NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

2018 NSSME+: Trends in U.S. Science Education From 2012 to 2018

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horizon RESEARCH, INC.

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Additional Information

More details and products from the 2018 NSSME+, as well as previous iterations of the study, can be found at: http://horizon-research.com/NSSME/

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Introduction

In 2018, the National Science Foundation supported the sixth in a series of surveys through a grant to Horizon Research, Inc. (HRI). The first survey was conducted in 1977 as part of a major assessment of science and mathematics education and consisted of a comprehensive review of the literature; case studies of 11 districts throughout the United States; and a national survey of teachers, principals, and district and state personnel. A second survey of teachers and principals was conducted in 1985–86 to identify trends since 1977. A third survey was conducted in 1993, a fourth in 2000, and a fifth in 2012. This series of studies has been known as the National Survey of Science and Mathematics Education (NSSME).

The 2018 iteration of the study included an emphasis on computer science, particularly at the high school level, which is increasingly prominent in discussions about K–12 STEM education and college and career readiness. The 2018 NSSME+ (the plus symbol reflecting the additional focus) was designed to provide up-to-date information and to identify trends in the areas of teacher background and experience, curriculum and instruction, and the availability and use of instructional resources. The research questions addressed by the study are:

1. To what extent do computer science, mathematics, and science instruction reflect what is known about effective teaching?
2. What are the characteristics of the computer science/mathematics/science teaching force in terms of race, gender, age, content background, beliefs about teaching and learning, and perceptions of preparedness?
3. What are the most commonly used textbooks/programs, and how are they used?
4. What influences teachers' decisions about content and pedagogy?
5. What formal and informal opportunities do computer science/mathematics/science teachers have for ongoing development of their knowledge and skills?
6. How are resources for computer science/mathematics/science education, including well-prepared teachers and course offerings, distributed among schools in different types of communities and different socioeconomic levels?

Complete details of the study—sample design, sampling error considerations, instrument development, data collection, and file preparation and analysis—as well as copies of the instruments are included in the Report of the 2018 NSSME+.[1]

This report focuses on trends in science education between 2012 and 2018. Importantly, the Next Generation Science Standards (NGSS)[2] were released in 2013. At the time surveys were administered in 2018, 39 states and the District of Columbia (DC) had adopted the NGSS or NGSS-like standards, some as early as 2013 and some as recently as 2017. Fifteen states and

[1] This and other products from the study are available free of charge at: http://horizon-research.com/NSSME.

[2] NGSS Lead States. (2013). *Next generation science standards: For states, by states.* The National Academies Press.

DC adopted in 2013 and 2014, 24 states between 2015 and 2017. Together, these states account for roughly two-thirds of the nation's K–12 student. The 2012 data can be thought of a baseline with regard to the NGSS.

Although a few items were revised between administrations of the surveys, large portions of the instruments remained the same. Only items that were substantively the same in 2012 and 2018 are included in this report; items with minor changes are described in table notes. All possible differences—both for individual items and for composite variables[3]—between 2012 and 2018 were tested for statistical significance. Statistically significant changes ($p < 0.05$) between 2012 and 2018 are denoted by an asterisk in each table.

In addition to providing national estimates, standard errors for these estimates are shown in parentheses in the tables. The standard error provides a measure of the range within which a sample estimate can be expected to fall a certain proportion of the time. For example, it may be estimated that 7 percent of all elementary science lessons involve the use of computers. If the standard error for this estimate is 1 percent, then according to the Central Limit Theorem, 95 percent of all possible samples of that same size selected in the same way would yield computer usage estimates between 5 percent and 9 percent (that is, 7 percent ± 2 standard errors).

The report is organized into major topical areas. Chapter Two focuses on science teachers' backgrounds and beliefs. Basic demographic data are presented along with information about course background, perceptions of preparedness, and pedagogical beliefs. The third chapter examines data on teachers' opportunities for professional development. Chapter Four presents information about the time spent on science in the elementary grades and about science offerings at the secondary level. The fifth chapter examines the instructional objectives of science classes and the activities teachers use to achieve these objectives. Chapter Six discusses the availability and use of various types of instructional resources. Finally, the last chapter presents data about a number of factors that are likely to affect science instruction, including school-wide programs, practices, and problems.

[3] Composite variables have the advantage of being more reliable than individual items. Each composite was calculated by summing the responses to the relevant items and then dividing by the total points possible. Composite scores can range from 0 to 100 points; someone who marks the lowest point on every item in a composite receives a score of 0, and someone who marks the highest point on every item receives a score of 100. NOTE: Some composite variables were computed differently in 2012 and 2018. To allow for comparisons across time, these were recomputed using only items common to both time points. Composite definitions are included in the Appendix.

Teacher Background and Beliefs

Overview

A diverse, well-prepared teaching force is essential for an effective education system. This chapter provides data on the nation's science teaching force, including age, gender, race/ethnicity, teaching experience, course background, beliefs about teaching and learning, and perceptions of preparedness, noting changes since 2012.

Teacher Characteristics

As can be seen in Table 2.1, the proportion of science teachers in 2018 who were female decreases as grade level increases, from 94 percent in elementary grades to 57 percent at the high school level. However, the 2018 data are no different than the 2012 data.

Table 2.1
Gender of the Science Teaching Force, by Grade Range†

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Female	94 (0.8)	94 (0.7)
Male	6 (0.8)	6 (0.7)
Middle		
Female	70 (2.0)	71 (1.8)
Male	30 (2.0)	28 (1.8)
High		
Female	54 (1.4)	57 (1.9)
Male	46 (1.4)	43 (1.9)

† There are no statistically significant differences in the distributions of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Teachers who describe themselves as Black/African American, Hispanic, and Asian continued to be underrepresented in the science teaching force in 2018. At a time when only about half of K–12 students are White and non-Hispanic, the vast majority of science teachers in each grade range still characterized themselves that way (see Table 2.2). Further, although there were some small shifts at the high school level, there were no substantial changes in the race/ethnicity composition of the science teaching force between 2012 and 2018.

Table 2.2
Race/Ethnicity of the Science Teaching Force, by Grade Range[a]

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
White	92 (1.4)	88 (1.5)
Hispanic or Latino	8 (1.4)	9 (1.6)
Black or African American	6 (1.2)	8 (1.2)
Asian	2 (0.5)	2 (0.6)
American Indian or Alaskan Native	1 (0.4)	1 (0.6)
Native Hawaiian or Other Pacific Islander	1 (0.3)	1 (0.4)
Middle		
White	91 (1.4)	91 (1.5)
Hispanic or Latino	5 (1.0)	7 (1.2)
Black or African American	6 (1.3)	8 (1.5)
Asian	2 (0.8)	2 (0.5)
American Indian or Alaskan Native	1 (0.3)	2 (0.6)
Native Hawaiian or Other Pacific Islander	0 (0.2)	0 (0.2)
High		
White*	93 (0.7)	91 (1.2)
Hispanic or Latino*	4 (0.6)	6 (0.8)
Black or African American	4 (0.5)	5 (0.9)
Asian*	3 (0.6)	5 (0.9)
American Indian or Alaskan Native	2 (0.4)	2 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.3)	0 (0.1)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Percentages may add to more than 100, as respondents were able to select more than one category.

The majority of the science teaching force was older than 40 in 2018, with roughly 25 percent of science teachers in each grade range being older than 50 (see Table 2.3). Fewer than 20 percent were age 30 or younger, and the distribution of science teachers by age has remained stable since 2012.

Table 2.3
Age (in Years) of the Science Teaching Force, by Grade Range †

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
≤ 30	18 (1.5)	19 (1.6)
31–40	29 (1.8)	28 (1.6)
41–50	25 (1.8)	29 (1.8)
51+	28 (1.8)	25 (1.5)
Middle		
≤ 30	11 (1.0)	17 (2.1)
31–40	28 (2.2)	29 (2.5)
41–50	28 (2.1)	26 (1.9)
51+	33 (2.7)	28 (2.2)
High		
≤ 30	16 (1.4)	14 (0.9)
31–40	30 (1.3)	31 (1.5)
41–50	24 (1.3)	28 (1.3)
51+	29 (1.6)	28 (1.4)

† There are no statistically significant differences in the distributions of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Teachers' experience teaching science at the K–12 level was similar across grade ranges, but the distribution of teachers by years of teaching experience has changed since 2012 among middle and high school science teachers (see Table 2.4). However, there is no clear pattern in the shifts. For example, the change does not appear to be due to teachers having more experience in 2018.

Table 2.4
Years of Experience Teaching Science, by Grade Range

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
0–2 years	16 (1.4)	15 (1.3)
3–5 years	17 (1.6)	19 (1.4)
6–10 years	21 (1.5)	19 (1.6)
11–20 years	28 (1.7)	31 (2.0)
≥ 21 years	17 (1.5)	16 (1.2)
Middle*		
0–2 years	14 (1.7)	21 (2.0)
3–5 years	19 (1.8)	15 (1.7)
6–10 years	26 (2.6)	18 (1.3)
11–20 years	26 (2.1)	34 (2.2)
≥ 21 years	16 (2.4)	12 (1.5)
High*		
0–2 years	13 (1.1)	15 (1.1)
3–5 years	15 (1.2)	13 (0.9)
6–10 years	23 (1.5)	17 (1.4)
11–20 years	31 (1.4)	35 (1.9)
≥ 21 years	18 (1.1)	20 (1.2)

* There is a statistically significant difference in the distribution of the responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

The shift among middle school science teachers is even more pronounced in terms of years of experience teaching at their school (see Table 2.5). In 2018, a third of middle school science teachers were in their first two years at their school.

Table 2.5
Years of Experience Teaching Any Subject at the Current School, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
0–2 years	24 (1.8)	24 (1.7)
3–5 years	23 (1.7)	24 (1.7)
6–10 years	23 (1.7)	18 (1.3)
11–20 years	21 (1.4)	24 (1.7)
≥ 21 years	9 (1.3)	9 (1.2)
Middle*		
0–2 years	22 (2.1)	34 (2.4)
3–5 years	22 (2.2)	18 (1.8)
6–10 years	24 (2.5)	20 (2.1)
11–20 years	23 (2.8)	21 (1.6)
≥ 21 years	8 (1.9)	8 (1.2)
High		
0–2 years	23 (1.3)	25 (1.4)
3–5 years	21 (1.2)	21 (1.6)
6–10 years	23 (1.4)	18 (1.3)
11–20 years	24 (1.3)	28 (1.8)
≥ 21 years	9 (1.0)	8 (0.8)

* There is a statistically significant difference in the distribution of the responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

Teacher Preparation

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, the NSSME+ 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 in both 2012 and 2018 had college or graduate degrees in science/engineering, which is not surprising given that the vast majority teach all core subjects. The percentage of teachers with one or more degrees in science/engineering increases as grade range increases, with 79 percent of high school science teachers in 2018 having a major in these fields. If the definition of degree in discipline is expanded to include degrees in science education, the proportion increases to 9 in 10 high school science teachers. Further, in 2018, both middle and high school science teachers were considerably more likely to have a degree in science or engineering compared to 2012.

Table 2.6
Science Teacher Degrees, by Grade Range

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
Science/Engineering	4 (0.7)	3 (0.5)
Science Education*	2 (0.5)	1 (0.3)
Science/Engineering or Science Education	5 (0.8)	3 (0.7)
Middle		
Science/Engineering*	26 (2.0)	42 (2.2)
Science Education*	27 (1.9)	36 (2.8)
Science/Engineering or Science Education*	41 (2.5)	54 (2.9)
High		
Science/Engineering*	61 (1.6)	79 (1.4)
Science Education*	48 (1.4)	57 (2.1)
Science/Engineering or Science Education*	82 (1.3)	91 (1.1)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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 in 2018 had coursework in the life sciences, and 59–72 percent had coursework in Earth/space science. In contrast, the percentage of teachers with at least one college course in chemistry or physics increases substantially with increasing grade range. Few teachers at any grade level had coursework in engineering.

For the most part, these percentages have not changed substantially since 2012, despite the increase in the proportion of middle and high school science teachers with a degree in science, engineering, or science education. Some exceptions are evident among middle school science teachers, who were more likely in 2018 than in 2012 to have at least one course in chemistry and physics but slightly less likely to have a course in biology. Also, elementary teachers were more likely in 2018 to have a course in environmental science and engineering, although for the latter, the change was only from 1 to 3 percent.

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

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
Biology/Life Science	90 (1.1)	89 (1.2)
Earth/Space Science	65 (2.0)	66 (1.5)
Chemistry	47 (1.8)	45 (1.8)
Environmental Science*	33 (1.8)	40 (1.8)
Physics	32 (1.7)	31 (1.7)
Engineering*	1 (0.4)	3 (0.5)
Middle		
Biology/Life Science*	96 (0.9)	91 (1.5)
Earth/Space Science	75 (2.3)	72 (2.4)
Chemistry*	72 (2.3)	80 (2.2)
Environmental Science	57 (2.5)	58 (2.3)
Physics*	61 (2.3)	69 (2.4)
Engineering	7 (1.1)	10 (1.7)
High		
Biology/Life Science	91 (0.9)	93 (0.7)
Earth/Space Science	61 (1.7)	59 (1.6)
Chemistry	93 (1.1)	95 (0.6)
Environmental Science	56 (1.1)	53 (1.3)
Physics	86 (1.1)	85 (1.4)
Engineering	14 (1.0)	13 (1.1)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Tables 2.8–2.12 provide additional information about secondary science teacher coursework in biology, chemistry, physics, Earth/space science, and environmental science. Each table shows the percentage of middle and high school teachers who had one or more courses beyond the introductory level, as well as the percentage who completed each of a number of individual courses. Teachers were also asked whether they had one or more teaching methods courses in a given discipline. In 2018, about half of teachers at each level 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) had methods courses in the other disciplines. In terms of differences between 2012 and 2018, slightly more middle school science teachers in 2018 had a course in genetics, microbiology, biochemistry, and evolution, but slightly fewer had an introductory course in biology (see Table 2.8). High school teachers were slightly more likely in 2018 to have a course in evolution than in 2012.

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

	PERCENT OF TEACHERS	
	2012	**2018**
Middle		
Introductory Biology/Life Science*	**96 (0.9)**	**88 (2.0)**
One or More Biology/Life Science Courses Beyond the Introductory Level	**65 (2.6)**	**65 (2.3)**
Anatomy/physiology	36 (2.1)	37 (2.1)
Ecology	33 (2.1)	34 (2.6)
Cell biology	28 (2.0)	34 (2.3)
Genetics*	24 (1.9)	33 (2.2)
Microbiology*	23 (1.7)	28 (1.7)
Botany	26 (2.0)	27 (2.1)
Zoology	25 (1.8)	24 (1.9)
Biochemistry*	16 (1.5)	22 (2.0)
Evolution*	14 (1.5)	21 (2.1)
Other biology/life science beyond the general/introductory level	35 (2.4)	33 (2.3)
Biology/Life Science Teaching Methods Course	**58 (2.8)**	**52 (2.2)**
High		
Introductory Biology/Life Science	**91 (0.9)**	**92 (0.8)**
One or More Biology/Life Science Courses Beyond the Introductory Level	**79 (1.2)**	**79 (1.5)**
Anatomy/physiology	54 (1.5)	51 (1.8)
Ecology	50 (1.5)	50 (1.8)
Cell biology	48 (1.5)	50 (1.7)
Genetics	54 (1.2)	56 (1.7)
Microbiology	48 (1.4)	48 (1.7)
Botany	44 (1.4)	40 (1.7)
Zoology	40 (1.4)	37 (1.6)
Biochemistry	43 (1.5)	43 (1.9)
Evolution*	27 (1.2)	32 (1.8)
Other biology/life science beyond the general/introductory level	47 (1.5)	45 (1.9)
Biology/Life Science Teaching Methods Course	**52 (1.5)**	**52 (1.7)**

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Looking at chemistry courses, middle school science teachers in 2018 were more likely than those in 2012 to have an introductory course, as well as a course in organic chemistry and biochemistry (see Table 2.9). Among high school teachers, the only change was in analytic chemistry, where the percentage of teachers with this course decreased from 29 percent in 2012 to 25 percent in 2018.

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

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Introductory Chemistry*	**72 (2.3)**	**79 (2.2)**
One or More Chemistry Courses Beyond the Introductory Level	**35 (2.3)**	**41 (2.3)**
Organic chemistry*	25 (2.0)	32 (2.1)
Biochemistry*	14 (1.4)	20 (2.0)
Inorganic chemistry	17 (1.7)	18 (1.7)
Physical chemistry	11 (1.1)	12 (1.4)
Analytic chemistry	7 (1.3)	7 (1.2)
Quantum chemistry	2 (0.6)	2 (0.4)
Other chemistry beyond the general/introductory level	8 (1.0)	8 (1.0)
Chemistry Teaching Methods Course	**15 (1.3)**	**15 (1.9)**
High		
Introductory Chemistry	**93 (1.1)**	**95 (0.6)**
One or More Chemistry Courses Beyond the Introductory Level	**74 (1.3)**	**72 (1.7)**
Biochemistry	40 (1.4)	40 (1.7)
Organic chemistry	64 (1.5)	64 (1.7)
Inorganic chemistry	46 (1.7)	42 (1.8)
Physical chemistry	26 (1.4)	26 (1.3)
Analytic chemistry*	29 (1.5)	25 (1.2)
Quantum chemistry	8 (0.8)	7 (0.6)
Other chemistry beyond the general/introductory level	19 (0.9)	17 (1.5)
Chemistry Teaching Methods Course	**21 (1.1)**	**23 (1.3)**

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Regarding physics course taking, there were no changes from 2012 to 2018 among middle school science teachers (see Table 2.10). High school teachers were slightly less likely in 2018 to have a course in several areas, including:

- Electricity and magnetism;
- Heat and thermodynamics;
- Mechanics;
- Modern or quantum physics;
- Optics; and
- Nuclear physics.

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

	PERCENT OF TEACHERS	
	2012	**2018**
Middle		
Introductory Physics	**61 (2.3)**	**67 (2.4)**
One or More Physics Courses Beyond the Introductory Level	**15 (1.5)**	**19 (1.8)**
Electricity and magnetism	8 (1.2)	6 (1.0)
Heat and thermodynamics	6 (0.8)	6 (1.3)
Mechanics	6 (1.1)	6 (1.3)
Modern or quantum physics	3 (0.5)	3 (0.7)
Optics	3 (0.5)	2 (0.7)
Nuclear physics	1 (0.3)	1 (0.3)
Other physics beyond the general/introductory level	8 (1.2)	8 (0.9)
Physics Teaching Methods Course	**14 (1.1)**	**16 (1.9)**
High		
Introductory Physics	**86 (1.1)**	**84 (1.4)**
One or More Physics Courses Beyond the Introductory Level*	**36 (1.6)**	**31 (1.6)**
Electricity and magnetism*	21 (1.1)	17 (1.1)
Heat and thermodynamics*	21 (1.1)	14 (1.2)
Mechanics*	22 (1.1)	19 (1.3)
Modern or quantum physics*	16 (1.0)	13 (1.0)
Optics*	13 (1.1)	9 (1.2)
Nuclear physics*	9 (0.8)	6 (0.7)
Other physics beyond the general/introductory level*	20 (1.4)	13 (1.2)
Physics Teaching Methods Course	**17 (1.0)**	**15 (1.3)**

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Course taking in Earth/space science and environmental science was quite stable from 2012 to 2018 (see Table 2.11). In Earth/space science, a smaller percentage of middle school teachers had an introductory course in 2018 than in 2012 (75 vs. 68 percent, respectively). Middle and high school science teachers were less likely in 2018 to have a course in environmental science teaching methods, and high school teachers were less likely to have an introductory course in environmental science (see Table 2.12).

