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Monitoring Progress Toward Successful K–12 STEM Education: A Comparison of 2018 and 2012 Data from the NSSME

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Disclaimer

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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/

TABLE OF CONTENTS

LIST OF TABLES

Monitoring Progress Toward Successful K–12 STEM Education: A Nation Advancing?[1] describes 14 indicators for assessing and tracking the health of pre-college STEM education in the United States. The National Survey of Science and Mathematics Education (NSSME) has periodically collected data about the status of the nation's K–12 science and mathematics education system since 1977. The 2018 NSSME+[2] (the plus sign reflecting the addition of computer science to the study), the sixth in the series of studies, provides an opportunity to examine the current status of the system relative to several of the indicators, specifically:

Indicator 2. Time allocated to teach science in grades K–5;

Indicator 3. Science-related learning opportunities in elementary schools;

Indicator 4. Adoption of instructional materials in grades K–12 that embody the *Common Core State Standards for Mathematics and A Framework for K–12 Science Education*;

Indicator 5. Classroom coverage of content and practices in the *Common Core State Standards for Mathematics and A Framework for K–12 Science Education*;

Indicator 6. Teachers' science and mathematics content knowledge for teaching; and

Indicator 7. Teachers' participation in STEM-specific professional development activities.

This report utilizes data from four instruments:

1. **Science Program Questionnaire (SPQ)**

   The SPQ was administered in each sampled school to an employee knowledgeable about the science program in the school as a whole (e.g., an administrator, a department chair, a lead teacher). It asked about school programs and practices to support science instruction, schoolwide professional development opportunities, and science courses offered at the school.

2. **Mathematics Program Questionnaire (MPQ)**

   Like the SPQ, the MPQ was administered in each school to an employee knowledgeable about the mathematics program in the school as a whole.

[1] National Research Council. (2013). *Monitoring progress toward successful K-12 STEM education: A nation advancing? Committee on the Evaluation Framework for Successful K–12 STEM Education*. Board on Science Education and Board on Testing and Assessment, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

[2] More information about the 2018 NSSME+ can be found in Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc.

3. **Science Teacher Questionnaire (STQ)**

   The STQ was administered to a sample of science teachers in each school and focused on several areas:

   - Teacher background (e.g., college coursework, experience) and opinions;
   - Instruction in a randomly selected science class;
   - Instruction in the most recently completed unit in the sampled class;
   - Instruction in the most recent lesson in the sampled class; and
   - Teacher demographics.

4. **Mathematics Teacher Questionnaire (MTQ)**

   Like the STQ, the MTQ was administered to a sample of mathematics teachers in each school and asked about the same set of subject-specific topics.

The remainder of this report is organized by indicator, showing relevant data from the 2018 NSSME. The report also shows comparisons between 2018 data and 2012 data (the previous iteration of the study) when available.[3]

When possible, data are also disaggregated by the status of states' adoption of the Next Generation Science Standards (NGSS):[4]

- Early Adopter is defined as the state adopting the NGSS or NGSS-like standards in 2013 or 2014 (15 states and the District of Columbia);
- Late Adopter is defined as the state adopting the NGSS or NGSS-like standards from 2015 to spring 2018, when data collection ended (24 states); and
- Non-Adopter is defined as the state not having adopted the NGSS or NGSS-like standards by spring 2018 (11 states).

[3] The 2012 NSSME and 2018 NSSME+ collected demographic data for each school, as well as for students in the randomly selected class of each teacher, which allows survey results to be disaggregated by factors such as community type, school size, proportion of students in the school eligible for free/reduced-price lunch, prior achievement level of the class, and proportion of students in the class from race/ethnic groups historically underrepresented in STEM. These types of analyses can provide insight into whether high quality computer science, mathematics, and science education are equitably available. Results of these "equity" analyses are not included in this report, but can be found in the Report of the 2012 National Survey of Science and Mathematics Education (Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., and Weis, A. M. (2013). *Report of the 2012 national survey of science and mathematics education.* Chapel Hill, NC: Horizon Research, Inc.) and the Report of the 2018 NSSME+.

