 (1.4)	38 (1.8)	64 (0.9)	75 (1.0)
Second Quartile	66 (1.3)	37 (1.7)	65 (1.0)	77 (0.9)
Third Quartile	63 (1.5)	39 (1.6)	64 (1.1)	74 (1.0)
Highest Quartile	62 (1.5)	35 (2.0)	62 (1.7)	70 (1.4)
Percent of Students in School Eligible for FRL				
Lowest Quartile	68 (1.6)	38 (1.5)	64 (1.0)	76 (0.9)
Second Quartile	65 (1.5)	39 (1.5)	65 (1.1)	75 (0.9)
Third Quartile	63 (1.5)	35 (1.6)	63 (1.3)	73 (1.1)
Highest Quartile	62 (1.5)	37 (2.2)	63 (1.4)	71 (1.4)

† The Perceptions of Preparedness to Teach Engineering composite was computed only for secondary science classes.

Table 2.61 shows the mean scores on each of the teacher preparedness composites for mathematics classes by the same three equity variables. As is the case in science, classes of mostly high prior achievers are significantly more likely than those that include mostly low prior achievers to be taught by teachers who feel well prepared in mathematics content and to implement instruction in a particular unit. Also similar to science, classes containing a higher proportion of students from race/ethnicity groups historically underrepresented in STEM and classes in higher poverty schools are somewhat less likely to be taught by teachers who feel well prepared to implement instruction in a particular unit.

Table 2.61
Equity Analyses of Class Mean Scores for Mathematics Teacher Perceptions of Preparedness Composites

	MEAN SCORE		
	CONTENT PREPAREDNESS	PEDAGOGICAL PREPAREDNESS	PREPAREDNESS TO IMPLEMENT INSTRUCTION IN PARTICULAR UNIT
Prior Achievement Level of Class			
Mostly High	84 (0.8)	71 (0.9)	85 (0.8)
Average/Mixed	79 (0.5)	70 (0.6)	82 (0.6)
Mostly Low	78 (1.1)	69 (1.1)	79 (1.0)
Percent of Historically Underrepresented Students in Class			
Lowest Quartile	81 (0.7)	68 (0.7)	83 (0.7)
Second Quartile	80 (0.8)	70 (0.8)	83 (0.9)
Third Quartile	78 (0.7)	70 (1.0)	81 (1.1)
Highest Quartile	79 (0.9)	71 (0.8)	80 (0.7)
Percent of Students in School Eligible for FRL			
Lowest Quartile	82 (0.7)	71 (0.8)	84 (0.8)
Second Quartile	79 (0.8)	69 (0.8)	82 (1.0)
Third Quartile	79 (0.9)	68 (0.9)	80 (0.9)
Highest Quartile	79 (0.9)	71 (0.8)	80 (0.7)

When examining these composites by equity factors for high school computer science, the results differ from those in science and mathematics (see Table 2.62). Although there appear to be relationships between the composites and the equity factors, none of the differences are statistically significant.

Table 2.62
Equity Analyses of Class Mean Scores for High School Computer Science Teacher Perceptions of Preparedness Composites

	MEAN SCORE		
	CONTENT PREPAREDNESS	PEDAGOGICAL PREPAREDNESS	PREPAREDNESS TO IMPLEMENT INSTRUCTION IN PARTICULAR UNIT
Prior Achievement Level of Class			
Mostly High	68 (2.3)	67 (2.2)	73 (3.1)
Average/Mixed	67 (2.1)	71 (2.3)	72 (2.3)
Percent of Historically Underrepresented Students in Class			
Lowest Quartile	64 (3.9)	65 (2.7)	70 (3.4)
Second Quartile	72 (3.5)	74 (3.8)	72 (3.1)
Third Quartile	65 (3.8)	68 (2.9)	75 (2.6)
Highest Quartile	69 (2.8)	73 (2.6)	73 (4.2)
Percent of Students in School Eligible for FRL			
Lowest Quartile	68 (1.9)	69 (2.4)	75 (2.1)
Second Quartile	66 (2.4)	68 (2.5)	70 (4.0)
Third Quartile	66 (5.1)	70 (4.6)	72 (2.5)
Highest Quartile	71 (4.8)	75 (3.9)	70 (5.8)

Teachers' Leadership Roles and Responsibilities

In addition to asking teachers about their educational background, beliefs, and preparedness, the survey asked teachers whether they have served in various leadership roles in the profession in the last three years. As can be seen in Table 2.63, elementary science teachers are far less likely than secondary teachers to have had many of these responsibilities. For example, 44–51 percent of secondary science teachers have: (1) served on a school- or district-wide committee specific to their subject or (2) observed another teachers' science lesson in order to provide feedback. Relatively few elementary science teachers have served in these roles. Elementary teachers may have fewer opportunities to serve on subject-specific committees or as an observer, as many are responsible for teaching all subjects in a self-contained setting on the same schedule as their colleagues. Secondary science teachers are also more likely than elementary teachers to have served as a formal mentor or coach for a science teacher. In contrast, elementary teachers are more likely to have supervised student teachers in the last three years.