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

	PERCENT OF TEACHERS	
	2012	**2018**
Middle		
Introductory Earth/Space Science*	**75 (2.3)**	**68 (2.6)**
One or More Earth/Space Science Courses Beyond the Introductory Level	**28 (1.8)**	**29 (2.1)**
Geology	22 (1.6)	22 (1.8)
Astronomy/astrophysics	16 (1.3)	15 (1.7)
Physical geography	14 (1.2)	13 (1.6)
Meteorology	9 (1.0)	9 (1.4)
Oceanography	10 (1.4)	8 (0.9)
Other Earth/space science beyond the general/introductory level	10 (1.0)	11 (1.3)
Earth/Space Science Teaching Methods Course	**27 (1.8)**	**22 (1.8)**
High		
Introductory Earth/Space Science	**61 (1.7)**	**58 (1.6)**
One or More Earth/Space Science Courses Beyond the Introductory Level*	**30 (1.4)**	**24 (1.4)**
Geology	23 (1.2)	19 (1.3)
Astronomy/astrophysics*	17 (1.1)	13 (1.2)
Meteorology	11 (1.0)	9 (1.0)
Physical geography	11 (0.9)	9 (1.0)
Oceanography	10 (0.9)	8 (0.9)
Other Earth/space science beyond the general/introductory level	13 (1.0)	11 (1.1)
Earth/Space Science Teaching Methods Course	**14 (1.0)**	**11 (1.1)**

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Introductory Environmental Science	**57 (2.5)**	**55 (2.4)**
One or More Environmental Science Courses Beyond the Introductory Level	**23 (1.7)**	**19 (1.7)**
Ecology	17 (1.6)	15 (1.4)
Conservation biology	8 (1.1)	8 (1.2)
Oceanography	6 (0.8)	5 (0.6)
Forestry	3 (0.6)	4 (1.3)
Hydrology	4 (0.8)	3 (0.6)
Toxicology	2 (0.4)	2 (0.4)
Other environmental science beyond the general/introductory level	10 (1.1)	8 (1.2)
Environmental Science Teaching Methods Course*	**20 (1.9)**	**14 (1.9)**
High		
Introductory Environmental Science*	**56 (1.1)**	**52 (1.2)**
One or More Environmental Science Courses Beyond the Introductory Level	**27 (1.3)**	**26 (1.4)**
Ecology	21 (1.3)	22 (1.3)
Conservation biology	10 (1.0)	11 (0.9)
Oceanography	9 (0.9)	8 (1.0)
Forestry	5 (0.6)	5 (1.0)
Hydrology	5 (0.6)	4 (0.6)
Toxicology	3 (0.5)	3 (0.5)
Other environmental science beyond the general/introductory level	13 (0.9)	13 (1.1)
Environmental Science Teaching Methods Course*	**13 (0.9)**	**7 (0.6)**

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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.[4] 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 in 2018 had courses in all three of those areas, and another 37 percent 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. The distribution of elementary teachers by amount of coursework was unchanged since 2012.

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

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

	PERCENT OF TEACHERS	
	2012	2018
Courses in Earth, life, and physical science[a]	36 (1.6)	34 (1.5)
Courses in 2 of the 3 areas	39 (1.8)	37 (1.6)
Course in 1 of the 3 areas	21 (1.4)	23 (1.4)
Courses in 0 of the 3 areas	5 (0.9)	7 (1.0)

† There is no statistically significant difference in the distribution of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

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

Forty-seven percent of middle grades teachers of general or integrated science had at least one college course in chemistry, Earth science, life science, and physics in 2018 (see Table 2.14). An additional 30 percent had coursework in 3 of the 4 areas. Compared to 2012, there was shift in the distribution of teachers by coursework, but there is no clear pattern of change.

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

	PERCENT OF TEACHERS*	
	2012	2018
Courses in chemistry, Earth science, life science, and physics	44 (2.6)	47 (2.6)
Courses in 3 of the 4 areas	27 (2.6)	30 (3.0)
Courses in 2 of the 4 areas	22 (2.2)	13 (1.9)
Course in 1 of the 4 areas	5 (1.0)	4 (0.9)
Courses in 0 of the 4 areas	1 (1.0)	7 (2.4)

* There is a statistically significant difference in the distribution of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

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 shows the percentage of teachers of each of these courses with a degree in the field in 2012 and 2018. The percentage of middle school life science/biology teachers with a degree in the subject increased from 27 to 40 percent between 2012 and 2018. At the high school level, both life science/biology and chemistry teachers were more likely to have a degree in their subject in 2018 than in 2012. The increase among chemistry teachers is particularly striking.

Table 2.15
Secondary Science Teachers With a Degree in Field, by Grade Range[a]

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Life science/biology*	27 (4.0)	40 (4.5)
Physical science	9 (3.9)	7 (3.3)
Earth science	10 (2.8)	5 (1.3)
High		
Life science/biology*	54 (2.4)	63 (2.5)
Chemistry*	25 (1.8)	42 (2.7)
Physics	20 (2.4)	24 (2.6)
Earth science	15 (2.9)	15 (2.9)
Environmental science	9 (2.9)	11 (3.4)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

At the opposite extreme, a quarter of Earth science teachers in 2018 had no coursework in the subject (see Table 2.16). In addition, there was an increase in the percentage of environmental science teachers with no coursework in the field, from 20 to 31 percent.

Table 2.16
Secondary Science Teachers With No Coursework in Subject, by Grade Range[a]

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Life science/biology	5 (2.7)	6 (2.0)
Physical science	18 (5.5)	9 (2.2)
Earth science	20 (3.7)	26 (5.3)
High		
Life science/biology	2 (0.9)	1 (0.5)
Chemistry	4 (2.1)	1 (0.6)
Physics	2 (0.7)	4 (1.2)
Earth science	15 (3.5)	26 (5.7)
Environmental science*	20 (3.7)	31 (4.4)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

Teachers were also asked about their path to certification. As can be seen in Table 2.17, elementary science teachers in 2018 were 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. High school science teachers were more likely than their elementary school counterparts to have completed a post-baccalaureate credentialing program that did not include a master's degree. And despite the increasing opportunities available for certification, these data have not changed since 2012.

Table 2.17
Science Teachers' Paths to Certification, by Grade Range†

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
An undergraduate program leading to a bachelor's degree and a teaching credential	61 (2.6)	65 (1.9)
A post-baccalaureate credentialing program (no master's degree awarded)	13 (1.8)	11 (1.5)
A master's program that also led to a teaching credential	25 (2.3)	22 (1.8)
Has not earned a teaching credential	1 (0.5)	1 (0.5)
Middle		
An undergraduate program leading to a bachelor's degree and a teaching credential	47 (3.6)	53 (2.8)
A post-baccalaureate credentialing program (no master's degree awarded)	23 (2.5)	20 (2.3)
A master's program that also led to a teaching credential	26 (3.1)	24 (2.7)
Has not earned a teaching credential	4 (1.5)	4 (1.3)
High		
An undergraduate program leading to a bachelor's degree and a teaching credential	34 (2.0)	40 (1.9)
A post-baccalaureate credentialing program (no master's degree awarded)	30 (1.9)	25 (1.7)
A master's program that also led to a teaching credential	28 (1.8)	28 (2.2)
Has not earned a teaching credential	8 (1.3)	7 (1.0)

† There are no statistically significant differences in the distribution of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Teachers' Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning. Tables 2.18–2.20 show the percentage of science teachers in each grade range agreeing with each of the statements that were asked in both 2012 and 2018. Large majorities of teachers across years and grade ranges agreed with two statements that align closely with what is known about how students learn: (1) students should have opportunities to share their thinking during class and (2) addressing topics in depth is better, even if that means covering fewer topics. The extent of agreement with these statements has not changed since 2012.

Unfortunately, agreement with statements that do not align with best practice is also largely unchanged, except for among elementary teachers, where the percentage agreeing with 3 of the 4 statements dropped between 2012 and 2018. For example, in 2012, 45 percent of elementary teachers agreed that teachers should explain an idea to students before having them consider evidence that relates to the idea, which runs counter to the principle that students should construct understanding by considering evidence. In 2018, only 33 percent of elementary teachers agreed with this statement. Middle school science teachers were also less likely to agree with this statement in 2018 than in 2012 (30 and 41percent, respectively). In 2018, high school teachers were less likely to agree that students learn science best in classes with students of similar abilities (60 and 65 percent, respectively).

Table 2.18
Elementary School Science Teachers Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	2018
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	98 (0.5)	96 (0.9)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	72 (1.6)	75 (2.1)
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.*	85 (1.3)	77 (2.1)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	54 (1.9)	56 (2.4)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.*	45 (1.9)	33 (2.1)
Students learn science best in classes with students of similar abilities.*	32 (1.7)	25 (1.9)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

Table 2.19
Middle School Science Teachers Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	2018
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	95 (1.1)	92 (1.9)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	77 (1.9)	74 (2.9)
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.	78 (2.1)	72 (2.3)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	57 (2.8)	57 (2.6)
Students learn science best in classes with students of similar abilities.	48 (2.3)	48 (3.6)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.*	41 (2.3)	30 (2.6)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

Table 2.20
High School Science Teachers Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	**2018**
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	92 (0.9)	89 (1.4)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	73 (1.3)	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.	70 (1.7)	66 (2.1)
Students learn science best in classes with students of similar abilities.*	65 (1.7)	60 (1.7)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	56 (1.9)	52 (2.0)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.	39 (1.7)	37 (2.3)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

The items related to traditional beliefs were combined into a composite variable. The composite scores, shown in Table 2.21, indicate that elementary, middle, and high school science teachers held moderately traditional beliefs but also that elementary and middle school teachers' beliefs have become slightly less traditional since 2012.

Table 2.21
Mean Scores for Science Teachers' Traditional Beliefs Composite[a]

	MEAN SCORE	
	2012	**2018**
Elementary*	59 (0.7)	55 (0.9)
Middle*	61 (0.9)	57 (1.1)
High*	61 (0.7)	59 (0.7)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a This composite variable was not originally computed for the 2012 study. To allow for comparisons across time, it was computed for 2012 using the 2018 definition.

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 2.22, these teachers did not feel equally well prepared to teach the various subjects. Although 73 percent of elementary teachers of self-contained classes felt very well prepared to teach mathematics, only 31 percent felt very well prepared to teach science. Further, the percentage of elementary teachers who felt very well prepared to teach science declined from 39 percent in 2012 to 31 percent in 2018.

Table 2.22
Elementary Teachers Feeling Very Well Prepared to Teach Each Subject

	PERCENT OF TEACHERS[a]	
	2012	2018
Reading/Language Arts*	81 (1.0)	77 (1.2)
Mathematics	77 (1.7)	73 (1.6)
Social studies*	47 (1.5)	42 (1.3)
Science*	39 (2.1)	31 (1.9)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

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

Focusing on science specifically, no more than a quarter of elementary teachers in 2018 felt very well prepared to teach the individual disciplines of life, Earth/space, and physical science (see Table 2.23). In addition, each of these percentages declined between 2012 and 2018. Somewhat encouraging is the large drop in the percentage of teachers who did not feel adequately prepared to teach engineering (see Table 2.24).

Table 2.23
Elementary Teachers Feeling
Very Well Prepared to Teach Various Science Disciplines

	PERCENT OF TEACHERS	
	2012	2018
Life science*	29 (1.6)	24 (1.5)
Earth/Space science*	26 (1.4)	20 (1.5)
Physical science*	17 (1.2)	13 (1.1)
Engineering	4 (0.6)	3 (0.6)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Table 2.24
Elementary Teachers Feeling
Not Adequately Prepared to Teach Various Science Disciplines

	PERCENT OF TEACHERS	
	2012	2018
Life science/biology	4 (0.6)	3 (0.7)
Earth/Space science*	4 (0.6)	6 (0.8)
Physical science	8 (1.0)	11 (1.3)
Engineering*	73 (1.7)	51 (2.2)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

The teacher questionnaires included a series of items about a single, randomly selected science class in the respondent's schedule. 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 2.25, middle school teachers' feelings of preparedness have changed little since 2012. The two exceptions in the percentage that felt very well prepared are both decreases—regarding Earth's features and physical processes, from 51 to 42 percent, and climate and weather, from 42 to 31 percent. The latter is particularly discouraging given the prominence of the topic, unless the decrease reflects teachers' heightened awareness of their lack of preparedness.

Table 2.25
Middle School Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF TEACHERS[a]	
	2012	2018
Earth/Space Science		
Earth's features and physical processes*	51 (2.9)	42 (2.2)
The solar system and the universe	36 (2.6)	32 (2.0)
Climate and weather*	42 (3.0)	31 (2.3)
Biology/Life Science		
Structures and functions of organisms	52 (3.1)	55 (2.7)
Ecology/ecosystems	48 (2.6)	52 (3.0)
Cell biology	49 (2.6)	50 (2.6)
Genetics	41 (2.5)	46 (3.0)
Evolution	33 (2.5)	40 (2.8)
Chemistry		
States, classes, and properties of matter	58 (2.5)	55 (2.6)
The periodic table	49 (2.3)	47 (3.0)
Atomic structure	45 (2.4)	46 (3.2)
Elements, compounds, and mixtures	53 (2.6)	45 (2.6)
Properties of solutions	33 (2.3)	30 (2.2)
Chemical bonding, equations, nomenclature, and reactions	31 (2.0)	28 (2.6)
Physics		
Forces and motion	42 (2.7)	44 (3.5)
Energy transfers, transformations, and conservation	37 (2.6)	39 (3.0)
Properties and behaviors of waves	23 (2.5)	21 (2.1)
Electricity and magnetism	23 (2.5)	19 (2.0)
Modern physics	5 (1.3)	7 (1.3)
Environmental and Resource Issues (e.g., land and water use, energy resources and consumption, sources and impacts of pollution)	35 (3.0)	31 (2.8)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Each middle school science teacher was asked about one set of science topics based on the discipline of his/her randomly selected class.

With only a couple of exceptions, there were no substantial changes between 2012 and 2018 in high school science teachers' ratings of preparedness (see Table 2.26). Among Earth/space teachers, the percentage of teachers who felt very well prepared to teach about Earth's features and physical processes decreased from 74 to 57 percent. Among chemistry teachers, the percentage that felt very well prepared to teach about atomic structure increased from 83 to 91 percent.

Table 2.26
High School Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Grade Range

	PERCENT OF TEACHERS[a]	
	2012	**2018**
Earth/Space Science		
Earth's features and physical processes*	74 (4.1)	57 (7.1)
The solar system and the universe	59 (4.9)	54 (6.9)
Climate and weather	60 (6.3)	54 (6.9)
Biology/Life Science		
Cell biology	75 (2.9)	75 (2.1)
Structures and functions of organisms	68 (3.1)	72 (2.9)
Genetics	69 (3.0)	71 (2.8)
Ecology/ecosystems	61 (2.7)	65 (2.8)
Evolution	56 (3.2)	63 (2.6)
Chemistry		
The periodic table	88 (3.2)	92 (1.9)
States, classes, and properties of matter	83 (3.2)	90 (1.9)
Elements, compounds, and mixtures	88 (3.2)	91 (1.9)
Atomic structure*	83 (3.2)	91 (1.7)
Chemical bonding, equations, nomenclature, and reactions	84 (3.4)	89 (1.8)
Properties of solutions	72 (3.4)	79 (2.4)
Physics		
Forces and motion	80 (3.7)	83 (3.8)
Energy transfers, transformations, and conservation	73 (4.5)	80 (3.7)
Properties and behaviors of waves	62 (4.3)	66 (3.8)
Electricity and magnetism	54 (4.0)	49 (4.7)
Modern physics	23 (2.7)	23 (2.8)
Environmental and Resource Issues (e.g., land and water use, energy resources and consumption, sources and impacts of pollution)	57 (6.7)	71 (5.8)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Each high school science teacher was asked about one set of science topics based on the discipline of his/her randomly selected class. High school multidisciplinary science teachers are not included in this table.

Table 2.27 displays mean scores for the composite variable Perceptions of Content Preparedness, which was defined based on the content of the randomly selected science class. The mean scores indicate that: (1) elementary teachers generally did not feel well prepared to teach science and (2) they felt less well prepared in 2018 than they did in 2012. High school teachers overall felt slightly better prepared in 2018 than they did in 2012.

Table 2.27
Mean Scores for Science Teachers' Perceptions of Content Preparedness Composite, by Grade Range

	MEAN SCORE	
	2012	**2018**
Elementary		
Science (Grades K–5)*	55 (2.6)	50 (0.8)
Middle		
All Middle School Sciences	**71 (1.2)**	**72 (0.8)**
Life Science	76 (3.5)	82 (2.0)
Earth/Space Science	78 (2.8)	80 (2.3)
Physical Science	69 (3.5)	71 (2.2)
Integrated/General Science	66 (1.1)	66 (1.0)
High		
All High School Sciences*	**85 (0.8)**	**88 (0.6)**
Chemistry	93 (1.9)	96 (0.8)
Biology/Life Science	86 (1.5)	87 (0.8)
Earth/Space Science	84 (1.9)	82 (2.5)
Physics	80 (1.7)	81 (1.4)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

One series of items focused on teacher preparedness for a number of tasks associated with instruction. Specifically, teachers responded to several items about how well prepared they felt to monitor and address student understanding, focusing on a specific unit in the randomly selected class. As can be seen in Table 2.28, elementary teachers were less likely to feel very well prepared for each of these tasks in 2018 than they did in 2012. For example, in 2012, 46 percent felt very well prepared to assess student understanding at the conclusion of the unit, compared to 32 percent in 2018. Among high school science teachers, there was a small decrease for the same item (from 64 to 59 percent), but otherwise there were no substantial changes among middle and high school teachers.

Table 2.28
Science Classes in Which Teachers Felt 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	
	2012	2018
Elementary		
Assess student understanding at the conclusion of this unit*	46 (2.2)	32 (1.8)
Monitor student understanding during this unit*	46 (2.2)	33 (1.9)
Implement the instructional materials to be used during this unit*,[a]	39 (2.7)	32 (2.0)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit*	28 (1.8)	22 (1.9)
Find out what students thought or already knew about the key science ideas*	38 (1.8)	31 (2.2)
Middle		
Assess student understanding at the conclusion of this unit	59 (2.5)	58 (2.0)
Monitor student understanding during this unit	51 (2.2)	51 (2.1)
Implement the instructional materials to be used during this unit[a]	51 (2.9)	45 (2.4)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	39 (2.3)	37 (2.1)
Find out what students thought or already knew about the key science ideas	41 (2.4)	39 (2.1)
High		
Assess student understanding at the conclusion of this unit*	64 (1.6)	59 (1.8)
Monitor student understanding during this unit	57 (1.6)	53 (1.8)
Implement the instructional materials to be used during this unit[a]	52 (2.3)	53 (1.6)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	49 (1.5)	45 (1.6)
Find out what students thought or already knew about the key science ideas*	42 (1.4)	38 (1.6)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] In 2012, this item was presented only to teachers who indicated using commercially published textbooks/modules in the most recent unit.