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

Time Allocated to Teach Science in Grades K–5

Both the 2012 NSSME and the 2018 NSSME+ collected data about three aspects of instructional time for science in grades K–5:

- How often science is taught;
- The average number of minutes per day spent teaching science; and
- The length of the most recent science lesson.

Most K–5 teachers teach in self-contained classrooms (i.e., they are responsible for teaching all academic subjects to a single group of students). As can be seen in Table 1, fewer than a quarter of grades K–5 self-contained classes received science instruction all or most days, every week of the school year in both 2012 and 2018. In 2018, only 18 percent of grades K–2 classes and 25 percent of grades 3–5 classes received science instruction all or most days, similar to the percentages of classes receiving daily science instruction in 2012.

Table 1
Frequency With Which Self-Contained Elementary Classes Received Science Instruction, by Year†

	PERCENT OF CLASSES	
	2012	**2018**
Grades K–5		
All/Most days, every week	24 (1.4)	21 (1.4)
Three or fewer days, every week	37 (1.4)	39 (1.6)
Some weeks, but not every week	39 (1.6)	40 (1.8)
Grades K–2		
All/Most days, every week	19 (1.6)	18 (1.7)
Three or fewer days, every week	40 (1.6)	41 (2.0)
Some weeks, but not every week	41 (2.0)	42 (2.3)
Grades 3–5		
All/Most days, every week	30 (2.1)	25 (2.0)
Three or fewer days, every week	33 (2.0)	38 (2.4)
Some weeks, but not every week	36 (2.2)	37 (2.2)

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

Teachers were also asked about the total number of minutes spent teaching science in a typical week. From this information, the average number of minutes per day spent teaching science across both self-contained and non-self-contained grades K–5 classes was determined (elementary science teachers who do not teach in self-contained classrooms, such as science specialists, were asked to respond for a randomly selected class). On average, about 25 minutes per day were devoted to science in grades K–5 classes in 2018 (see Table 2), similar to the time spent in 2012.

Table 2
Average Number of Minutes Per Day Spent Teaching Science in Elementary Classes, by Year†

	2012		2018	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Grades K–5	24.40	18.94	24.97	19.58
Grades K–2	18.15	12.99	18.18	14.02
Grades 3–5	29.88	21.49	31.36	21.81

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

Table 3 shows the mean duration of elementary teachers' most recent science lesson, an indication of how long a typical science lesson is when science is taught. Given that many elementary teachers do not teach science every day, the means in Table 3 are higher than those in Table 2. The average class lengths in both grades K–2 classes and grades 3–5 classes were similar in 2012 and 2018, with lessons in grades K–2 lasting about 40 minutes, and those in grades 3–5 lasting about 50 minutes on average.

Table 3
Duration of the Most Recent Elementary Science Lesson (in Minutes), by Year†

	2012		2018	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Grades K–5	45.61	37.54	44.31	18.06
Grades K–2	39.55	21.23	39.27	15.52
Grades 3–5	50.84	46.31	49.03	18.99

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

Science-Related Learning Opportunities in Elementary Schools

Science program representatives were asked to indicate which of a variety of programs or practices their school offered to enhance student interest and/or achievement in science and/or engineering. The practices included activities such as science or engineering clubs, competitions (e.g., Science Olympiad), and partnerships with entities in the community (e.g., mentors, businesses, institutes of higher education).

Table 4 shows the percentage of elementary schools offering these programs and practices. In 2018, two-thirds of elementary schools encouraged students to participate in science and/or engineering summer programs or camps; only half did so in 2012. Several other programs and practices were also more common in 2018 than they had been in 2012, including holding family science and/or engineering nights, offering formal after-school programs for enrichment in science and/or engineering, and offering engineering clubs. The increase in the percentages of schools with these programs and practices may be related to the emphasis on engineering in the *Framework for K–12 Science Education* (hereafter referred to as the "*Framework*").[5]

Table 4
Elementary School Programs/Practices to Enhance Students' Interest and/or Achievement in Science/Engineering, by Year