Table 2.63
Science Teachers Having Various Leadership Responsibilities Within the Last Three Years, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Served on a school or district/diocese-wide science committee	22 (1.9)	44 (3.1)	51 (2.0)
Observed another teacher's science lesson for the purpose of giving him/her feedback	11 (1.6)	44 (3.1)	50 (2.3)
Taught a science lesson for other teachers in their school to observe	8 (1.1)	37 (2.9)	38 (2.1)
Served as a lead teacher or department chair in science	14 (1.6)	37 (2.7)	33 (2.0)
Led or co-led a workshop or professional learning community for other teachers focused on science or science teaching	8 (1.4)	22 (2.3)	28 (1.7)
Served as a formal mentor or coach for a science teacher	4 (0.7)	21 (2.1)	27 (1.8)
Supervised a student teacher in their classroom	30 (2.2)	22 (2.2)	22 (2.3)

Roles and responsibilities held by mathematics teachers within the past three years are quite similar to those held by science teachers and vary by grade range in similar ways (see Table 2.64). Secondary mathematics teachers, like secondary science teachers, are more likely than their elementary counterparts to have served as a formal mentor but less likely to have supervised student teachers. Elementary teachers are much more likely to have taught a mathematics lesson for other teachers in their school to observe than a science lesson.

Table 2.64
Mathematics Teachers Having Various Leadership Responsibilities Within the Last Three Years, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Observed another teacher's mathematics lesson for the purpose of giving him/her feedback	27 (1.9)	47 (3.0)	53 (2.0)
Served on a school or district/diocese-wide mathematics committee	21 (1.6)	45 (2.9)	49 (2.1)
Taught a mathematics lesson for other teachers in their school to observe	28 (1.7)	43 (2.9)	41 (2.4)
Served as a formal mentor or coach for a mathematics teacher	6 (1.2)	21 (1.9)	29 (2.0)
Served as a lead teacher or department chair in mathematics	14 (1.6)	31 (2.3)	28 (1.8)
Led or co-led a workshop or professional learning community for other teachers focused on mathematics or mathematics teaching	10 (1.2)	23 (2.2)	26 (1.8)
Supervised a student teacher in their classroom	27 (2.2)	21 (2.1)	20 (1.8)

Table 2.65 shows results in this area for high school computer science teachers. Over a third have (1) served on a school computer science committee, (2) been a lead teacher or department chair, and (3) taught a computer science lesson for other teachers to observe. Results in this area may be lower for computer science than the other subjects because, in high schools that offer computer science, many have only one computer science teacher.

Table 2.65
High School Computer Science Teachers Having Various Leadership Responsibilities Within the Last Three Years

	PERCENT OF TEACHERS
Served on a school or district/diocese-wide computer science committee	39 (4.0)
Served as a lead teacher or department chair	36 (3.6)
Taught a computer science lesson for other teachers to observe	36 (3.7)
Led or co-led a workshop or professional learning community for other teachers focused on computer science or computer science teaching	22 (3.1)
Observed another teacher's computer science lesson for the purpose of giving him/her feedback	17 (2.7)
Supervised a student teacher in their classroom	15 (2.6)
Served as a formal mentor or coach for a computer science teacher	10 (2.2)

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 prepared in each area. About three-quarters of elementary teachers feel very well prepared to teach reading/language arts and mathematics, but fewer than half feel very well prepared to teach science.

In part, this result may be due to very few elementary science and mathematics teachers having undergraduate majors in these fields. Elementary teachers also have less extensive college coursework in science/mathematics than their middle grades counterparts, who in turn have had less science/mathematics coursework than their high school counterparts. High school computer science teachers have had little college coursework in their field, with only about one-quarter having a degree in the subject. Many teachers at all grade levels have less extensive backgrounds in the discipline they teach than is recommended by NSTA, NCTM, and CTSA/ ISTE. In addition, few science teachers, at any grade level, feel well prepared to teach engineering, a key element of the Next Generation Science Standards (NGSS).

Teachers' beliefs about effective instruction are, in some ways, in line with current recommendations from research and, in other ways, are not well aligned. A large majority of teachers in all subject/grade-range categories hold relatively strong reform-oriented beliefs (e.g., believing that it is better to cover fewer topics in depth). However, many continue to share beliefs characteristic of more traditional instruction, such as believing that students should be given definitions for new vocabulary at the beginning of instruction, that teachers should explain an idea to students before having them consider evidence for it, and that hands-on activities should be used primarily to reinforce ideas students have already learned.

The 2018 NSSME+ also found that well-prepared teachers are not necessarily equitably distributed. Classes in schools with high proportions of students eligible for free/reduced-price lunch are more likely than classes in schools with few such students to be taught by new teachers. In addition, science and mathematics classes categorized as consisting of "mostly high prior achievers" are more likely than those categorized as "mostly low prior achievers" to be taught by teachers who feel well prepared to implement instruction in a particular unit (e.g., implement the instructional materials, monitor student understanding). Unlike science and mathematics, there are no statistically significant differences by these factors for computer science classes.

About half or fewer science and mathematics teachers have held various leadership roles in the profession (e.g., serving on a science committee, supervising a student teacher, leading a workshop) in the last three years. In most cases, elementary science and mathematics teachers are the least likely to hold such roles, with the exception of supervising a student teacher, in which elementary teachers are more likely than their secondary counterparts. Fewer than 40 percent of high school computer science teachers have served in such capacities. These teachers may have limited opportunities to take on roles such as observing others' instruction, teaching a lesson for others to observe, or serving as a mentor, because in many high schools that offer computer science courses, there is only one computer science teacher.