The items in Table 2.29 were combined to create a composite variable named Perceptions of Preparedness to Implement Instruction in Particular Unit. As can be seen in Table 2.30, feelings of preparedness increase with increasing grade range. It is also clear that elementary teachers' feelings of preparedness decreased between 2012 and 2018.

Table 2.29
Mean Scores for Science Teachers' Perceptions of Preparedness to Implement Instruction in Particular Unit Composite

	MEAN SCORE	
	2012	2018
Elementary*	75 (0.8)	69 (0.9)
Middle	79 (0.8)	78 (0.9)
High	82 (0.6)	80 (0.5)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Summary
In terms of gender and race/ethnicity, the science teaching force remained stable between 2012 and 2018. The vast majority of elementary teachers were female and White. Teacher gender

became somewhat less disproportionate as grade level increases, but race/ethnicity did not. The fact that teacher race/ethnicity has not changed considerably since 2012, even while student demographics have, means that students were increasingly unlikely to be taught by teachers that reflect the nation’s population.

Although the data reveal no changes in teachers’ pathways to certification, they do point to substantial increases in the percentage of secondary teachers with a science-related degree. For example, the percentage of middle grades science teachers with a degree in science or engineering increased from 26 to 42 percent, and the percentage of high school science teachers with such degrees increased from 61 to 79 percent.

The data also indicate some shifts away from traditional beliefs about science instruction, particularly among elementary teachers. For example, between 2012 and 2018, there was a decrease from 45 to 33 percent agreeing that teachers should explain ideas to students before having them consider evidence.

Perhaps the most alarming trends are in elementary teachers’ perceptions of preparedness, with regard to both content and pedagogy. Regarding content, there was a decrease from 39 to 31 percent of teachers who reported feeling very well prepared to teach science. Further, there was a decrease in the percentage who felt very well prepared to teach each science discipline. On a more positive note, the percentage of elementary teachers who reported feeling not adequately prepared to teach engineering decreased from 73 to 51 percent.

In terms of pedagogical preparedness, there were significant decreases in the percentage of elementary teachers who felt very well prepared for each of several pedagogies, including:

- Assessing student understanding at the conclusion of a unit;
- Monitoring student understanding during a unit;
- Implementing the instructional materials to be used during a unit;
- Anticipating difficulties that students may have with particular science ideas and procedures; and
- Finding out what students thought or already knew about the key science ideas.

Science Professional Development

Overview

Science teachers, like all professionals, need opportunities to keep up with advances in their field, including both disciplinary content and how to help their students learn important science concepts. Staying up to date is particularly challenging for science teachers at the elementary level because they typically teach multiple subjects. The 2018 NSSME+ collected data on teachers' participation in in-service education and other professional activities, as well as data on study groups, one-on-one coaching provided by schools and districts. The data are discussed in this chapter, comparing them to data from 2012.

Teacher Professional Development

One important measure of teachers' continuing education is how long it has been since they participated in professional development. In 2018, with the exception of elementary teachers, roughly 80 percent or more of science teachers had participated in discipline-focused professional development (i.e., focused on science content or the teaching of science) within the preceding three years (see Table 3.1). Elementary science teachers stand out for the relative paucity of professional development in science or science teaching, with less than about 60 percent having participated in the preceding three years. The data are largely unchanged since 2012, although there is a shift in the distribution among elementary teachers, which appears to be due to an increase in the percentage who never participated in science professional development.

Table 3.1
Most Recent Participation in Science Professional Development, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary*		
In the last 3 years	59 (2.0)	57 (2.2)
4–6 years ago	16 (1.4)	8 (1.2)
7–10 years ago	5 (0.8)	5 (0.7)
More than 10 years ago	5 (0.8)	6 (1.0)
Never	15 (1.4)	24 (1.5)
Middle		
In the last 3 years	82 (2.3)	78 (2.1)
4–6 years ago	6 (1.2)	6 (1.4)
7–10 years ago	3 (1.0)	2 (0.8)
More than 10 years ago	4 (1.3)	3 (0.8)
Never	6 (1.4)	11 (1.6)
High		
In the last 3 years	85 (1.3)	83 (1.3)
4–6 years ago	7 (0.7)	5 (0.8)
7–10 years ago	2 (0.3)	2 (0.4)
More than 10 years ago	1 (0.4)	2 (0.6)
Never	5 (1.0)	7 (0.9)

* There is a statistically significant difference in the distribution of the responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

As can be seen in Table 3.2, about a quarter of middle school science teachers and about a third of high school science teachers had participated in more than 35 hours of science professional development in the last three years. In contrast, 43 percent of elementary teachers had no science professional development in the preceding three years. There were no changes in these data between 2012 and 2018.

Table 3.2
Time Spent on Science Professional Development in the Last Three Years, by Grade Range†

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
None	41 (2.0)	43 (2.2)
Less than 6 hours	24 (1.4)	20 (1.6)
6–15 hours	22 (1.7)	20 (1.5)
16–35 hours	8 (0.9)	12 (1.3)
More than 35 hours	4 (0.7)	5 (0.8)
Middle		
None	18 (2.3)	22 (2.2)
Less than 6 hours	12 (2.0)	8 (1.1)
6–15 hours	24 (1.8)	23 (2.4)
16–35 hours	20 (2.0)	21 (1.6)
More than 35 hours	27 (2.0)	26 (1.8)
High		
None	15 (1.4)	18 (1.3)
Less than 6 hours	8 (1.2)	8 (1.3)
6–15 hours	20 (1.1)	18 (1.6)
16–35 hours	21 (1.4)	22 (1.3)
More than 35 hours	36 (1.1)	34 (1.6)

† There are no statistically significant differences in the distribution of the responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Teachers who had recently participated in professional development were asked about the type of activities. Across grade ranges, teachers were less likely in 2018 than in 2012 to have participated in a professional learning community, lesson study, or teacher study group (see Table 3.3). Among secondary science teachers, there appears to be a sharp decrease in receiving feedback from a coach or mentor, dropping from just over half of teachers in 2012 to about one-third in 2018.

Table 3.3
Science Teachers Participating in Various Professional Development Activities in Last Three Years, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Attended a professional development program/workshop	84 (1.8)	89 (2.0)
Participated in a professional learning community/lesson study/teacher study group*	55 (2.4)	42 (2.9)
Received assistance or feedback from a formally designated coach/mentor	24 (2.5)	28 (2.6)
Attended a national, state, or regional science teacher association meeting	8 (1.2)	12 (1.8)
Middle		
Attended a professional development program/workshop	91 (1.7)	94 (1.2)
Participated in a professional learning community/lesson study/teacher study group*	75 (2.5)	61 (3.1)
Received assistance or feedback from a formally designated coach/mentor*	47 (3.5)	33 (3.4)
Attended a national, state, or regional science teacher association meeting	35 (2.8)	37 (3.2)
High		
Attended a professional development program/workshop	90 (1.2)	91 (1.5)
Participated in a professional learning community/lesson study/teacher study group*	73 (1.6)	55 (1.7)
Received assistance or feedback from a formally designated coach/mentor*	54 (2.4)	35 (2.1)
Attended a national, state, or regional science teacher association meeting	44 (1.7)	40 (2.0)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Teachers who had participated in professional development in the preceding three years were also asked a series of questions about the characteristics of those experiences. The questions were designed to align with best practice in professional development[5]—for example, having opportunities to: (1) participate with other teachers from their school and those who have similar teaching assignments; (2) engage in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; and (3) to apply what they have learned in their classrooms and subsequently discuss how it went.

As can be seen in Table 3.4, there were several changes between 2012 and 2018 in the professional development experiences of elementary science teachers. For example, these teachers were more likely in 2018 to have opportunities to work closely with other teachers from their school (34 percent in 2012 vs. 57 percent in 2018) and with other teachers who taught the same grade or subject, whether or not they were from their school (37 percent in 2012 vs. 47 percent in 2018). The characteristics of professional development experiences for secondary teachers are largely unchanged.

[5] Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199.

Elmore, R. F. (2002). *Bridging the gap between standards and achievement: The imperative for professional development in education.* Washington, DC: Albert Shanker Institute.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., and Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915–945.

Table 3.4
Science Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent, by Grade Range[a]

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Worked closely with other teachers from their school*	34 (3.5)	57 (3.3)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school*	37 (3.4)	47 (3.2)
Had opportunities to engage in science investigations/engineering design challenges*,[b]	48 (3.5)	38 (3.0)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	31 (3.5)	31 (2.9)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	34 (3.3)	30 (2.6)
Middle		
Worked closely with other teachers from their school	61 (3.5)	62 (3.5)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	54 (4.0)	53 (3.0)
Had opportunities to engage in science investigations/engineering design challenges[b]	52 (3.0)	46 (3.5)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	40 (3.4)	38 (3.1)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	51 (4.5)	40 (3.1)
High		
Worked closely with other teachers from their school*	62 (2.6)	55 (2.3)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	58 (2.6)	54 (2.1)
Had opportunities to engage in science investigations/engineering design challenges[b]	45 (2.8)	45 (2.4)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	33 (2.4)	39 (2.3)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	47 (2.4)	43 (2.4)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes science teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

[b] In 2012, this item did not include "engineering design challenges."

Responses to these five items describing the characteristics of professional development experiences were combined into a single composite variable called Extent Professional Development Aligns with Elements of Effective Professional Development. As can be seen in Table 3.5, the mean scores on this composite were all relatively low, and there were no changes from 2012 to 2018.

Table 3.5
Teacher Mean Scores for Extent Professional Development Aligns With Elements of Effective Professional Development Composite[†,a]

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary	50 (1.9)	51 (1.5)
Middle	62 (1.8)	58 (1.3)
High	59 (1.3)	57 (1.0)

† There are no statistically significant differences between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

a This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Another series of items asked about the focus of professional development opportunities teachers had in the last three years. As can be seen in Table 3.6, little has changed since 2012. Roughly half of secondary science teachers' recent professional development heavily emphasized monitoring student understanding during science instruction and deepening science content knowledge. Among the few changes, professional development opportunities for elementary teachers were slightly less likely in 2018 to emphasize finding out what students think or already know prior to instruction on a topic (41 vs. 35 percent). Opportunities in this area for high school teachers decreased similarly (44 vs. 37 percent). Professional development opportunities for high school teachers also declined regarding monitoring student understanding during science instruction (55 vs. 47 percent) and learning about difficulties that students may have with particular science ideas (49 vs. 40 percent). Taken together, these data suggest less emphasis in 2018 on attention to student thinking in professional development opportunities.

Table 3.6
Science Teachers Reporting That Their Professional Development in the Last Three Years Gave Heavy Emphasis[a] to Various Areas, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Monitoring student understanding during science instruction	45 (3.0)	40 (3.3)
Deepening their own science content knowledge	37 (2.9)	39 (2.6)
Finding out what students think or already know prior to instruction on a topic	41 (2.8)	35 (3.0)
Implementing the science textbook/modules to be used in their classroom	39 (3.5)	34 (2.9)
Learning about difficulties that students may have with particular science ideas	30 (2.6)	26 (3.2)
Middle		
Monitoring student understanding during science instruction	54 (3.3)	47 (3.7)
Deepening their own science content knowledge	51 (4.0)	51 (3.3)
Finding out what students think or already know prior to instruction on a topic	46 (3.8)	42 (3.7)
Implementing the science textbook/modules to be used in their classroom	30 (2.9)	30 (3.1)
Learning about difficulties that students may have with particular science ideas	42 (3.1)	35 (3.0)
High		
Monitoring student understanding during science instruction*	55 (2.2)	47 (2.0)
Deepening their own science content knowledge	48 (2.1)	45 (1.9)
Finding out what students think or already know prior to instruction on a topic*	44 (2.3)	37 (2.0)
Implementing the science textbook/modules to be used in their classroom	29 (1.7)	29 (1.9)
Learning about difficulties that students may have with particular science ideas*	49 (2.5)	40 (2.0)

* There is a statistically significant difference between teachers in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes science teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

Professional Development Offerings at the School Level

The data presented in this chapter thus far are drawn from the science teacher questionnaire. The 2018 NSSME+ also included a School Program Questionnaire for science, which was completed by a person knowledgeable about school science programs, policies, and practices. School representatives were asked whether professional development workshops in science had been offered by their school and/or district, possibly in conjunction with other school districts, colleges/universities, museums, professional associations, or commercial vendors. As can be seen in Table 3.7, there was no change between 2012 and 2018, with about half or fewer schools having locally offered workshops on science.

Table 3.7
Science Professional Development Workshops Offered Locally in the Last Three Years[†]

	PERCENT OF SCHOOLS	
	2012	**2018**
Elementary	48 (2.9)	51 (2.8)
Middle	42 (3.6)	48 (2.6)
High	36 (4.0)	41 (2.9)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Science program representatives who indicated that workshops had been offered locally in the last three years were asked about the extent to which that professional development emphasized each of a number of areas. The data in Table 3.8 suggest that, with one exception, the emphasis of professional development has not changed since 2012. Two-thirds of schools indicated that workshops emphasized deepening teachers' understanding of state standards and the majority that workshops emphasized deepening teachers' understanding of science concepts. The one exception relates to emphasis on deepening teachers' understanding of how students think about various science ideas, which increased from 31 percent of schools in 2012 to 46 percent in 2018.

Table 3.8
Locally Offered Science Professional Development Workshops in the Last Three Years With a Substantial Emphasis[a] **in Each of a Number of Areas**

	PERCENT OF SCHOOLS	
	2012	**2018**
Deepening teachers' understanding of the state science/engineering standards	64 (2.9)	66 (2.9)
Deepening teachers' understanding of science concepts[b]	52 (3.2)	57 (3.1)
How to use technology in science/engineering instruction	41 (2.9)	48 (3.3)
Deepening teachers' understanding of how students think about various science ideas*	31 (2.4)	46 (3.4)
How to use particular science/engineering instructional materials (e.g., textbooks or modules)	52 (3.1)	45 (3.2)
How to monitor student understanding during science instruction	33 (2.6)	40 (3.1)
How to adapt science instruction to address student misconceptions	31 (2.7)	35 (3.2)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

b In 2012, this item read "science content" instead of "science concepts."

One concern about professional development workshops is that teachers may not be given adequate assistance in applying what they learned to their own instruction. Teacher study groups (professional learning communities, lesson study, etc.) have the potential to help teachers focus on instruction. School science program representatives were asked whether their school had offered teacher study groups in the last three years where teachers met on a regular basis to discuss science teaching and learning. As can be seen in Table 3.9, fewer than half of schools offered such opportunities, and they were more common in middle and high schools than in elementary schools. The availability is unchanged since 2012 regardless of grade level. This finding seems to conflict with data in Table 3.3, which show considerable decreases in teachers participating in such groups. It may be that participation dropped even as availability remained steady, although, as shown in Table 3.10, participation in study groups tended to be required.

Table 3.9
Teacher Study Groups Offered at Schools in the Last Three Years†

	PERCENT OF SCHOOLS	
	2012	2018
Elementary	32 (3.0)	28 (2.4)
Middle	43 (3.7)	45 (2.8)
High	47 (4.4)	45 (3.1)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Tables 3.10–3.14 present additional information provided by school program representatives about school-based teacher study groups focused on science. As can be seen in Table 3.10, the characteristics of study groups have been quite stable. Over three-fourths required participation, and just over half met for the entire school year. However, there is considerable variation in the frequency of these study group meetings. Among schools that had study groups, about a quarter had groups that meet more than twice a month.

Table 3.10
Participation, Duration, and Frequency of Science Teacher Study Groups†

	PERCENT OF SCHOOLS[a]	
	2012	2018
Participation Required		
Yes	79 (2.5)	78 (2.7)
No	21 (2.5)	22 (2.7)
Duration of Study Group		
No specified duration	38 (2.9)	34 (3.2)
Less than one semester	2 (0.8)	3 (1.1)
One semester	4 (1.2)	8 (2.4)
Entire school year	56 (3.0)	55 (3.3)
Frequency of Meetings		
No specified frequency	38 (2.9)	34 (3.2)
Less than once a month	16 (2,7)	15 (2.4)
Once a month	20 (2.4)	18 (2.5)
Twice a month	8 (1.1)	10 (1.8)
More than twice a month	19 (2.4)	24 (2.3)

† There are no statistically significant differences in the distributions of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

a Includes only those schools that offered teacher study groups in the last three years.

Data about whether schools have had designated leaders for the teacher study groups and where those leaders come from are presented in Table 3.11. Of the schools that offer study groups, about two-thirds had designated leaders, who most often came from within the school (50 percent). Again, there were no changes from 2012 to 2018.

Table 3.11
Origin of Designated Leaders of Science Teacher Study Groups†

	PERCENT OF SCHOOLS[a]	
	2012	2018
No designated leader	44 (3.3)	37 (3.0)
The school	49 (3.4)	50 (3.1)
Elsewhere in the district/diocese[b]	14 (1.9)	17 (2.6)
College/University	1 (0.3)	1 (0.3)
External consultants	6 (1.7)	6 (1.8)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

[a] Includes only those schools that offered teacher study groups in the last three years.

[b] This item was presented only to public and Catholic schools.

Information about the composition of teacher study groups is shown in Table 3.12. Most schools that had science-focused teacher study groups included teachers from multiple grade levels (63 percent) and limited participation in the study groups to teachers from their school (54 percent), although the latter practice was less common in 2018. Otherwise, no changes in how schools structure study groups are apparent.

Table 3.12
Composition of Science Teacher Study Groups

	PERCENT OF SCHOOLS[a]	
	2012	2018
Include teachers from multiple grade levels	65 (3.4)	63 (2.9)
Limited to teachers from this school*	66 (3.9)	54 (3.5)
Include school and/or district/diocese administrators	44 (3.7)	46 (3.1)
Include teachers from other schools in the district/diocese[b]	35 (3.8)	27 (2.8)
Include higher education faculty or other “consultants”	10 (2.4)	11 (2.2)
Include teachers from other schools outside of your district/diocese[c]	7 (3.0)	5 (1.8)
Include parents/guardians or other community members	0 (0.1)	0 (0.2)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only those schools that offered teacher study groups in the last three years.

[b] This item was presented only to public and Catholic schools.

[c] In 2012, this item read “jurisdiction” instead of “district/diocese.”

School science program representatives were also asked about the activities typically included in science-focused teacher study groups. With only one exception, these activities are unchanged since 2012 (see Table 3.13). In 2018, study groups were considerably less likely to analyze instructional materials than in 2012 (65 vs. 51 percent). The two most common activities were planning lessons together and analyzing assessment results.

Table 3.13
Description of Activities in Typical Science Teacher Study Groups

	PERCENT OF SCHOOLS[a]	
	2012	2018
Plan science/engineering lessons together	67 (3.0)	67 (2.8)
Analyze student science assessment results	73 (3.5)	65 (3.1)
Analyze science/engineering instructional materials (e.g., textbooks or modules)*	65 (3.3)	51 (2.9)
Examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	37 (3.6)	38 (3.2)
Engage in science investigations	25 (2.9)	30 (3.4)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Includes only those schools that offered teacher study groups in the last three years.

Further, school program representatives were asked about the extent to which teacher study groups have addressed each of a number of topics. Like other data on science-focused study groups, these are largely unchanged (see Table 3.14). By far, the most common emphasis was deepening teachers' understanding of state standards (two-thirds of schools that offer study groups). The one change is in emphasis on deepening teachers' understanding of science concepts, which decreased from 50 percent in 2012 to 41 percent in 2018.