	PERCENT OF SCHOOLS	
	2012	**2018**
Encourages students to participate in science and/or engineering summer programs or camps (e.g., offered by community colleges, universities, museums, or science centers)*1	50 (3.5)	68 (2.8)
Holds family science and/or engineering nights*1	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*1	30 (2.7)	39 (2.9)
Offers one or more science clubs*1	20 (2.6)	36 (3.2)
Offers formal after-school programs for enrichment in science and/or engineering*1	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*1	7 (2.0)	28 (2.5)
Coordinates meetings with adult mentors who work in science and/or engineering fields*1	16 (2.4)	26 (2.8)
Has one or more teams participating in engineering competitions (e.g., Robotics)*1	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)

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

5 National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K–12 Science Education Standards, Board on Science Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Adoption of Instructional Materials in Grades K–12 That Embody the *Common Core State Standards for Mathematics* and *A Framework for K–12 Science Education*

The 2018 NSSME+ collected data on instructional materials designated for use and actually used in science and mathematics classes, such as commercially published textbooks/modules, lessons from subscription websites, and lessons teachers created. This section of the report describes these data, as well as titles and publisher information for the specific textbooks used most frequently. However, it is important to note that determining the extent to which materials embody the *Common Core State Standards: Mathematics* (CCSSM)[6] and the *Framework* would require analysis of the materials, which is beyond the scope of the NSSME.

Science Instructional Materials

The 2018 NSSME+ asked teachers whether instructional materials were designated for use in their class by the school or district. The majority of science classes at each grade band had instructional materials designated by their district in 2018 (see Table 5).

Table 5
Science Classes for Which Instructional Resources Were Designated in 2018

	PERCENT OF CLASSES
Elementary	72 (2.4)
Middle	66 (2.8)
High	58 (2.0)

In science classes that had materials designated, commercially published textbooks were the most common type, designated for use in two-thirds of elementary classes and the vast majority of middle and high school classes (see Table 6). Other commonly designated materials in elementary classes were commercially published kits/modules and state, county, or district-developed materials designated for use.

[6] National Governors Association Center for Best Practices and Council of Chief State School Officers. (2010). *Common core state standards for mathematics.* Washington, DC: National Governors Association Center for Best Practices and Council of Chief State School Officers.

Table 6
Science Classes for Which Various Types of Instructional Resources Were Designated in 2018,[a] by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks[*1]	67 (2.9)	87 (1.8)	95 (0.9)
State, county, district, or diocese-developed units or lessons[*2]	43 (2.2)	32 (2.3)	27 (1.7)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	20 (1.9)	26 (2.2)	25 (2.0)
Commercially published kits/modules (printed or electronic)[*1]	51 (2.7)	36 (3.1)	22 (2.0)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)[*3]	39 (2.7)	39 (2.8)	16 (1.5)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	9 (1.2)	15 (2.0)	11 (1.8)

[*1] There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

[*2] There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

[*3] There is a statistically significant difference between high school classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only those teachers who indicated that their randomly selected science class had an instructional material designated by the state, district, or diocese.

Table 7 displays the types of materials designated in science classes in 2018 by NGSS-Adoption Status. One finding that stands out from these data is that there are not major differences by adoption status, though there are some small differences. Commercially published kits and modules were more likely to be designated for use in classes in early and late-adoption states than in non-adoption states, perhaps because these types of materials are more closely aligned with the vision of the NGSS. Science classes in non-adoption states were more likely than classes in late-adoption states to have commercially published textbooks designated for use. Science classes in non-adoption states were also more likely to have materials developed by the state, county, or district designated for use than science classes in early adoption states.