Table 3.14
Science Teacher Study Groups Offered in the Last Three Years With a Substantial Emphasis[a] in Each of a Number of Areas

	PERCENT OF SCHOOLS	
	2012	2018
Deepening teachers' understanding of the state science/engineering standards	69 (3.3)	66 (3.2)
How to use technology in science/engineering instruction	45 (3.8)	47 (3.5)
How to use particular science/engineering instructional materials (e.g., textbooks or modules)	48 (3.2)	46 (3.4)
How to monitor student understanding during science/engineering instruction	48 (3.5)	44 (3.0)
Deepening teachers' understanding of how students think about various science ideas	41 (3.8)	44 (3.1)
Deepening teachers' understanding of science concepts*	50 (3.6)	41 (3.0)
How to adapt science instruction to address student misconceptions	41 (3.5)	38 (2.9)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

Although there is general agreement that teachers can benefit from participating in professional development workshops and study groups, it is often difficult to find time for these activities. School representatives were given a list of ways in which time might be provided for teachers to participate in professional development (regardless of whether it was offered by the school or district) and asked to indicate which were used in their school. Across grade levels, it became more likely in 2018 for schools to use professional days or teacher work days before or after the students' school year (see Table 3.15). For example, at the elementary level, there was an increase from 27 percent in 2012 to 37 percent in 2018. Among elementary and middle schools, there was an increase in using teachers' common planning time for science professional development, in both cases from about 3 in 10 schools to about 4 in 10.

Table 3.15
How Schools Provide Time for Science Professional Development, by Grade Range

	PERCENT OF SCHOOLS	
	2012	**2018**
Elementary		
Professional days/teacher work days during the students' school year	40 (2.7)	43 (3.2)
Common planning time for teachers*	31 (2.9)	41 (3.1)
Professional days/teacher work days before and/or after the students' school year*	27 (2.4)	37 (3.3)
Substitute teachers to cover teachers' classes while they attend professional development	26 (2.8)	26 (2.8)
Early dismissal and/or late start for students	18 (2.1)	19 (2.2)
Middle		
Professional days/teacher work days during the students' school year	50 (3.0)	54 (3.5)
Common planning time for teachers*	29 (3.0)	40 (3.4)
Professional days/teacher work days before and/or after the students' school year*	33 (3.0)	44 (3.3)
Substitute teachers to cover teachers' classes while they attend professional development	32 (2.8)	36 (3.1)
Early dismissal and/or late start for students	23 (2.5)	27 (2.5)
High		
Professional days/teacher work days during the students' school year	54 (3.4)	54 (3.2)
Common planning time for teachers	27 (3.3)	33 (2.9)
Professional days/teacher work days before and/or after the students' school year*	35 (2.3)	46 (3.2)
Substitute teachers to cover teachers' classes while they attend professional development	34 (2.5)	38 (3.0)
Early dismissal and/or late start for students	33 (3.1)	36 (2.9)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Professional development workshops and teacher study groups can provide important opportunities for teachers to deepen their disciplinary and pedagogical content knowledge, and to develop skill in using that knowledge for key tasks of teaching, such as analyzing student work to determine what a student does and does not understand. When resources allow, one-on-one coaching can be a powerful tool to help teachers improve their practice. School program representatives were asked whether any teachers in their school had access to one-on-one coaching focused on improving their science instruction. These data are shown in Table 3.16 and indicate increases between 2012 and 2018 in this form of support at both the elementary and high school levels. Interestingly, there was a sharp decrease in the percentage of high school science teachers receiving this kind of support (see Table 3.3), suggesting that although more schools have been offering coaching, fewer teachers benefitted from their services.

Table 3.16
Schools Providing One-on-One Science-Focused Coaching

	PERCENT OF SCHOOLS	
	2012	**2018**
Elementary*	17 (1.9)	27 (2.7)
Middle	17 (2.1)	23 (2.7)
High*	22 (2.0)	30 (3.0)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

In schools where science teachers have access to one-on-one coaching, program representatives were asked who provided the coaching services. These data are unchanged since 2012; roughly three-quarters of schools that offered coaching used a combination of administrators and teachers/coaches (see Table 3.17).

Table 3.17
Teaching Professionals Providing One-on-One Science-Focused Coaching†

	PERCENT OF SCHOOLS[a]	
	2012	2018
Both administrators and teachers/coaches[b]	64 (3.9)	73 (3.6)
Teachers/coaches[b] only	24 (3.5)	20 (3.3)
Administrators only	12 (3.4)	7 (2.2)

† There are no statistically significant differences in the distributions of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).
[a] Includes only those schools that provide science-/mathematics-focused coaching.
[b] Includes teachers/coaches of all levels of teaching responsibility: full-time, part-time, and not teaching.

Although most schools had both teachers/coaches and administrators provide coaching, it appears that teachers/coaches were responsible for the bulk of it. Table 3.18 shows the percentage of schools with coaching provided by different professionals. These data indicate that, compared to 2012, schools were relying more in 2018 on individuals who did not have classroom teaching responsibilities. For example, of schools that provided one-on-one coaching in 2012, 24 percent relied on teachers/coaches with no teaching duties, compared to 37 percent in 2018. Further, the percentage of schools relying on district-level supervisors or coordinators for coaching increased from 20 to 36 percent.

Table 3.18
Teaching Professionals Providing One-on-One Science-Focused Coaching to a Substantial Extent[a]

	PERCENT OF SCHOOLS[b]	
	2012	2018
Teachers/coaches who have full-time classroom teaching responsibilities	34 (3.8)	40 (3.6)
Teachers/coaches who do not have classroom teaching responsibilities*	24 (3.4)	37 (3.5)
District/Diocese administrators including science supervisors/coordinators*,[c]	20 (2.9)	36 (4.6)
The principal of the school	14 (4.1)	21 (3.2)
An assistant principal at the school*	7 (1.9)	18 (2.9)
Teachers/coaches who have part-time classroom teaching responsibilities	17 (3.1)	16 (2.8)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).
[a] Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."
[b] Includes only those schools that provide science-focused coaching.
[c] This item was presented only to public and Catholic schools.

In addition, school science program representatives were asked about the services provided to teachers in need of special assistance. In 2018, 33–44 percent of schools, depending on grade range, provided guidance from a formally designated mentor or coach (see Table 3.19). Interestingly, and perhaps discouragingly, there appears to be a sharp decrease in this approach to supporting teachers who need extra help. For example, at the high school level, the percentage of schools offering such assistance decreased from 63 percent in 2012 to 44 percent in 2018.

Table 3.19
Services Provided to Science Teachers in Need of Special Assistance in Teaching, by Grade Range

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Guidance from a formally designated mentor or coach*	51 (3.4)	33 (2.5)
Seminars, classes, and/or study groups*	41 (2.5)	30 (3.1)
A higher level of supervision than for other teachers	12 (2.1)	15 (2.2)
Middle		
Guidance from a formally designated mentor or coach*	50 (3.3)	35 (2.9)
Seminars, classes, and/or study groups*	52 (3.0)	28 (3.6)
A higher level of supervision than for other teachers	21 (2.3)	22 (2.5)
High		
Guidance from a formally designated mentor or coach*	63 (3.3)	44 (3.4)
A higher level of supervision than for other teachers	34 (2.7)	33 (3.3)
Seminars, classes, and/or study groups*	50 (3.7)	25 (2.9)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Responses to whether schools/districts provide science workshops, teacher study groups, and one-on-one coaching were combined to look at the proportion of schools that did not offer any of these types of professional development. In 2018, about a third of schools did not offer some form of professional development in science in the preceding three years, which is unchanged since 2012 (see Table 3.20).

Table 3.20
Schools Not Offering Any Type of Professional Development in the Last Three Years†

	PERCENT OF SCHOOLS	
	2012	2018
Elementary	34 (2.9)	33 (2.6)
Middle	34 (3.5)	32 (2.8)
High	36 (4.5)	29 (2.9)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Summary

In 2018, the amount of professional development teachers participated in was largely unchanged since 2012. However, a discouraging trend is an increase the percentage of elementary teachers with no science-related professional development in the preceding three years, from 15 to 24 percent. And although participation increased with increasing grade range, even among high school science teachers, only about a third had participated in more than 35 hours in the preceding three years.

Regarding characteristics of professional development, there were some notable changes from 2012 to 2018. Among elementary teachers who had professional development, there was an increase in teachers working with other teachers during their professional development experiences. For example, the percentage who worked closely with other teachers from their school in science-related professional increased from 34 to 57 percent.

The workshop was still by far the most common type of professional development, and at the secondary level, there were sharp decreases in the percentage of teachers participating in professional learning communities, lesson study groups, and other kinds of teacher study groups. There was also a decrease in teachers receiving coaching or mentoring. For example, the percentage of high school science teachers who received assistance from a formally designated coach or mentor decreased from 57 to 35 percent between 2012 and 2018, even though there was an increase in the percentage of schools offering one-on-one coaching. This form of support, however, was less likely to be targeted to teachers needing special assistance.

Despite the sharp decrease in teachers participating in study groups, there was no change in the percentage of schools offering them. Just over a fourth of elementary schools and just under half of secondary schools made them available. Half or more of these groups lasted the entire school year, met at least once a month, had a leader from within the school, included teachers from multiple grade levels, and restricted participation to teachers from the school. The most common activities were planning science or engineering lessons together, analyzing student science assessment results, and analyzing science/engineering instructional materials (e.g., textbooks or modules).

Across grade ranges, the data show an increase in schools using professional days or work days for professional development. For example, among high schools, the percentage adopting this practice increased from 35 to 46 percent. At the elementary and middle grades, there was an increase in using common planning time for professional development.

Science Courses

Overview

The 2018 NSSME+ collected data on science course offerings in the nation's schools. In addition, teachers provided information about time spent on science instruction in the elementary grades, titles and duration of secondary science courses, and data about the students in a randomly selected class, including the number, gender and racial/ethnic composition. These data are presented in the following sections.

Time Spent in Elementary Science Instruction

Self-contained elementary teachers were asked how often they teach science. In 2018, only 17 percent of grades K–3 classes and 35 percent of grades 4–6 classes received science instruction all or most days, every week of the school year (see Table 4.1). Many elementary classes received science instruction only a few days a week or during some weeks of the year. The frequency of science instruction has not changed since 2012.

Table 4.1
Frequency With Which Self-Contained Elementary Teachers Taught Science, by Grade Range†

	PERCENT OF CLASSES	
	2012	2018
Grades K–3		
All/Most days, every week	20 (1.5)	17 (1.5)
Three or fewer days, every week	39 (1.5)	40 (1.8)
Some weeks, but not every week	41 (1.9)	43 (2.0)
Grades 4–6		
All/Most days, every week	35 (2.6)	35 (3.1)
Three or fewer days, every week	33 (2.6)	36 (3.1)
Some weeks, but not every week	32 (2.5)	29 (2.4)

† There are no statistically significant differences in the distributions of responses between classes in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

The survey also asked the approximate number of minutes typically spent teaching science, mathematics, social studies, and reading/language arts in self-contained classes. The average number of minutes per day typically spent on instruction in each subject in grades K–3 and 4–6 is shown in Table 4.2. To facilitate comparisons among the subject areas, only teachers who teach all four of these subjects to one class of students were included in this analysis. The data for each subject are unchanged since 2012 with two exceptions. In grades K–3 classes, the average number of minutes per day on mathematics instruction increased from 54 in 2012 to 57 in 2018, and in grades 4–6 classes, science instruction increased from 24 to 27 minutes per day. Though small, these increases result in several additional hours of instruction over a school year.

Table 4.2
Average Number of Minutes Per Day Spent Teaching Each Subject in Self-Contained Classes,[a] by Grade Range

	NUMBER OF MINUTES	
	2012	2018
Grades K–3		
Reading/Language Arts	89 (1.7)	89 (1.7)
Mathematics*	54 (1.0)	57 (0.8)
Science	19 (0.5)	18 (0.5)
Social Studies	16 (0.4)	16 (0.4)
Grades 4–6		
Reading/Language Arts	83 (2.2)	82 (2.4)
Mathematics	61 (1.4)	63 (1.6)
Science*	24 (0.9)	27 (0.8)
Social Studies	21 (0.8)	21 (0.8)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only self-contained elementary teachers who indicated they teach reading, mathematics, science, and social studies to one class of students.

Science Course Offerings

Middle and high school program representatives were asked about science course offerings in their school. Middle schools were asked whether they offer single-discipline courses (e.g., life science, physical science), coordinated/integrated science courses, or both in each grade 6–8 contained in the school. As can be seen in Table 4.3, these data are stable from 2012 to 2018, with a roughly equal split between multi-discipline courses and single-discipline courses (roughly 40 percent each), with the remaining schools offering both types of courses.

Table 4.3
Type of Middle School Science Courses Offered, by Grade†

	PERCENT OF SCHOOLS	
	2012	2018
Grade 6		
Multi-Discipline Science Courses Only	45 (4.1)	45 (3.5)
Single-Discipline Science Courses Only	36 (3.6)	35 (3.5)
Both	19 (3.5)	19 (3.2)
Grade 7		
Multi-Discipline Science Courses Only	38 (3.7)	41 (3.5)
Single-Discipline Science Courses Only	46 (3.8)	40 (3.8)
Both	15 (3.6)	18 (3.0)
Grade 8		
Multi-Discipline Science Courses Only	36 (3.7)	42 (3.4)
Single-Discipline Science Courses Only	47 (3.8)	40 (3.7)
Both	18 (3.5)	18 (2.9)

† There are no statistically significant differences in the distributions of responses between schools 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Table 4.4 shows science courses offered in high schools. In 2018, almost all schools (97 percent) with grades 9–12 offered courses in biology/life science, with 70 percent offering non-college prep courses, 73 percent offering 1st year college prep courses, and 60 percent offering at least one 2nd year biology/life science course. The percentage of schools offering 1st year college prep biology decreased from 84 percent in 2012 to 73 percent in 2018.

Overall, 94 percent of high schools offered some form of chemistry course. First-year college prep chemistry courses were offered in 72 percent of high schools and 2nd year chemistry in 45 percent. Most high schools (82 percent) offered physics courses. Three-fifths offered 1st year physics, and two-fifths offered 2nd year physics. Within physics, there was a shift in 2018 away from 1st year college prep to non-college prep and 2nd year advanced courses.

Most high schools (84 percent) offered coursework in coordinated/integrated science (including physical science), a sharp increase over 2012 (61 percent). Fewer high schools offered courses in environmental science (66 percent) or Earth/space science (59 percent) than in the other science disciplines, but both types of courses were more common in 2018 than in 2012.

Nearly one-half of high schools offered at least one engineering course, twice as many as in 2012. Almost one-third offer non-college prep and 1st year college prep engineering courses, both sharp increases over 2012. Only 17 percent of high schools offer a 2nd year engineering course.

Table 4.4
High Schools Offering Various Science Courses

	PERCENT OF SCHOOLS	
	2012	**2018**
Biology/Life Science		
Any level	93 (3.2)	97 (1.7)
Non-college prep	68 (3.6)	70 (3.0)
1st year college prep, including honors*	84 (3.7)	73 (3.4)
2nd year advanced	58 (3.5)	60 (3.8)
Chemistry		
Any level	89 (3.6)	94 (1.9)
Non-college prep	48 (3.3)	58 (3.0)
1st year college prep, including honors	80 (3.8)	72 (3.3)
2nd year advanced	40 (2.7)	45 (3.3)
Physics		
Any level	79 (3.7)	82 (3.0)
Non-college prep*	34 (2.9)	45 (3.4)
1st year college prep, including honors*	72 (3.7)	60 (3.2)
2nd year advanced*	32 (2.2)	40 (2.8)
Coordinated/Integrated/Interdisciplinary Science Courses (including General Science and Physical Science)		
Any level*	61 (3.9)	84 (2.3)
Non-college prep*	54 (3.9)	70 (2.6)
College prep, including honors	43 (2.8)	46 (3.4)
Environmental Science/Ecology		
Any level*	43 (3.1)	66 (3.2)
Non-college prep*	28 (2.4)	44 (3.5)
1st year college prep, including honors	28 (2.2)	26 (2.5)
2nd year advanced*	17 (1.3)	27 (2.4)
Earth/Space Science		
Any level*	46 (3.7)	59 (3.5)
Non-college prep*	37 (3.0)	47 (3.6)
1st year college prep, including honors	25 (3.2)	23 (2.5)
2nd year advanced	4 (0.7)	6 (1.2)
Engineering		
Any level*	22 (1.9)	46 (3.2)
Non-college prep*	13 (1.9)	31 (2.7)
1st year college prep, including honors*	11 (1.3)	29 (2.5)
2nd year advanced*	5 (1.0)	17 (2.1)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Table 4.5 shows the percentage of high schools offering each of the Advanced Placement (AP) science courses, and Table 4.6 shows the percentage of grades 9–12 students in the nation at those schools (i.e., students with access to those courses). The percentages in the two tables are quite different because schools with larger enrollments are more likely to offer AP courses. Differences between 2012 and 2018 are apparent in two types of course. First, the percentage of schools offering any AP Physics course increased from 26 to 41 percent. (Note, however, that the percentage of students with access to this course did not increase.) Second, there was a slight increase in the percentage of schools offering AP environmental science, from 17 to 23 percent. The percentage of students with access to the AP environmental science also increased, from 38 to 48 percent. Otherwise, student access to AP science courses has neither increased nor decreased, indicating that in 2018, a substantial proportion of students still did not have access to some of these courses.

Table 4.5
Access to AP Science Courses, by Schools

	PERCENT OF HIGH SCHOOLS OFFERING	
	2012	2018
AP Biology	43 (2.8)	43 (3.1)
AP Physics (any course)*	26 (1.9)	41 (3.2)
AP Chemistry	34 (2.3)	36 (2.8)
AP Environmental Science*	17 (1.3)	23 (2.4)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Table 4.6
Access to AP Science Courses, by Students

	PERCENT OF HIGH SCHOOL STUDENTS WITH ACCESS	
	2012	2018
AP Biology	74 (1.6)	73 (2.4)
AP Physics (any course)	57 (1.7)	63 (2.6)
AP Chemistry	68 (1.7)	65 (2.4)
AP Environmental Science*	38 (1.9)	48 (2.6)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Across the disciplines, about half of high schools offered at least one AP science course, either each year or in alternating years (see Table 4.7). Approximately the same percentage of schools offered 1–5 AP science courses, with about 10 percent of schools in each category. Only 3 percent of schools offered all of the currently available AP science courses. Comparing 2012 and 2018, there was a change in the distribution, which appears to be due to an increase in the percentage of schools offering five or more AP courses, from 5 to 13 percent.

Table 4.7
Number of AP Science Courses Offered at High Schools

	PERCENT OF SCHOOLS*	
	2012	2018
0 courses	54 (3.1)	49 (3.7)
1 course	11 (2.1)	10 (2.1)
2 courses	10 (1.4)	9 (1.4)
3 courses	11 (1.4)	10 (1.6)
4 courses	10 (1.2)	9 (1.3)
5 or more courses[a]	5 (0.8)	13 (1.6)

* There is a statistically significant difference in the distributions of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

[a] In 2012, the maximum amount of AP science courses was 5. In 2018, the maximum amount was 7.

The survey also asked if high schools offer International Baccalaureate (IB) courses. As can be seen in Table 4.8, very few schools offered the IB program in 2018, and fewer than 1 in 10 high school students had access to any of these science courses (see Table 4.9). There were no changes from 2012 to 2018.

Table 4.8
Access to IB Science Courses, by Schools†

	PERCENT OF HIGH SCHOOLS OFFERING	
	2012	2018
IB Biology	3 (0.6)	3 (0.7)
IB Chemistry	3 (0.6)	2 (0.5)
IB Physics	3 (0.6)	2 (0.6)
IB Environmental Systems and Societies	n/a	2 (0.5)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Table 4.9
Access to IB Science Courses, by Students†

	PERCENT OF HIGH SCHOOL STUDENTS WITH ACCESS	
	2012	2018
IB Biology	9 (1.2)	8 (1.6)
IB Chemistry	7 (1.2)	6 (1.2)
IB Physics	7 (1.2)	5 (1.4)
IB Environmental Systems and Societies	n/a	4 (1.1)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

The survey asked high schools about opportunities provided to students to take science and engineering courses not offered on-site. As previously described, 82 percent of high schools offered at least one physics course in 2018. A small additional percentage of schools provided students with access to physics, either by offering it in alternative years or by allowing students to take the course off campus (see Table 4.10). Students at over half of high schools (54 percent) had students take science and/or engineering courses at a college/university, and almost half (46 percent) provided access to concurrent credit/dual enrollment courses—courses that count for high school and college credit. Both of these represent substantial increases over 2012. About 2 in 5 high schools allowed students to take science and/or engineering courses at a Career and Technical Education center or virtually through other schools/institutions, again a large increase over 2012. Fewer than 1 in 5 high schools had students take science/engineering courses at another high school or provided their own science and/or engineering courses virtually.

Table 4.10
Science Programs and Practices Currently Being Implemented in High Schools

	PERCENT OF SCHOOLS	
	2012	**2018**
Physics courses are offered this school year or in alternating years, on or off site.	88 (2.9)	87 (2.8)
Students can go to a college or university for science and/or engineering courses.*	22 (2.4)	54 (3.0)
Science and/or engineering courses offered by telecommunications*,[a]	18 (2.9)	49 (3.3)
Concurrent college and high school credit/dual enrollment courses are offered this school year or in alternating years.*	28 (2.8)	46 (3.2)
Students can go to a Career and Technical Education center for science and/or engineering instruction.*	22 (3.2)	41 (2.3)
Students can go to another K–12 school for science and/or engineering courses.*	8 (2.5)	17 (2.1)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] In 2018, this is a combination of two items representing program representatives that indicate either “This school provides students access to virtual science and/or engineering courses offered by other schools/institutions (for example: online, videoconference)” or “This school provides its own science and/or engineering courses virtually (for example: online, videoconference).”

In terms of the most commonly offered high school science courses, there was no change from 2012 to 2018 (see Table 4.11). Biology/life science courses were the most commonly offered, followed by chemistry, physics, and multi-discipline courses.

Table 4.11
Most Commonly Offered High School Science Courses†

	PERCENT OF CLASSES	
	2012	2018
Biology/Life Science		
Non-college prep	8 (0.7)	7 (0.9)
1st year college prep, including honors	24 (1.3)	22 (1.4)
2nd year advanced	7 (0.9)	8 (1.3)
Chemistry		
Non-college prep	3 (0.5)	3 (0.5)
1st year college prep, including honors	17 (0.8)	16 (1.1)
2nd year advanced	2 (0.4)	3 (0.5)
Physics		
Non-college prep	2 (0.4)	2 (0.4)
1st year college prep, including honors	10 (0.9)	8 (0.8)
2nd year advanced	2 (0.4)	2 (0.4)
Earth/Space Science		
Non-college prep	4 (0.6)	3 (0.8)
1st year college prep, including honors	4 (0.6)	2 (0.5)
2nd year advanced	0 (0.2)	0 (0.2)
Environmental Science/Ecology		
Non-college prep	2 (0.4)	3 (0.6)
1st year college prep, including honors	1 (0.4)	2 (0.6)
2nd year advanced	2 (0.5)	2 (0.4)
Multi-Discipline Science Courses (e.g., General Science, Integrated Science, Physical Science)		
Non-college prep	6 (0.8)	8 (0.8)
1st year college prep, including honors	5 (0.7)	5 (0.8)
2nd year advanced	0 (0.1)	1 (0.4)

† There is no statistically significant difference in the distributions of responses between classes in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Other Characteristics of Science Classes

The 2018 NSSME+ found that the average size of science classes was generally 21–24 students, unchanged since 2012 (see Table 4.12). Table 4.13 shows average class size in different high school courses. As can be seen in Figure 4.1, however, these averages can obscure a wide variation in class sizes. For example, 15 percent of high school science classes in both years had 30 or more students.

Table 4.12
Average Science Class Size†

	AVERAGE NUMBER OF STUDENTS	
	2012	2018
Elementary	21.9 (0.2)	21.6 (0.2)
Middle	23.6 (0.4)	23.4 (0.4)
High	21.7 (0.3)	20.9 (0.3)

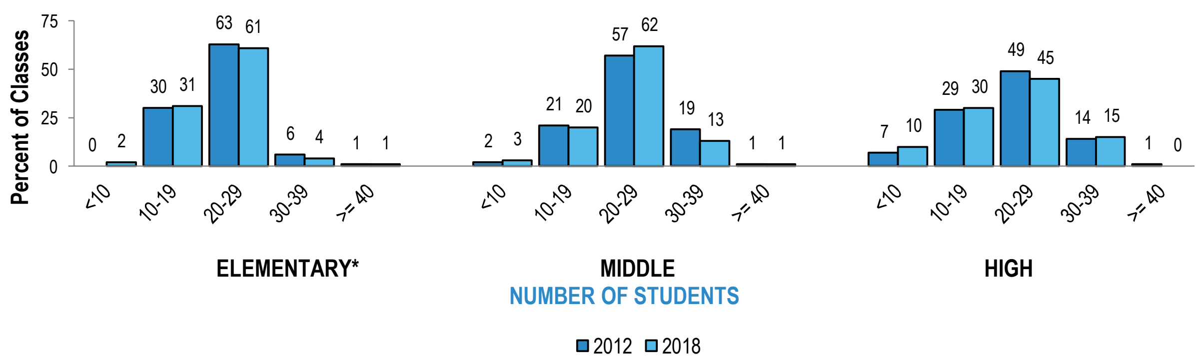
† There are no statistically significant differences between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Table 4.13
Average High School Science Class Size†

	AVERAGE NUMBER OF STUDENTS	
	2012	2018
Non-college prep	21.3 (0.5)	20.5 (0.7)
1st year biology	21.9 (0.7)	23.0 (0.5)
1st year chemistry	22.3 (0.6)	22.2 (0.6)
1st year physics	20.5 (1.0)	19.2 (1.0)
Advanced science courses	18.9 (0.8)	18.4 (0.7)

† There are no statistically significant differences between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Science Class Size



* There is a statistically significant difference in the distributions of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

Figure 4.1

Table 4.14 shows the percentages of female students and students from race/ethnicity groups historically underrepresented in STEM in classes in the different grade bands. With regard to gender, female students were just as likely as male students to be in science classes, regardless of grade level. In high school, where students are generally not required to take science every year, the data show that students from historically underrepresented race/ethnicity groups were less likely to take science. However, relative to 2012, the percentage of these students increased at each grade range. In elementary and middle school science classes, students from historically underrepresented race/ethnicity groups composed almost half of the enrollment in 2018.

Table 4.14
Average Percentages of Female and Historically Underrepresented Students in Science Classes

	PERCENT OF STUDENTS	
	2012	**2018**
Female		
Elementary	48 (0.5)	49 (0.5)
Middle	46 (0.7)	48 (0.7)
High	49 (0.8)	48 (0.7)
Historically Underrepresented		
Elementary*	39 (1.9)	46 (1.9)
Middle*	36 (1.6)	45 (1.7)
High*	31 (1.2)	36 (1.5)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

In terms of gender, specific high school science courses tended to have classes that were evenly split between male and female students on average. Exceptions were non-college prep science classes and 1st year physics classes, which had smaller percentages of female students. There was a decrease in the percentage of female students in 1st year physics classes between 2012 and 2018.

A pattern of decreasing enrollment of students from race/ethnicity groups historically underrepresented in STEM is seen in the class composition data across the progression of high school science courses (see Table 4.15). For example, in 2018, students from these groups made up 43 percent of students in non-college prep science classes and 35 percent of students in 1st year biology classes, compared to only 27 percent in advanced science classes. For the latter two categories of courses, the percentages are disproportionately low compared to the student population. These data are unchanged from 2012.

Table 4.15
Average Percentages of Female and Historically Underrepresented Students in High School Science Courses

	PERCENT OF STUDENTS	
	2012	2018
Female		
Non-college prep	45 (1.2)	45 (1.2)
1st year biology	49 (1.6)	51 (1.5)
1st year chemistry	51 (1.4)	51 (1.1)
1st year physics*	49 (1.8)	41 (1.9)
Advanced science courses	54 (1.9)	54 (3.1)
Historically Underrepresented		
Non-college prep	36 (2.3)	43 (2.8)
1st year biology	33 (2.7)	35 (3.0)
1st year chemistry	30 (1.8)	35 (2.2)
1st year physics	23 (2.7)	30 (3.0)
Advanced science courses	21 (2.3)	27 (3.9)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Summary

At most, only about a third of self-contained elementary classes received science instruction every day in 2018, and in grades K–3, the percentage was even lower. In grades K–3, students received an average of less than 20 minutes of science instruction per day. Neither of these findings has changed since 2012. In grades 4–6 self-contained classes, science instruction averaged 27 minutes per day, which is a small but significant increase over 2012.

In terms of course offerings at the secondary level, there is no change in the middle grades, where multi-discipline and single-discipline courses were about equally likely to be offered. At the high school level, though, several shifts are apparent. More schools are offering non-college prep versions of science subjects, but perhaps most striking is the increase in schools offering environmental science/ecology (from 43 to 66 percent) and engineering (from 22 to 46 percent).

There was also an increase in schools offering some type of AP Physics (from 26 to 41 percent) and AP Environmental Science (from 17 to 23 percent). Despite these increases, a substantial proportion of students still did not have access to some of these courses. For example, in 2018, a third of high school students did not have access to AP Physics or AP Chemistry.

In terms of the students taking science courses, overall, female students were generally just as likely as male students to be enrolled, regardless of grade range. The one exception is high school physics, where female students accounted for only 41 percent of students. Further, this represents a decrease from 49 percent in 2012. Enrollment of students from race/ethnicity groups historically underrepresented in STEM in high school college prep science courses was disproportionately low. These students accounted for 43 percent of enrollment in non-college prep courses, roughly a third in first-year science courses, but only 27 percent in advanced courses.

More encouragingly, there have been substantial increases in schools offering opportunities for students to experience science and engineering courses outside of traditional school-based offerings. These include students being able to go to a college or university for science and/or engineering courses, take courses by telecommunications, participate in dual enrollment courses, and go to a Career and Technical Education center for science and/or engineering instruction.

Instructional Decision Making, Objectives, and Activities

Overview

The 2018 NSSME+ collected data about teachers' perceptions of their autonomy in making curricular and instructional decisions. Questions also focused on teachers' instructional objectives, class activities they use in accomplishing these objectives, and how student performance is assessed in a particular, randomly selected class. These data are discussed in the following sections.

Teachers' Perceptions of Their Decision-Making Autonomy

Teachers were asked the extent to which they had control over a number of curricular and instructional decisions for their classes. As can be seen in Table 5.1, in science classes across all grade levels, teachers tended to perceive themselves as having strong control over pedagogical decisions such as determining the amount of homework to be assigned (59–74 percent), selecting teaching techniques (48–68 percent), and choosing criteria for grading student performance (41–59 percent). In contrast, especially in the elementary grades, teachers were less likely to feel strong control in determining course goals and objectives (17–36 percent); selecting textbooks/modules/programs (15–36 percent); and selecting content, topics, and skills to be taught (13–34 percent).

There are a handful of areas in which teachers perceived more control over curriculum and instruction in 2018 than they did in 2012. Elementary and middle grades teachers were more likely in 2018 to report strong control over selecting curriculum materials, and middle grades teachers were more likely to perceive strong control over determining course goals and objectives. Further, the percentage of teachers perceiving no control over these decisions decreased (see Table 5.2). For example, elementary, middle, and high school science teachers were considerably less likely in 2018 than in 2012 to report no control over selecting curriculum materials.

Table 5.1
Science Classes in Which Teachers Reported Having Strong Control Over Various Curricular and Instructional Decisions, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Determining the amount of homework to be assigned	64 (2.7)	59 (2.5)
Selecting teaching techniques	53 (2.5)	48 (2.3)
Choosing criteria for grading student performance	43 (3.3)	41 (2.5)
Determining course goals and objectives	14 (2.0)	17 (2.7)
Selecting curriculum materials (e.g., textbooks/modules)*	5 (1.1)	15 (2.5)
Selecting content, topics, and skills to be taught	10 (1.8)	13 (2.6)
Middle		
Determining the amount of homework to be assigned	75 (3.2)	73 (2.2)
Selecting teaching techniques	67 (3.6)	67 (2.4)
Choosing criteria for grading student performance	58 (3.5)	59 (2.6)
Determining course goals and objectives*	21 (3.0)	33 (3.0)
Selecting curriculum materials (e.g., textbooks/modules)*	14 (2.7)	28 (2.9)
Selecting content, topics, and skills to be taught	20 (2.9)	27 (3.0)
High		
Determining the amount of homework to be assigned	76 (1.9)	74 (1.8)
Selecting teaching techniques	73 (2.0)	68 (2.3)
Choosing criteria for grading student performance	61 (2.3)	54 (2.2)
Determining course goals and objectives	36 (2.3)	36 (2.5)
Selecting curriculum materials (e.g., textbooks/modules)	33 (2.6)	36 (2.0)
Selecting content, topics, and skills to be taught	35 (2.7)	34 (2.2)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Table 5.2
Science Classes in Which Teachers Reported Having No Control Over Various Curricular and Instructional Decisions, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Determining the amount of homework to be assigned	2 (1.1)	4 (0.9)
Selecting teaching techniques	1 (0.4)	2 (0.5)
Choosing criteria for grading student performance	5 (1.3)	5 (0.9)
Determining course goals and objectives*	39 (2.8)	27 (2.2)
Selecting curriculum materials (e.g., textbooks/modules)*	44 (3.2)	29 (2.3)
Selecting content, topics, and skills to be taught	39 (2.7)	34 (2.6)
Middle		
Determining the amount of homework to be assigned	0 (0.2)	0 (0.2)
Selecting teaching techniques	0 (0.3)	0 (0.1)
Choosing criteria for grading student performance	2 (0.6)	3 (1.3)
Determining course goals and objectives*	28 (2.8)	20 (2.0)
Selecting curriculum materials (e.g., textbooks/modules)*	31 (2.7)	17 (2.3)
Selecting content, topics, and skills to be taught	23 (2.9)	24 (2.9)
High		
Determining the amount of homework to be assigned	0 (0.3)	1 (0.5)
Selecting teaching techniques	0 (0.2)	1 (1.3)
Choosing criteria for grading student performance	1 (0.4)	2 (0.5)
Determining course goals and objectives	15 (1.2)	12 (1.4)
Selecting curriculum materials (e.g., textbooks/modules)*	25 (2.0)	12 (1.7)
Selecting content, topics, and skills to be taught	13 (1.3)	11 (1.3)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

These items were combined into two composite variables—Curriculum Control and Pedagogy Control. Curriculum Control consists of the following items:

- Determining course goals and objectives;
- Selecting curriculum materials; and
- Selecting content, topics, and skills to be taught.

For Pedagogy Control, the items are:

- Selecting teaching techniques;
- Determining the amount of homework to be assigned; and
- Choosing criteria for grading student performance.

Table 5.3 displays the mean scores on these composites, which indicate that teachers perceived more control over decisions related to pedagogy than curriculum. They also show that perceived control over curriculum-related decisions increased from 2012 to 2018 at each grade range.

Table 5.3
Science Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	2012	2018
Curriculum[a]		
Elementary*	32 (1.7)	41 (2.2)
Middle*	45 (2.2)	55 (2.2)
High*	59 (1.6)	64 (1.4)
Pedagogy		
Elementary	81 (1.2)	79 (1.2)
Middle	88 (1.3)	87 (1.1)
High*	89 (0.7)	87 (1.0)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Instructional Objectives

The survey provided a list of possible objectives of instruction and asked teachers how much emphasis each would receive in an entire course of a particular, randomly selected class. Table 5.4 shows the percentage of science classes by grade range placing heavy emphasis on a subset of these objectives. In 2018, understanding science concepts was the most frequently emphasized objective, although more so in secondary classes (about three-quarters of middle and high school classes) than in elementary (fewer than half of classes). All other objectives were considerably less likely to receive heavy emphasis. For example, only about a third of high school science classes placed heavy emphasis on increasing students' interest in science and engineering. Further, compared to 2012, classes were considerably less likely in 2018 to emphasize this objective, as well as learning about real-life applications of science and engineering. However, it is important to note that "engineering" did not appear in the 2012 version of these survey items.

Table 5.4
Science Classes With Heavy Emphasis on Various Instructional Objectives, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Understanding science concepts*	59 (2.2)	47 (1.7)
Increasing students' interest in science/engineering*,[a]	56 (2.0)	27 (2.2)
Learning about real-life applications of science/engineering*,[a]	46 (2.3)	20 (2.1)
Middle		
Understanding science concepts	80 (2.1)	77 (1.8)
Increasing students' interest in science/engineering*	57 (2.2)	35 (2.1)
Learning about real-life applications of science/engineering*	45 (2.3)	28 (2.0)
High		
Understanding science concepts*	80 (1.2)	76 (1.8)
Increasing students' interest in science/engineering*	50 (1.4)	31 (1.5)
Learning about real-life applications of science/engineering*	45 (1.5)	29 (1.2)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] In 2012, this item did not include "engineering."

The items in Table 5.4 were combined into a composite variable titled "Reform-Oriented Instructional Objectives." The three items are:

- Understanding science concepts;
- Increasing students' interest in science/engineering; and
- Learning about real-life applications of science/engineering.

The mean scores for this composite are shown in Table 5.5. Given the decreases evident in Table 5.4, it is not surprising that the composite mean scores also decreased from 2012 to 2018. The change at the elementary level is particularly large.

Table 5.5
Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite[a]

	MEAN SCORE	
	2012	2018
Elementary*	82 (0.7)	69 (0.9)
Middle*	85 (0.7)	76 (0.8)
High*	84 (0.4)	77 (0.6)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Class Activities

Teachers responded to several items about their instruction in the randomly selected class. One item asked how often they use different pedagogies (e.g., explaining ideas to students, small group work). Response options for these items were: never, rarely (e.g., a few times a year), sometimes (e.g., once or twice a month), often (e.g., once or twice a week), and all or almost all science lessons. Teachers were also asked two questions about their most recent lesson in this class: (1) how instructional time was apportioned and (2) what instructional activities took place.