Table 7
Science Classes for Which Various Types of Instructional Resources Were Designated in 2018,[a] by State NGSS-Adoption Status

	PERCENT OF CLASSES		
	NON-ADOPTERS	LATE ADOPTERS	EARLY ADOPTERS
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks*1	83 (2.6)	72 (3.0)	78 (3.3)
Commercially published kits/modules (printed or electronic)*2	35 (2.6)	43 (3.0)	46 (3.4)
State, county, district, or diocese-developed units or lessons*3	40 (2.7)	39 (2.5)	31 (2.6)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	37 (2.5)	31 (2.5)	31 (3.1)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	26 (2.1)	20 (2.2)	21 (2.1)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	13 (1.7)	9 (1.2)	9 (1.6)

*1 There is a statistically significant difference between classes in non-adoption states and classes in late-adoption states (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between classes in non-adoption states and classes in each of the other two adoption groups (two-tailed independent samples t-test, $p < 0.05$).

*3 There is a statistically significant difference between classes in early adoption states and classes in each of the other two adoption groups (two-tailed independent samples t-test, $p < 0.05$).

a Includes only those teachers who indicated that their randomly selected science class had an instructional material designated by the state, district, or diocese.

Another question asked teachers how often they use various types of instructional materials in their classes. As shown in Table 8, units or lessons created by teachers were used at least once a week in the large majority of middle and high school science classes and in almost half of elementary classes in 2018. About half of all elementary science classes used lessons and resources from subscription-based websites at least once a week; these types of materials were used less frequently in middle and high school classes. Commercially published textbooks were used at least once a week in 38–50 percent of classes depending on grade range.

Table 8
Science Classes Basing Instruction on Various Instructional Resources at Least Once a Week in 2018, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Units or lessons you created (either by yourself or with others)*1	47 (2.4)	76 (2.0)	86 (1.0)
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks*2	38 (1.9)	45 (2.6)	50 (1.7)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)*1	28 (2.0)	43 (2.4)	49 (1.7)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)*3	23 (2.1)	31 (1.8)	31 (1.8)
Commercially published kits/modules (printed or electronic)*2	29 (2.1)	21 (2.4)	21 (1.5)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*1	49 (2.2)	34 (1.9)	16 (1.1)
State, county, district, or diocese-developed units or lessons*1	32 (2.4)	21 (1.9)	14 (1.2)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	7 (1.0)	9 (1.0)	9 (1.0)

*1 There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between elementary classes and high school classes (two-tailed independent samples t-test, $p < 0.05$).

*3 There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

Table 9 shows the types of instructional materials used at least once a week in K–12 science classes by state NGSS-adoption status. Science classes in non-adoption states and early adoption states were both more likely to use commercially published textbooks than science classes in late-adoption states. Science classes in non-adoption states were more likely than both late-adoption and early adoption states to use lessons or resources from websites that have an associated cost.

Table 9
Science Classes Basing Instruction on Various Instructional Resources at Least Once a Week in 2018, by State NGSS-Adoption Status

	PERCENT OF CLASSES		
	NON-ADOPTERS	LATE ADOPTERS	EARLY ADOPTERS
Units or lessons you created (either by yourself or with others)	65 (2.0)	64 (2.0)	61 (2.8)
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks*1	47 (2.6)	38 (2.1)	45 (2.5)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	38 (1.7)	35 (2.5)	38 (2.3)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*2	42 (2.2)	36 (2.3)	32 (1.9)
Commercially published kits/modules (printed or electronic)	22 (1.8)	25 (1.9)	28 (2.5)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	26 (1.5)	27 (2.4)	27 (2.1)
State, county, district, or diocese-developed units or lessons	27 (1.9)	26 (2.5)	21 (1.8)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	9 (1.2)	8 (1.0)	6 (0.9)

*1 There is a statistically significant difference between classes in late adoption states and classes in each of the other two adoption groups (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between classes in non-adoption states and classes in early adoption states (two-tailed independent samples t-test, $p < 0.05$).

Those teachers indicating that their class used commercially published textbooks/modules were asked to provide additional details, such as the title, publisher, and copyright year of the materials. Table 10 shows the science materials used in each grade range in 2018 by at least 10 percent of classes; secondary textbooks are also shown by course type.