Depending on grade range, 42–48 percent of classes in 2018 included the teacher explaining science ideas in all or almost all lessons (see Table 5.6). The majority of elementary science classes engaged in whole class discussions in nearly every lesson, though this activity becomes less frequent as grade level increases. Approximately a third of K–12 science classes had students work in small groups in all or almost all science lessons.

Comparing 2012 to 2018, no changes are evident in elementary science instruction. In the middle grades, science classes were less likely in 2018 to include the teacher explaining science ideas to the whole class in all or almost all lessons (54 vs. 46 percent) and more likely to have students work in small groups (25 vs. 33 percent). Similar changes are apparent at the high school level. However, high school science classes were less likely in 2018 to engage the whole class in discussions (38 vs. 31 percent).

Table 5.6
Science Classes in Which Teachers Reported Using Various Activities in All or Almost All Lessons, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Engage the whole class in discussions	57 (1.6)	55 (1.5)
Explain science ideas to the whole class	50 (1.8)	48 (1.8)
Have students work in small groups	28 (1.9)	30 (2.0)
Focus on literacy skills (e.g., informational reading or writing strategies)	17 (1.5)	20 (1.5)
Have students do hands-on/laboratory activities	16 (1.5)	16 (1.9)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	13 (1.2)	14 (1.3)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*	15 (1.3)	11 (1.4)
Engage the class in project-based learning (PBL) activities	9 (1.3)	8 (2.0)
Have students practice for standardized tests	4 (0.8)	5 (0.9)
Middle		
Engage the whole class in discussions	48 (2.5)	42 (2.1)
Explain science ideas to the whole class*	54 (2.2)	46 (2.1)
Have students work in small groups*	25 (2.0)	33 (2.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	10 (1.5)	11 (1.4)
Have students do hands-on/laboratory activities	10 (1.4)	11 (1.4)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	13 (1.5)	17 (1.9)
Have students read from a textbook, module, or other material in class, either aloud or to themselves	12 (2.0)	8 (1.7)
Engage the class in project-based learning (PBL) activities	6 (1.2)	8 (1.4)
Have students practice for standardized tests	5 (1.2)	4 (0.8)
High		
Engage the whole class in discussions*	38 (1.5)	31 (1.6)
Explain science ideas to the whole class*	56 (1.6)	42 (1.7)
Have students work in small groups*	22 (1.4)	30 (1.5)
Focus on literacy skills (e.g., informational reading or writing strategies)*	4 (0.6)	6 (0.9)
Have students do hands-on/laboratory activities*	8 (0.7)	12 (1.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	7 (0.7)	8 (0.9)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*	7 (0.8)	4 (0.7)
Engage the class in project-based learning (PBL) activities*	3 (0.5)	6 (0.7)
Have students practice for standardized tests	5 (0.5)	5 (0.8)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

In 2018, three instructional activities occurred at least once a week in a large majority of science classes across grade levels (see Table 5.7): explaining science ideas to the whole class (85–92 percent), engaging the whole class in discussions (78–90 percent), and having students work in small groups (75–87 percent). Over half of elementary science classes and about two-thirds of secondary science classes included hands-on/laboratory activities on a weekly basis. In addition, roughly 30 percent of classes engaged students in project-based learning activities weekly.

Elementary and middle school science classes were much more likely than high school classes to include literacy activities (e.g., reading from a science textbook, writing reflections) at least once a week. Interestingly, reading from a science textbook was less likely in 2018 than in 2012 across grade ranges. High school science classes were more likely in 2018 to have students write reflections. Both middle and high school science classes were more likely in 2018 than in 2012 to engage students in PBL activities.

Table 5.7
Science Classes in Which Teachers Reported Using Various Activities at Least Once a Week, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Engage the whole class in discussions	90 (0.9)	90 (1.0)
Explain science ideas to the whole class	88 (1.3)	85 (1.9)
Have students work in small groups	72 (1.8)	75 (1.6)
Focus on literacy skills (e.g., informational reading or writing strategies)*	48 (2.0)	60 (1.6)
Have students do hands-on/laboratory activities	55 (1.9)	53 (1.9)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	44 (2.0)	43 (2.0)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*	48 (2.4)	37 (1.7)
Engage the class in project-based learning (PBL) activities	30 (1.7)	29 (2.2)
Have students practice for standardized tests	19 (1.7)	17 (1.3)
Middle		
Engage the whole class in discussions	92 (1.0)	89 (1.2)
Explain science ideas to the whole class*	96 (0.9)	92 (1.0)
Have students work in small groups*	79 (1.9)	87 (1.5)
Focus on literacy skills (e.g., informational reading or writing strategies)	44 (2.2)	46 (2.3)
Have students do hands-on/laboratory activities	62 (2.4)	63 (2.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	44 (2.1)	47 (2.1)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*	56 (2.3)	39 (2.6)
Engage the class in project-based learning (PBL) activities*	23 (1.9)	31 (2.3)
Have students practice for standardized tests	23 (1.9)	19 (1.7)
High		
Engage the whole class in discussions*	83 (1.0)	78 (1.3)
Explain science ideas to the whole class*	95 (0.8)	92 (0.9)
Have students work in small groups	83 (1.2)	84 (1.5)
Focus on literacy skills (e.g., informational reading or writing strategies)*	25 (1.5)	33 (1.6)
Have students do hands-on/laboratory activities	70 (1.5)	68 (1.6)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*	21 (1.3)	28 (1.4)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*	37 (1.6)	26 (1.7)
Engage the class in project-based learning (PBL) activities*	18 (1.2)	28 (1.7)
Have students practice for standardized tests	20 (1.2)	20 (1.5)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

In addition to asking about class activities in the course as a whole, teachers were asked about activities that took place during their most recent science lesson in the randomly selected class. As can be seen in Table 5.8, the teacher explaining science ideas to the whole class was the most common activity across grade bands, occurring in three-quarters or more of classes. Whole class discussions were also relatively common, though more so in elementary classes than in middle or high school classes (86, 67, and 59 percent of classes, respectively). Almost half of elementary and middle school classes included students doing hands-on/laboratory activities and students reading about science in the most recent lesson, compared to 4 in 10 or fewer high school classes.

Comparing 2018 to 2012, three types of activities became less common across all grade bands:

- Whole class discussion;
- Teacher explaining a science idea to the whole class; and
- Students completing textbook/worksheet problems.

In addition, both elementary and high school science classes were less likely in 2018 to include students reading about science in their most recent lesson.

Table 5.8
Science Classes Participating in Various Activities in Most Recent Lesson, by Grade Range

	PERCENT OF CLASSES	
	2012	**2018**
Elementary		
Whole class discussion*	91 (1.1)	86 (1.2)
Teacher explaining a science idea to the whole class*	89 (1.2)	83 (1.5)
Students doing hands-on/laboratory activities	52 (1.9)	47 (2.1)
Students reading about science*	53 (2.2)	45 (2.1)
Teacher conducting a demonstration while students watched	40 (2.0)	37 (2.1)
Students completing textbook/worksheet problems*	43 (1.8)	35 (1.8)
Test or quiz	12 (1.2)	9 (1.1)
Practicing for standardized tests*	5 (0.8)	2 (0.6)
Middle		
Whole class discussion*	77 (1.8)	67 (2.3)
Teacher explaining a science idea to the whole class*	89 (1.4)	74 (2.2)
Students doing hands-on/laboratory activities	50 (2.3)	46 (2.0)
Students reading about science	50 (2.1)	48 (2.6)
Teacher conducting a demonstration while students watched	32 (2.4)	30 (2.1)
Students completing textbook/worksheet problems*	51 (2.2)	39 (2.2)
Test or quiz*	22 (2.0)	14 (1.5)
Practicing for standardized tests	9 (1.2)	8 (1.0)
High		
Whole class discussion*	67 (1.4)	59 (1.6)
Teacher explaining a science idea to the whole class*	90 (0.9)	81 (1.3)
Students doing hands-on/laboratory activities	39 (1.5)	40 (1.6)
Students reading about science*	35 (1.5)	29 (1.6)
Teacher conducting a demonstration while students watched	32 (1.4)	31 (1.6)
Students completing textbook/worksheet problems*	59 (1.6)	44 (1.6)
Test or quiz*	20 (1.4)	16 (1.2)
Practicing for standardized tests	10 (0.8)	8 (0.9)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

The survey also asked teachers to estimate the time spent on each of a number of types of activities in this most recent science lesson. Across the grades, about 40 percent of class time was spent on whole class activities, 30 percent on small group work, and 20 percent on students working individually (see Table 5.9). Non-instructional activities, including attendance taking and interruptions, accounted for about 10 percent of science class time. The distribution of percentage of time at each grade range changed significantly between 2012 and 2018. However, there are no clear differences at the activity level, aside from a possible shift from whole class activities to small group work at the middle and secondary levels.

Table 5.9
Average Percentage of Time Spent on Different Activities in the Most Recent Science Lesson, by Grade Range

	PERCENT OF CLASS TIME	
	2012	2018
Elementary*		
Whole class activities (e.g., lectures, explanations, discussions)	43 (0.8)	41 (0.9)
Small group work	32 (0.9)	33 (1.0)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	19 (0.6)	18 (0.8)
Non-instructional activities (e.g., attendance taking, interruptions)	6 (0.3)	8 (0.4)
Middle*		
Whole class activities (e.g., lectures, explanations, discussions)	40 (0.9)	32 (0.8)
Small group work	31 (1.2)	35 (1.1)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	20 (0.9)	22 (0.8)
Non-instructional activities (e.g., attendance taking, interruptions)	10 (0.3)	12 (0.3)
High*		
Whole class activities (e.g., lectures, explanations, discussions)	43 (0.6)	38 (0.8)
Small group work	30 (0.7)	34 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	18 (0.6)	19 (0.8)
Non-instructional activities (e.g., attendance taking, interruptions)	9 (0.3)	10 (0.2)

* There is a statistically significant difference in the distribution of responses between classes in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. In 2018, just over three-fourths of elementary science classes assigned fewer than 15 minutes of homework per week, with the amount of time increasing as grade range increases (see Table 5.10). Still, even at the high school level, almost two-thirds of science classes assigned less than one hour of homework per week. There are no differences between the 2012 and 2018 data.

Table 5.10
Amount of Homework Assigned in Science Classes Per Week, by Grade Range†

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Fewer than 15 minutes per week	73 (2.8)	78 (3.0)
16–30 minutes per week	17 (2.5)	12 (1.4)
31–60 minutes per week	7 (2.0)	8 (2.6)
61–90 minutes per week	2 (1.2)	2 (1.1)
91–120 minutes per week	0 (0.2)	0 (0.1)
More than 2 hours per week	0 (0.3)	0 ---[a]
Middle		
Fewer than 15 minutes per week	22 (2.2)	23 (2.5)
16–30 minutes per week	29 (2.7)	33 (2.8)
31–60 minutes per week	30 (2.6)	31 (2.7)
61–90 minutes per week	14 (2.1)	8 (1.4)
91–120 minutes per week	3 (0.8)	3 (1.0)
More than 2 hours per week	2 (1.6)	2 (1.2)
High		
Fewer than 15 minutes per week	9 (1.1)	12 (1.3)
16–30 minutes per week	17 (1.6)	19 (1.3)
31–60 minutes per week	34 (2.1)	33 (1.6)
61–90 minutes per week	24 (1.8)	22 (1.9)
91–120 minutes per week	7 (1.1)	7 (0.9)
More than 2 hours per week	9 (1.1)	7 (0.9)

† There are no statistically significant differences in the distributions of responses between classes in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

[a] No elementary science teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

Summary

In both 2012 and 2018, science teachers tended to feel more control over decisions related to pedagogy than those related to curriculum. However, between 2012 and 2018, the percentage of teachers who felt control over curriculum-related decisions grew significantly. For example, in 2018, teachers in each grade range were more likely to feel some control over selecting curriculum materials. Teachers' perceived control over pedagogy-related decisions, which was already quite high in 2012, did not change, with the exception of a very small decrease among high school teachers.

In terms of instructional objectives, increasing students' understanding of science concepts was by far the most frequently emphasized, although it was less prevalent at the elementary and high school levels in 2018 compared to 2012. Increasing students' interest in science/engineering and learning about real-life applications of these subjects lagged far behind.

There were several shifts in the prevalence of class activities between 2012 and 2018, although engaging the whole class in discussion and explaining ideas to the whole class remained at or near the top of those most commonly used. At the secondary level, there was a shift away from explaining ideas to the whole class and toward having students work in small groups. Also, across grade levels there was a decrease in having students read from a science textbook and complete textbook/worksheet problems. Finally, middle and high school classes became more likely to engage students in project-based learning activities. There were no changes in the amount of homework assigned in science classes, regardless of grade level.

Instructional Resources

Overview

The quality and availability of instructional resources is a major factor in science teaching. The 2018 NSSME+ included a series of items on textbooks and instructional programs—which ones teachers use and how they use them. Teachers were also asked about the availability and use of a number of other instructional resources. The following sections present these data, comparing them to 2012.

Use of Textbooks and Other Instructional Resources

Teachers were asked whether the most recent unit in their randomly selected class was based primarily on a commercially published textbook or materials developed by the state or district. As shown in Table 6.1, more than half of science classes, regardless of grade range, were based on such materials in 2018. At the elementary level, there was a substantial increase between 2012 and 2018, from just over half of classes to almost two-thirds.

Table 6.1
Classes in Which the Most Recent Unit Was Based on a Commercially Published Textbook or a Material Developed by the State or District[a]

	PERCENT OF CLASSES	
	2012	2018
Elementary*	52 (2.4)	65 (2.1)
Middle	58 (2.3)	54 (2.3)
High	57 (1.5)	54 (1.9)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] The 2012 teacher survey item did not include "material developed by the state or district."

When teachers responded that their most recent unit was based on one of these materials, they were asked how they used them (see Table 6.2). Two important findings emerge from these data. First, when classes used commercially published or state/district-developed materials, the materials heavily influenced instruction in all subjects at all grade ranges. Teachers in more than 70 percent of these classes across grade-level categories used the textbook substantially to guide the overall structure and content emphasis of their units. Second, it is clear that teachers modified their materials substantially when designing instruction. In roughly half or more of classes, teachers incorporated activities from other sources substantially and "picked and skipped" parts of the material. At the elementary level, this "pick-and-skip" approach was more common in 2018 than in 2012 (51 and 42 percent of classes, respectively).

Table 6.2
Ways Science Teachers Substantially[a] Used Their Textbook in Most Recent Unit, by Grade Range

	PERCENT OF CLASSES[b]	
	2012	2018
Elementary		
I used these materials to guide the structure and content emphasis of the unit.	77 (2.8)	77 (3.1)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	64 (2.7)	65 (2.7)
I picked what is important from these materials and skipped the rest.*	42 (2.2)	51 (3.1)
Middle		
I used these materials to guide the structure and content emphasis of the unit.	66 (2.7)	72 (2.8)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	75 (2.5)	78 (2.8)
I picked what is important from these materials and skipped the rest.	49 (3.2)	54 (3.4)
High		
I used these materials to guide the structure and content emphasis of the unit.*	64 (2.1)	76 (2.0)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	79 (1.7)	78 (2.1)
I picked what is important from these materials and skipped the rest.	51 (2.0)	53 (2.6)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

[b] Includes only those classes in which the most recent unit was based on a commercially published or state/district-developed material.

Teachers in roughly half of science classes using this type of material skipped activities substantially. As can be seen in Table 6.3, some of the most frequently selected reasons for skipping parts of the materials were: (1) having another activity that works better than the one skipped and (2) the science ideas addressed not being included in pacing guides or standards. Although having activities that work better was clearly a prominent factor in decisions to skip parts of the material, it became less so in elementary and high school science classes between 2012 and 2018. At the elementary level, two other factors became less prominent: (1) students already knowing the science ideas or being able to learn them without the activities skipped (60 percent in 2012 vs. 49 percent in 2018) and (2) the activities skipped were too difficult for the students (50 percent and 38 percent, respectively).

At the high school level, two factors became more prominent across time: (1) the science ideas addressed not being included in pacing guide/standards (60 percent and 73 percent, respectively) and (2) the activities were too difficult for the students (49 percent and 59 percent, respectively).

Table 6.3
Reasons Why Parts of Science Materials Were Skipped, by Grade Range

	PERCENT OF CLASSES[a]	
	2012	2018
Elementary		
I have different activities for those science ideas that work better than the ones I skipped.*	84 (2.8)	69 (3.9)
The science ideas addressed in the activities I skipped are not included in my pacing guide/standards.	66 (3.5)	63 (3.9)
I did not have the materials needed to implement the activities I skipped.	62 (3.4)	62 (4.5)
My students already knew the science ideas or were able to learn them without the activities I skipped.*	60 (3.8)	49 (3.5)
The activities I skipped were too difficult for my students.*	50 (4.0)	38 (3.7)
Middle		
I have different activities for those science ideas that work better than the ones I skipped.	89 (3.2)	83 (3.4)
The science ideas addressed in the activities I skipped are not included in my pacing guide/standards.	65 (5.0)	76 (3.4)
I did not have the materials needed to implement the activities I skipped.	61 (5.2)	56 (4.1)
My students already knew the science ideas or were able to learn them without the activities I skipped.	56 (4.1)	52 (4.4)
The activities I skipped were too difficult for my students.	47 (5.0)	43 (3.9)
High		
I have different activities for those science ideas that work better than the ones I skipped.*	88 (1.8)	77 (4.0)
The science ideas addressed in the activities I skipped are not included in my pacing guide/standards.*	60 (3.1)	73 (3.2)
I did not have the materials needed to implement the activities I skipped.	49 (3.1)	54 (3.7)
My students already knew the science ideas or were able to learn them without the activities I skipped.	57 (2.9)	52 (3.5)
The activities I skipped were too difficult for my students.*	49 (3.1)	59 (3.4)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only those classes in which the most recent unit was based on a commercially published or state/district-developed material.

Given that teachers often skipped activities in their materials because they knew of better ones, it is perhaps not surprising that teachers in well more than half of science classes using a textbook or state/district-developed material supplemented it. Of the reasons listed on the questionnaire, two stand out above the rest: (1) differentiating instruction for students at different achievement levels and (2) providing students with additional practice (see Table 6.4). The influence of standardized testing is also evident, with 47–60 percent supplementing for test-preparation purposes. Finally, in 42–49 percent of classes, depending on subject and grade level, teachers supplemented their materials because their pacing guide indicated that they should. Comparing 2012 to 2018, this factor became less prominent in elementary science classes (58 percent and 42 percent, respectively) but more prominent at the high school level (37 percent and 46 percent, respectively). Supplementing for differentiation purposes became somewhat less prominent in elementary science classes (93 percent and 84 percent, respectively) and in middle grades science classes (96 percent and 90 percent, respectively). Finally, at the elementary level, science classes were less likely to supplement in order to provide additional practice (86 percent and 77 percent, respectively).

Table 6.4
Reasons Why Science Materials Were Supplemented, by Grade Range

	PERCENT OF CLASSES[a]	
	2012	2018
Elementary		
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.*	93 (1.6)	84 (2.4)
Supplemental activities were needed to provide students with additional practice.*	86 (2.1)	77 (2.8)
Supplemental activities were needed to prepare students for standardized tests.	49 (4.1)	47 (3.7)
My pacing guide indicated that I should use supplemental activities.*	58 (3.2)	42 (3.6)
Middle		
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.*	96 (1.2)	90 (2.6)
Supplemental activities were needed to provide students with additional practice.	94 (2.4)	90 (2.3)
Supplemental activities were needed to prepare students for standardized tests.	63 (5.4)	60 (3.9)
My pacing guide indicated that I should use supplemental activities.	49 (4.6)	49 (3.9)
High		
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	92 (1.4)	86 (3.5)
Supplemental activities were needed to provide students with additional practice.	93 (1.6)	86 (3.7)
Supplemental activities were needed to prepare students for standardized tests.	53 (3.3)	53 (3.6)
My pacing guide indicated that I should use supplemental activities.*	37 (2.5)	46 (3.3)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only those classes in which the most recent unit was based on a commercially published or state/district-developed material.

Facilities and Equipment

In 2018, electrical outlets and running water were widely available in all grade ranges (see Table 6.5). Fewer than a third of elementary classes had access to lab tables, but they were widespread in middle school classrooms and especially in high school classrooms. There were no changes in availability between 2012 and 2018.

Table 6.5
Availability[a] of Laboratory Facilities in Science Classes, by Grade Range[†]

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Electric outlets	90 (1.6)	93 (1.1)
Faucets and sinks	83 (2.3)	83 (2.0)
Lab tables	28 (3.0)	29 (3.1)
Middle		
Electric outlets	95 (2.1)	98 (0.7)
Faucets and sinks	92 (2.1)	89 (1.5)
Lab tables	80 (3.1)	81 (2.0)
High		
Electric outlets	99 (0.8)	98 (0.6)
Faucets and sinks	97 (1.0)	95 (0.9)
Lab tables	94 (1.4)	94 (1.1)
Gas for burners	87 (1.7)	85 (1.7)
Fume hoods	82 (2.0)	82 (1.8)

† There are no statistically significant differences between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

a Includes only those science teachers indicating the resource is either located in the classroom or available in another room.

The 2018 NSSME+ also asked science program representatives how much money their schools spent during the most recently completed school year on three kinds of resources: equipment (excluding computers), consumable supplies (e.g., chemicals, graph paper), and software specific to science instruction. By dividing these amounts by school enrollment, per-pupil estimates were generated. Table 6.6 shows the 2012 per pupil spending (PPS), 2012 PPS adjusted for inflation, and 2018 PPS. Total PPS increased sharply from elementary to middle to high school. For a class of 30 students, the expenditures equate to less than $60 per class at the elementary level, less than $100 per class in middle grades, and about $200 per high school class.

Table 6.6
Median Amount Schools Spent Per Pupil on Science Equipment, Consumable Supplies, and Software, by Grade Range†

	MEDIAN AMOUNT		
	2012	2012 (ADJ.)[a]	2018
Elementary			
Consumable supplies	$0.95 (0.1)	$1.04 (0.1)	$1.03 (0.2)
Equipment	$0.26 (0.1)[b]	$0.29 (0.1)[b]	$0.35 (0.1)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.00 ---[c]
Total	**$1.55 (0.3)**	**$1.69 (0.3)**	**$1.98 (0.5)**
Middle			
Consumable supplies	$1.45 (0.1)	$1.59 (0.1)	$1.42 (0.2)
Equipment	$0.71 (0.2)	$0.78 (0.2)	$1.02 (0.2)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.00 ---[c]
Total	**$3.13 (0.4)**	**$3.43 (0.4)**	**$3.27 (0.6)**
High			
Consumable supplies	$3.44 (0.2)	$3.77 (0.3)	$3.26 (0.3)
Equipment	$2.06 (0.3)	$2.26 (0.3)	$2.25 (0.3)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.00 ---[c]
Total	**$6.11 (0.7)**	**$6.69 (0.7)**	**$6.88 (0.7)**

† There are no statistically significant differences between schools in 2012, after adjusting for inflation, and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

a In order to compare per pupil spending between 2012 and 2018, the dollar value for 2012 was adjusted to account for inflation based on the Consumer Price Index from the Bureau of Labor Statistics.

b Standard errors for medians are typically computed in Wesvar 5.1 using the Woodruff method. Wesvar was unable to compute a standard error for this estimate using this method; thus, the potentially less-consistent replication standard error is reported.

c It was not possible to compute a standard error using either the Woodruff or the replication methods.

Expenditures for science instruction seem to be reflected in teachers' ratings of the adequacy of resources they have on hand. As can be seen in Table 6.7, the overall pattern is that teachers of classes in the higher grades were generally more likely than those in lower ones to rate the availability of resources as adequate. In elementary grades, teachers of fewer than half of classes rated the availability of resources as adequate, compared to two-thirds or more at the high school level. At the same time, teachers' ratings of adequacy for some resources improved between 2012 and 2018. In all grade ranges, the proportion of classes with adequate instructional technology (as rated by teachers) increased substantially. In middle and secondary classrooms, ratings for the adequacy of equipment improved.

Table 6.7
Adequacy[a] of Resources for Science Instruction, by Grade Range

	PERCENT OF CLASSES	
	2012	**2018**
Elementary		
Instructional technology (e.g., calculators, computers, probes/sensors)*	33 (2.3)	49 (2.8)
Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners)	35 (2.0)	39 (2.5)
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	32 (2.3)	38 (2.6)
Consumable supplies (e.g., chemicals, living organisms, batteries)	31 (2.0)	30 (2.8)
Middle		
Instructional technology (e.g., calculators, computers, probes/sensors)*	38 (2.3)	57 (2.5)
Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners)*	48 (2.5)	58 (2.9)
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	56 (2.6)	62 (2.7)
Consumable supplies (e.g., chemicals, living organisms, batteries)	42 (2.2)	45 (2.7)
High		
Instructional technology (e.g., calculators, computers, probes/sensors)*	50 (1.9)	70 (2.1)
Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners)*	62 (1.7)	73 (1.9)
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	71 (1.5)	72 (2.0)
Consumable supplies (e.g., chemicals, living organisms, batteries)*	60 (1.7)	67 (2.1)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Includes science teachers indicating 4 or 5 on a five-point scale ranging from 1 "not adequate" to 5 "adequate."

These items were combined into a composite variable named Adequacy of Resources for Instruction. As shown in Table 6.8, perceptions of the adequacy of resources increased with increasing grade range. Further, the mean scores at the middle and high school levels increased from 2012 to 2018.

Table 6.8
Class Mean Scores for the
Adequacy of Resources for Instruction Composite

	MEAN SCORE	
	2012	**2018**
Elementary	49 (1.4)	52 (1.7)
Middle*	57 (1.4)	65 (1.4)
High*	68 (0.9)	76 (1.1)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

Summary

At the elementary level, the percentage of classes basing their most recent unit on a published material (published commercially or by the state or school district) increased between 2012 and 2018. There was, however, no change at the secondary level. Across all grades, more than half of classes still based their most recent until on one of these types of materials.

When teachers based their units on such materials, they tended to modify them. Teachers in two-thirds or more of science classes supplemented their materials substantially regardless of grade range, and more than half skipped substantial parts of their materials. When teachers skipped, the most common reason was having activities that teachers believed work better, although this reason became less prevalent between 2012 and 2018 at the elementary and high school levels. Another prominent factor in skipping was the guidance included in pacing guides and standards. When teachers supplemented their materials, it was frequently for the purpose of differentiating instruction, although this factor became slightly less common in elementary and middle grades between 2012 and 2018. Providing additional practice was also a frequent reason for supplementing.

There was no change in the availability of common laboratory facilities. With the exception of lab tables at the elementary level, more than 80 percent of classes had access to the most common types of facilities (e.g., running water, electrical outlets). And although per pupil spending remained low from 2012 to 2018, secondary science teachers' ratings of the adequacy of their resources improved. Increases in the perceived adequacy of instructional technology were particularly large across grade ranges.

Factors Affecting Instruction

Overview

Students' opportunities to learn science are affected by a myriad of factors, including teacher preparedness, school and district policies and practices, and administrator and community support. Although the primary focus of the 2018 NSSME+ was on teachers and teaching, the study also collected information on the context of classroom practice. Among the data collected were the extent of use of various programs and practices in the school, science course requirements, the extent of influence of state standards, and the extent of various problems that may affect instruction in the school. These data, as well as data from the 2012 NSSME, are presented in the following sections.

School Programs and Practices

Elementary school program representatives were asked about several instructional arrangements for students in elementary self-contained classrooms, such as whether they were pulled out for remediation or enrichment in science and whether they received science instruction from specialists instead of, or in addition to, their regular teacher. Table 7.1 shows the percentage of elementary schools indicating that each program or practice is in place. In 2018, the use of elementary science specialists, either instead of, or in addition to, the regular classroom teacher, was uncommon (7–15 percent of schools). Pull-out science instruction, whether for remediation or enrichment, was also quite rare (8–10 percent of schools). There were no changes in these data between 2012 and 2018.

Table 7.1
Use of Various Science Instructional Arrangements in Elementary Schools†

	PERCENT OF SCHOOLS	
	2012	2018
Students in self-contained classes are pulled out from science instruction for additional instruction in other content areas.	22 (2.3)	28 (2.9)
Students in self-contained classes receive instruction from a district/diocese/school science specialist *in addition* to their regular teacher.[a]	16 (2.4)	15 (2.1)
Students in self-contained classes are pulled out for enrichment in science.	10 (1.8)	10 (1.8)
Students in self-contained classes are pulled out for remedial instruction in science.	7 (1.5)	8 (1.7)
Students in self-contained classes receive instruction from a district/diocese/school science specialist *instead of* their regular teacher.[a]	10 (1.9)	7 (1.8)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

a In 2012, this item did not include "district/diocese/school."

High school program representatives were asked how many years of science students are required to take in order to graduate. As can be seen in Table 7.2, the vast majority of high schools required at least three years of science. For most schools, graduation requirements were just as demanding as state university entrance requirements.[6] However, when there was a difference, graduation requirements tended to be more rigorous; 40 percent of high schools

[6] State (public) university entrance requirements were mined from the Internet. When state university systems included multiple tiers, the lowest four-year university tier requirements were used.

required more science for graduation than state universities did for entrance. Comparing 2012 to 2018, although high school science graduation requirements did not change significantly, there is a shift in the distribution of science courses required for university entrance. In 2012, 73 percent of schools were in states that required three years of science instruction; only 56 percent of schools were in such states in 2018. In contrast, the percentage of schools in states requiring only two years was 23 percent in 2012 and 39 percent in 2018.

Table 7.2
High School Science Graduation vs. State University Entrance Requirements

	PERCENT OF SCHOOLS	
	2012	**2018**
Graduation Requirement		
1 Year	1 (1.0)	0 (0.0)
2 Years	14 (1.6)	14 (2.5)
3 Years	64 (2.5)	66 (2.9)
4 Years	21 (2.4)	20 (2.2)
State University Entrance Requirement*		
1 Year	0 ---[a]	2 (0.5)
2 Years	23 (1.4)	39 (3.0)
3 Years	73 (2.2)	56 (3.0)
4 Years	4 (2.1)	3 (0.8)
Difference*		
2 Years Fewer Required for Graduation	2 (1.2)	0 ---[a]
1 Year Fewer Required for Graduation	9 (2.0)	4 (1.9)
No Difference	59 (3.3)	56 (2.6)
1 Year More Required for Graduation	24 (2.9)	29 (2.5)
2 Years More Required for Graduation	6 (0.8)	11 (1.6)
3 Years More Required for Graduation	0 ---[a]	0 (0.1)

* There is a statistically significant difference in the distribution of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p < 0.05$).

[a] No schools in the sample were in this category. Thus, it is not possible to compute the standard error of this estimate.

Program representatives were asked to indicate which of several practices their school employs to enhance student interest and/or achievement in science. The results are shown in Table 7.3. Such programs tended to be more prevalent as grade range increases. For example, in 2018, more than three-quarters of high schools offered after-school help in science and engineering, compared to about a third of elementary schools. Similarly, 47 percent of high schools had one or more teams participating in engineering competitions, compared to only 24 percent of elementary schools. The data also show several increases since 2012 in use of these programs and practices (sometimes quite large), especially at the elementary and middle grades levels. For example, in 2012, only about a quarter of elementary schools held family science or engineering nights, compared to almost half in 2018. At the middle grades, only 29 percent of schools offered one or more science clubs in 2012, compared to 45 percent in 2018. And at the high school level, the proportion of schools that had teams participating in engineering competitions increased from one-third to almost one-half.

Table 7.3
School Programs/Practices to Enhance Students' Interest and/or Achievement in Science/Engineering, by Grade Range

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Encourages students to participate in science and/or engineering summer programs or camps (e.g., offered by community colleges, universities, museums, or science centers)*	50 (3.5)	68 (2.8)
Holds family science and/or engineering nights*	26 (2.8)	44 (3.0)
Participates in a local or regional science and/or engineering fair	35 (3.0)	40 (2.8)
Coordinates visits to business, industry, and/or research sites related to science and/or engineering*,[a]	30 (2.7)	39 (2.9)
Offers one or more science clubs*	20 (2.6)	36 (3.2)
Offers formal after-school programs for enrichment in science and/or engineering*	17 (2.5)	32 (2.7)
Offers after-school help in science and/or engineering (e.g., tutoring)	31 (2.7)	31 (2.7)
Offers one or more engineering clubs*	7 (2.0)	28 (2.5)
Coordinates meetings with adult mentors who work in science and/or engineering fields*,[a]	16 (2.4)	26 (2.8)
Has one or more teams participating in engineering competitions (e.g., Robotics)*	11 (1.9)	24 (2.4)
Has one or more teams participating in science competitions (e.g., Science Olympiad)	13 (2.0)	17 (2.0)
Middle		
Encourages students to participate in science and/or engineering summer programs or camps (e.g., offered by community colleges, universities, museums, or science centers)*	63 (3.6)	73 (2.9)
Holds family science and/or engineering nights*	23 (3.0)	34 (3.0)
Participates in a local or regional science and/or engineering fair	39 (3.3)	48 (3.2)
Coordinates visits to business, industry, and/or research sites related to science and/or engineering[a]	35 (3.4)	45 (3.7)
Offers one or more science clubs*	29 (3.0)	45 (3.7)
Offers formal after-school programs for enrichment in science and/or engineering*	24 (2.7)	39 (2.9)
Offers after-school help in science and/or engineering (e.g., tutoring)	53 (3.6)	51 (2.9)
Offers one or more engineering clubs*	13 (2.5)	36 (2.9)
Coordinates meetings with adult mentors who work in science and/or engineering fields*,[a]	24 (3.0)	34 (3.0)
Has one or more teams participating in engineering competitions (e.g., Robotics)*	19 (2.4)	35 (2.9)
Has one or more teams participating in science competitions (e.g., Science Olympiad)*	22 (2.2)	29 (2.9)
High		
Encourages students to participate in science and/or engineering summer programs or camps (e.g., offered by community colleges, universities, museums, or science centers)	75 (3.5)	78 (3.3)
Holds family science and/or engineering nights	16 (2.9)	19 (2.3)
Participates in a local or regional science and/or engineering fair	46 (3.2)	46 (3.6)
Coordinates visits to business, industry, and/or research sites related to science and/or engineering[a]	48 (3.6)	55 (3.0)
Offers one or more science clubs	47 (3.4)	54 (3.5)
Offers formal after-school programs for enrichment in science and/or engineering	29 (3.1)	32 (2.5)
Offers after-school help in science and/or engineering (e.g., tutoring)	81 (2.9)	79 (2.9)
Offers one or more engineering clubs*	21 (2.0)	35 (2.6)
Coordinates meetings with adult mentors who work in science and/or engineering fields*,[a]	28 (2.6)	39 (2.9)
Has one or more teams participating in engineering competitions (e.g., Robotics)*	33 (2.4)	47 (3.0)
Has one or more teams participating in science competitions (e.g., Science Olympiad)	40 (3.4)	43 (3.0)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] In 2012, this item read "Sponsors" instead of "Coordinates."

Extent of Influence of State Standards

School science program representatives were given a series of statements about the influence of state standards in their school and district and asked about the extent to which they agreed with each. As can be seen in Table 7.4, it is clear that state standards have a major influence at the school level. For example, 79 percent or more of program representatives agreed that teachers in the school teach to the state science standards. Similarly, a large majority of representatives agreed that state science standards have been thoroughly discussed by teachers in the school and that there was a school-wide effort to align instruction to standards. It is somewhat surprising that for less than two-thirds of schools, the school or district organized professional development based on their science standards. Given that 40 states and the District of Columbia adopted the NGSS or NGSS-like standards since 2012, it is also surprising that there was no change in the percentage of elementary and high school schools with school- or district-organized professional development on state standards. There was an increase among middle schools, from 52 percent in 2012 to 61 percent in 2018. The only other change in these data is a decrease at the elementary level in the percentage of schools with a school-wide effort to align science instruction with state science standards, from 80 percent in 2012 to 71 percent in 2018.

Table 7.4

Influence[a] of State Science Standards in Schools, by Grade Range

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Most science teachers in this school teach to the state standards.	83 (2.6)	79 (2.6)
There is a school-wide effort to align science instruction with the state science standards.*	80 (2.3)	71 (2.8)
State science standards have been thoroughly discussed by science teachers in this school.	69 (2.7)	65 (3.1)
The school/district/diocese organizes science professional development based on state standards.[b]	56 (2.7)	54 (3.2)
Middle		
Most science teachers in this school teach to the state standards.	86 (2.5)	84 (2.5)
There is a school-wide effort to align science instruction with the state science standards.	83 (2.4)	79 (3.1)
State science standards have been thoroughly discussed by science teachers in this school.	77 (3.0)	76 (3.1)
The school/district/diocese organizes science professional development based on state standards.*[,b]	52 (3.0)	61 (3.0)
High		
Most science teachers in this school teach to the state standards.	81 (3.8)	84 (2.7)
State science standards have been thoroughly discussed by science teachers in this school.	83 (2.9)	78 (3.0)
There is a school-wide effort to align science instruction with the state science standards.	82 (3.1)	78 (3.2)
The school/district/diocese organizes science professional development based on state standards.[b]	54 (2.4)	57 (3.4)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes schools indicating "strongly agree" or "agree" on a five-point scale ranging from 1 "strongly disagree" to 5 "strongly agree."

[b] In 2012, the item read "district/diocese" instead of "school/district/diocese."

By combining these items in a composite variable, an overview of the influence of standards is possible. The mean composite scores reflect the lack of change in individual items (see Table 7.5).

Table 7.5
School Mean Scores for the Focus on State Science Standards Composite†

	MEAN SCORE	
	2012	**2018**
Elementary	69 (1.1)	66 (1.6)
Middle	72 (1.3)	73 (1.6)
High	74 (1.4)	73 (1.4)

† There are no statistically significant differences between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Factors That Promote and Inhibit Effective Instruction

Program representatives were also given a list of factors and asked to indicate their influence on science instruction. Because there is little variation by grade range, the results are presented for schools overall (see Table 7.6). Two factors were perceived by a majority of schools as promoting effective science instruction: (1) school/district science professional development policies and practices and (2) the importance that the school places on science. With regard to the latter, there was a decrease from 2012 (60 percent of schools) to 2018 (51 percent of schools). There was also a decrease in the percentage of schools where time provided for science-related professional development was seen as a promoting science instruction (from 44 to 36 percent).

Table 7.6
Extent to Which Various Factors Promoted[a] Effective Science Instruction

	PERCENT OF SCHOOLS	
	2012	**2018**
The school/district/diocese science professional development policies and practices[b]	52 (2.5)	52 (2.4)
The importance that the school places on science*	60 (2.1)	51 (2.5)
How science instructional resources are managed (e.g., distributing and refurbishing materials)	53 (2.5)	49 (2.5)
The amount of time provided by the school/district/diocese for teacher professional development in science*,[c]	44 (2.3)	36 (2.2)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Schools rated the effect of each factor on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction." This table includes those indicating 4 or 5.

b In 2012, this item read "district/diocese" instead of "school/district/diocese."

c In 2012, the item read "Time provided for teacher professional development in science."

These items were combined into a composite variable in order to look at the effects of the factors on science more holistically. As Table 7.7 displays, elementary schools generally provided a less supportive context for science instruction than middle or high schools. In addition, there was a decrease at each grade range from 2012 to 2018, suggesting the context became less supportive.

Table 7.7
School Mean Scores for the Supportive Context for Science Instruction Composite[a]

	MEAN SCORE	
	2012	2018
Elementary*	68 (1.5)	56 (1.5)
Middle*	68 (1.9)	61 (1.6)
High*	68 (1.4)	64 (1.4)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Program representatives were also asked to rate whether each of several factors was a problem for instruction in their school (see Tables 7.8–7.10). Inadequate science-related professional development opportunities was perceived as a problem by 61–76 percent of the schools, inadequate materials for differentiating instruction by 54–67 percent, and inadequate funds for purchasing science equipment and supplies by 54–62 percent. For the most part, these data did not change between 2012 and 2018. At each grade range, inadequate funds for purchasing equipment and supplies was less likely in 2018 than in 2012 to be seen as a problem. A similar decrease is evident among middle and high schools regarding lack of science facilities. In contrast, among high schools, lack of parent/guardian support and involvement was considerable more likely in 2018 than in 2012 to be seen as a problem (63 percent and 44 percent, respectively).

Table 7.8
Elementary School Science Program Representatives Viewing Each of a Number of Factors as a Problem[a] for Science Instruction in Their School

	PERCENT OF SCHOOLS	
	2012	2018
Inadequate science-related professional development opportunities	72 (2.9)	76 (2.5)
Insufficient instructional time to teach science[b]	68 (2.9)	71 (2.9)
Inadequate materials for differentiating science instruction[c]	63 (3.0)	67 (2.6)
Inadequate funds for purchasing science equipment and supplies*	72 (2.7)	62 (2.7)
Inadequate teacher preparation to teach science	52 (3.0)	59 (2.7)
Lack of science facilities (e.g., lab tables, electric outlets, faucets and sinks in classrooms)	66 (3.1)	58 (3.1)
Lack of science textbooks/modules[d]	40 (3.2)	46 (2.7)
Lack of teacher interest in science	39 (3.0)	46 (2.8)
Lack of parent/guardian support and involvement[e]	38 (3.0)	45 (2.8)
Inappropriate student behavior	37 (2.7)	43 (2.4)
Large class sizes	42 (2.9)	42 (2.7)
High student absenteeism	28 (2.7)	33 (2.3)
Low student interest in science	35 (3.2)	29 (2.7)
Community resistance to the teaching of "controversial" issues in science (e.g., evolution, climate change)	22 (3.1)	16 (2.3)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes schools indicating "somewhat of a problem" or "serious problem" on a three-point scale from 1 "not a significant problem" to 3 "serious problem."

[b] In 2012, the item did not include "instructional."

[c] In 2012, the item read "individualizing" instead of "differentiating."

[d] In 2012, the item read "Inadequate supply of science textbooks/modules."

[e] In 2012, the item read "Lack of parent/guardian support and involvement for science education."

Table 7.9
Middle School Science Program Representatives Viewing Each of a Number of Factors as a Problem[a] for Science Instruction in Their School

	PERCENT OF SCHOOLS	
	2012	2018
Inadequate science-related professional development opportunities	65 (3.0)	64 (3.3)
Inadequate funds for purchasing science equipment and supplies*	75 (2.5)	60 (3.2)
Inadequate materials for differentiating science instruction[b]	66 (2.9)	59 (3.4)
Lack of science facilities (e.g., lab tables, electric outlets, faucets and sinks in classrooms)*	64 (3.3)	53 (3.0)
Lack of parent/guardian support and involvement[c]	44 (3.3)	51 (2.5)
Insufficient instructional time to teach science[d]	51 (3.3)	50 (3.3)
Inappropriate student behavior	41 (3.0)	46 (2.4)
Large class sizes	42 (3.1)	46 (2.6)
Low student interest in science	51 (3.6)	44 (3.0)
Lack of science textbooks/modules[e]	43 (3.5)	43 (3.5)
Inadequate teacher preparation to teach science	36 (3.7)	39 (3.0)
High student absenteeism	38 (2.8)	39 (2.8)
Lack of teacher interest in science	21 (3.3)	25 (3.3)
Community resistance to the teaching of "controversial" issues in science (e.g., evolution, climate change)	28 (3.9)	19 (2.8)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes schools indicating "somewhat of a problem" or "serious problem" on a three-point scale from 1 "not a significant problem" to 3 "serious problem."

[b] In 2012, the item read "individualizing" instead of "differentiating."

[c] In 2012, the item read "Lack of parent/guardian support and involvement for science education."

[d] In 2012, the item did not include "instructional."

[e] In 2012, the item read "Inadequate supply of science textbooks/modules."

Table 7.10
High School Science Program Representatives Viewing Each of a Number of Factors as a Problem[a] for Science Instruction in Their School

	PERCENT OF SCHOOLS	
	2012	2018
Lack of parent/guardian support and involvement*,[b]	44 (3.1)	63 (3.0)
Inadequate science-related professional development opportunities	62 (3.6)	61 (3.5)
Low student interest in science	57 (3.6)	61 (3.3)
High student absenteeism	48 (3.3)	56 (3.5)
Inadequate funds for purchasing science equipment and supplies*	67 (2.6)	54 (2.9)
Inadequate materials for differentiating science instruction[c]	62 (3.0)	54 (3.0)
Large class sizes	42 (2.7)	46 (3.3)
Insufficient instructional time to teach science[d]	48 (3.7)	45 (3.5)
Inappropriate student behavior	41 (2.8)	42 (3.7)
Lack of science facilities (e.g., lab tables, electric outlets, faucets and sinks in classrooms)*	53 (3.5)	41 (3.4)
Lack of science textbooks/modules[e]	44 (3.9)	37 (3.2)
Inadequate teacher preparation to teach science	23 (3.6)	27 (3.5)
Community resistance to the teaching of "controversial" issues in science (e.g., evolution, climate change)	23 (2.4)	21 (3.1)
Lack of teacher interest in science	12 (2.6)	13 (2.7)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes schools indicating "somewhat of a problem" or "serious problem" on a three-point scale from 1 "not a significant problem" to 3 "serious problem."

[b] In 2012, the item read "Lack of parent/guardian support and involvement for science education."

[b] In 2012, the item read "individualizing" instead of "differentiating."

[d] In 2012, the item did not include "instructional."

[e] In 2012, the item read "Inadequate supply of science textbooks/modules."

Composite variables created from these items allow for a summary of the factors affecting science instruction. Resource-related issues were less problematic at the middle and high school levels (see Table 7.11). Otherwise, there are no changes between 2012 and 2018.

Table 7.11
School Mean Scores for Factors Affecting Science Instruction Composites

	MEAN SCORE	
	2012	2018
Extent to Which a Lack of Resources is Problematic [a]		
Elementary	42 (1.8)	38 (1.5)
Middle*	43 (2.1)	35 (1.7)
High*	38 (2.4)	29 (1.8)
Extent to Which Student Issues Are Problematic [a]		
Elementary	20 (1.4)	21 (1.1)
Middle	28 (1.8)	28 (1.4)
High	30 (1.4)	33 (1.9)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Teachers were asked about factors that affect instruction in their randomly selected class. Elementary science teacher results are shown in Table 7.12. Similar to findings from the program questionnaires, teachers indicated that students' motivation, interest, and effort in science tend to promote science instruction in elementary classes (75 percent). Comparing 2018 to 2012, there were decreases in the percentage of classes in which teacher evaluation policies, parent/guardian expectations and involvement, and textbook selection policies were seen as promoting science instruction.

Table 7.12
Extent to Which Various Factors Promoted[a] Instruction in Elementary Science Classes

	PERCENT OF CLASSES	
	2012	2018
Students' motivation, interest, and effort in science	79 (1.9)	75 (2.2)
Principal support	70 (2.5)	65 (2.5)
Current state standards	67 (2.6)	64 (2.3)
Amount of time for you to plan, individually and with colleagues	55 (2.3)	57 (2.8)
Pacing guides	56 (2.8)	55 (2.7)
Amount of time available for your professional development	49 (2.4)	44 (2.7)
Teacher evaluation policies*	48 (2.7)	38 (3.1)
Parent/guardian expectations and involvement*	48 (2.7)	37 (2.3)
State/district/diocese testing/accountability policies[b]	40 (3.0)	36 (2.5)
Textbook/module selection policies*	44 (2.9)	32 (2.5)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Schools rated the effect of each factor on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction." This table includes those indicating 4 or 5.

[b] This item was presented only to public and Catholic schools.

In middle school science classes, principal support, current state standards, and the amount of time provided to plan individually and with colleagues were seen as promoting effective instruction in two-thirds or more of classes (see Table 7.13). There were decreases in the percentage of classes in which teachers saw teacher evaluation policies and textbook selection policies as promoting science instruction. For example, the proportion of classes in which teachers saw textbook selection policies as promoting science instruction decreased from 50 to 37 percent.

Table 7.13
Extent to Which Various Factors Promoted[a] Instruction in Middle School Science Classes

	PERCENT OF CLASSES	
	2012	**2018**
Students' motivation, interest, and effort in science	67 (3.3)	58 (2.4)
Principal support	77 (2.5)	71 (2.5)
Current state standards	67 (3.1)	68 (2.5)
Amount of time for you to plan, individually and with colleagues	63 (3.6)	66 (2.6)
Pacing guides	51 (3.4)	54 (2.8)
Amount of time available for your professional development	56 (3.8)	51 (2.8)
Teacher evaluation policies*	50 (3.6)	40 (2.7)
Parent/guardian expectations and involvement	43 (3.8)	40 (2.4)
State/district/diocese testing/accountability policies[b]	37 (3.5)	35 (2.8)
Textbook/module selection policies*	50 (3.8)	37 (2.8)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

[a] Schools rated the effect of each factor on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction." This table includes those indicating 4 or 5.

[b] This item was presented only to public and Catholic schools.

Similar to middle school classes, the amount of time for teachers to plan individually and with colleagues, as well as principal support, were both seen as promoting science instruction in two-thirds or more of high school science classes (see Table 7.14). Science classes were more likely in 2018 than in 2012 to be taught by teachers who saw their planning time as promoting instruction. However, several other factors became less likely to be seen as promoting instruction:

- Principal support (74 vs. 66 percent);
- College entrance requirements (61 vs. 53 percent);
- Parent/guardian expectations and involvement (52 vs. 43 percent);
- Teacher evaluation policies (51 vs. 42 percent); and
- Textbook selection policies (49 vs. 38 percent).

Table 7.14
Extent to Which Various Factors Promoted[a] Instruction in High School Science Classes

	PERCENT OF CLASSES	
	2012	2018
Students' motivation, interest, and effort in science	62 (2.0)	60 (1.9)
Principal support*	74 (2.0)	66 (1.9)
Current state standards	54 (2.1)	55 (2.2)
Amount of time for you to plan, individually and with colleagues*	59 (2.3)	69 (2.2)
Pacing guides	49 (2.3)	48 (2.3)
Amount of time available for your professional development	51 (2.4)	52 (2.2)
Teacher evaluation policies*	51 (2.0)	42 (2.3)
Parent/guardian expectations and involvement*	52 (2.1)	43 (2.6)
State/district/diocese testing/accountability policies[b]	30 (2.1)	29 (1.8)
Textbook/module selection policies*	49 (2.4)	38 (2.5)
College entrance requirements*	61 (2.2)	53 (2.1)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a Schools rated the effect of each factor on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction." This table includes those indicating 4 or 5.

b This item was presented only to public and Catholic schools.

Composites from these teacher questionnaire items were created to summarize the extent to which various factors support effective science instruction. The means for each composite, by grade range are shown in Table 7.15. Several patterns are apparent in the results. The extent to which the policy environment promotes effective instruction was about the same across grade levels. At the elementary level, the mean scores for the policy environment composite were lower in 2018 than in 2012. No other changes were evident.

Table 7.15
Class Mean Scores for Factors Affecting Science Instruction Composites

	MEAN SCORE	
	2012	2018
Extent to Which School Support Promotes Effective Instruction		
Elementary	62 (1.6)	62 (1.6)
Middle	66 (2.5)	67 (2.0)
High	65 (1.5)	69 (1.5)
Extent to Which the Policy Environment Promotes Effective Instruction [a]		
Elementary*	66 (1.3)	62 (1.0)
Middle	65 (1.7)	63 (1.1)
High	62 (0.9)	61 (0.8)

* There is a statistically significant difference between classes in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).

a This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed using only the items in common at both time points.

Summary

Science instruction in elementary grades typically occurs in self-contained classes. Rarely did students receive additional, enrichment, or remedial science instruction. In fact, more common than all of these arrangements was students being pulled out of science for additional instruction in other content areas—over a quarter of elementary schools employed this practice. None of these findings changed since 2012.

Across grade levels, there were many increases between 2012 and 2018 in programs to enhance students' interest or achievement in science and engineering. These increases were particularly evident at the elementary level. For example, the proportion of elementary schools offering family science or engineering nights increased from 26 to 44 percent. The proportion of middle schools offering engineering clubs increased from 13 to 36 percent, and the proportion of high schools with student teams participating in engineering competitions increased from 33 to 47 percent.

At the same time, the overall context for science instruction appears to have become somewhat less supportive since 2012. The percentage of schools in which the importance the school places on science was rated as a factor promoting instruction decreased from 60 to 51 percent. The decline in supportiveness of context is particularly noticeable at the elementary level. In contrast, at the secondary level, the context appears to have become more supportive in terms of resource availability.

Finally, course requirements for high school graduation have not changed since 2012, but the requirements for state university entrance have. There appears to be a considerable decrease in the percentage of schools where states require three science courses for university admission and a commensurate increase in those where states require only two courses.

Recomputed Composite Definitions

Some composite variables were computed differently for this report than in an individual year's report to allow for comparisons between the two time points. The definitions for the recomputed composites are shown in the following tables.

Definitions of Recomputed Teacher Composites

Composite definitions for the 2012 and 2018 science teacher questionnaires (STQ) are presented below along with the item numbers from the respective questionnaires.

Table A-1
Extent Professional Development Aligns With Elements of Effective Professional Development†

	2012 STQ ITEM	2018 STQ ITEM
I had opportunities to engage in science investigations/engineering design challenges.	Q35a	Q33a
I had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction, e-portfolios).	Q35b	Q33c
I had opportunities to apply what I learned to my classroom and then come back and talk about it as part of the professional development.	Q35c	Q33e
I worked closely with other teachers from my school.	Q35d	Q33f
I worked closely with other teachers who taught the same grade and/or subject whether or not they were from my school.	Q35e	Q33g
Number of Items in Composite	**5**	**5**
Reliability – Cronbach's Coefficient Alpha	**0.72**	**0.68**
Confirmatory Factor Analysis Fit Index – SRMR	**0.05**	**0.05**

† These items were presented only to teachers who participated in science-related professional development in the last three years.

Table A-2
Traditional Teaching Beliefs

	2012 STQ ITEM	2018 STQ ITEM
Students learn science best in classes with students of similar abilities.	Q42a	Q38a
At the beginning of instruction on a science idea, students should be provided with definitions for new scientific vocabulary that will be used.	Q42e	Q38c
Teachers should explain an idea to students before having them consider evidence that relates to the idea.	Q42f	Q38d
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	Q42i	Q38f
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.55†**	**0.65**
Confirmatory Factor Analysis Fit Index – SRMR	**0.02**	**0.08**

† Although the Cronbach's alpha is lower than typically accepted standards, the composite was computed for 2012 because the SRMR statistic is sufficiently low to support its computation.

Table A-3
Curriculum Control

	2012 STQ ITEM	2018 STQ ITEM
Determining course goals and objectives	Q44a	Q44a
Selecting curriculum materials (for example: textbooks/modules)	Q44b	Q44b
Selecting content, topics, and skills to be taught	Q44c	Q44c
Number of Items in Composite	**3**	**3**
Reliability – Cronbach's Coefficient Alpha	**0.80**	**0.85**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.03**

Table A-4
Reform-Oriented Instructional Objectives

	2012 STQ ITEM	2018 STQ ITEM
Understanding science concepts	Q49b	Q45b
Learning about real-life applications of science/engineering	Q49d	Q45f
Increasing students' interest in science	Q49e	Q45g
Number of Items in Composite	**3**	**3**
Reliability – Cronbach's Coefficient Alpha	**0.63**	**0.63**
Confirmatory Factor Analysis Fit Index – SRMR	**0.08**	**0.08**

Table A-5
Extent to Which the Policy Environment Promotes Effective Instruction

	2012 STQ ITEM	2018 STQ ITEM
Current state standards	Q68a	Q60a
School/District/Diocese pacing guides	Q68c	Q60b
State/District/Diocese testing/accountability policies†	Q68d/e	Q60c
Textbook/module selection policies	Q68f	Q60d
Teacher evaluation policies	Q68g	Q60e
Number of Items in Composite	**5**	**5**
Reliability – Cronbach's Coefficient Alpha	**0.81**	**0.80**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.06**

† This item was presented only to teachers in public and Catholic schools.

Definitions of Recomputed Program Composites

Composite definitions for the 2012 and 2018 science program questionnaires (SPQ) are presented below along with the item numbers from the respective questionnaires.

Table A-6
Supportive Context for Science Instruction

	2012 SPQ ITEM	2018 SPQ ITEM
School/district/Diocese science professional development policies and practices†	Q32a	Q16a
Amount of time provided for teacher professional development in science	Q32b	Q16b
Importance that the school places on science	Q32c	Q16c
Other school and/or district and/or diocese initiatives	Q32e	Q16d
How science instructional resources are managed (e.g., distributing and refurbishing materials)	Q32f	Q16f
Number of Items in Composite	**5**	**6**
Reliability – Cronbach's Coefficient Alpha	**0.76**	**0.85**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.04**

† This item was presented only to teachers in public and Catholic schools.

Table A-7
Extent to Which a Lack of Resources Is Problematic

	2012 SPQ ITEM	2018 SPQ ITEM
Lack of science facilities (e.g., lab tables, electric outlets, faucets and sinks in classrooms)	Q33a	Q17a
Inadequate funds for purchasing science equipment and supplies	Q33b	Q17b
Lack of science textbooks/modules	Q33c	Q17c
Inadequate materials for differentiating science instruction	Q33d	Q17e
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.76**	**0.75**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.05**

Table A-8
Extent to Which Student Issues Are Problematic

	2012 SPQ ITEM	2018 SPQ ITEM
Low student interest in science	Q33e	Q17f
Low student prior knowledge and skills	Q33f	Q17g
High student absenteeism	Q33n	Q17n
Inappropriate student behavior	Q33o	Q17o
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.78**	**0.78**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.05**