Table 10
Most Commonly Used Science Materials in 2018 in Each Grade Range and Course

	PUBLISHER	TITLE
Elementary		
Science	Houghton Mifflin Harcourt	*Science Fusion*
	Delta Education	*FOSS*
	Houghton Mifflin Harcourt	*Harcourt Science*
	Pearson	*Interactive Science*
Middle		
Earth/Space Science	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
General/Integrated Science	Pearson	*Interactive Science*
	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
	McGraw-Hill Education	*Glencoe Science*
	Houghton Mifflin Harcourt	*Holt Science & Technology*
Life Science	Pearson	*Interactive Science*
	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
	Houghton Mifflin Harcourt	*Life Science*
	Houghton Mifflin Harcourt	*Holt Science & Technology*
Physical Science	McGraw-Hill Education	*Glencoe iScience*
	Houghton Mifflin Harcourt	*Physical Science*
High		
Biology/Life Science	Pearson	*Biology*
	Houghton Mifflin Harcourt	*Biology*
Chemistry	Pearson	*Chemistry*
	Houghton Mifflin Harcourt	*Modern Chemistry*
	McGraw-Hill Education	*Chemistry Matter and Change*
Earth/Space Science	Pearson	*Earth Science*
	McGraw-Hill Education	*Earth Science*
Environmental Science/Ecology	Houghton Mifflin Harcourt	*Environmental Science*
	Cengage	*Living in the Environment*
Multi-discipline	McGraw-Hill Education	*Physical Science*
	Houghton Mifflin Harcourt	*Physical Science*
Physics	Pearson	*Conceptual Physics*
	Houghton Mifflin Harcourt	*Physics*

In 2018, the commercially published materials used in a majority of science classes were relatively old. As can be seen in Table 11, about three-quarters of science classes across grade ranges were using textbooks published prior to the release of the NGSS in 2013.

Table 11
Publication Year of Science Materials Used in 2018, by Grade Range†

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
2013 or earlier (Prior to the release of the NGSS)	73 (3.5)	81 (3.1)	77 (1.9)
2014	10 (2.5)	4 (1.4)	7 (1.0)
2015	9 (2.3)	4 (1.2)	7 (1.0)
2016	6 (1.3)	5 (1.4)	4 (0.7)
2017	3 (0.9)	4 (2.0)	4 (1.1)
2018	0 (0.1)	1 (0.7)	1 (0.3)

† There are no significant differences among classes in different grade levels (two-tailed independent samples t-test, $p \geq 0.05$).

Classes in early and late-adoption states were especially likely to be using older materials; in 2018, about 80 percent were using textbooks published before the release of the NGSS (see Table 12). There is a difference in the age of materials used in science classes between non-adoption states and early and late-adopting states, with non-adopters appearing to be more likely to have been using newer materials.

Table 12
Publication Year of Science Materials Used in 2018, by State NGSS-Adoption Status

	PERCENT OF CLASSES*1		
	NON-ADOPTERS	LATE ADOPTERS	EARLY ADOPTERS
2013 or earlier (Prior to the release of the NGSS)	67 (3.9)	79 (3.2)	82 (2.4)
2014	14 (3.1)	4 (1.2)	4 (1.2)
2015	13 (2.6)	5 (2.3)	3 (0.8)
2016	3 (0.8)	6 (1.3)	6 (1.3)
2017	3 (1.1)	5 (1.5)	4 (1.2)
2018	0 (0.1)	0 (0.2)	1 (0.5)

*1 There is a statistically significant difference between classes in non-adoption states and classes in each of the other two adoption groups (Chi-square test of independence, $p < 0.05$).

Mathematics Instructional Materials

Table 13 shows the percentage of mathematics classes in 2018 that had instructional materials designated by the school or district. Although the likelihood of having materials designated decreased from elementary school to high school, the majority of all mathematics classes had materials designated.

Table 13
Mathematics Classes for Which Instructional Resources Were Designated in 2018

	PERCENT OF CLASSES
Elementary	91 (1.3)
Middle	80 (2.1)
High	66 (1.7)

Table 14 displays the types of materials designated for use in mathematics classes in 2018. As in science, commercially published textbooks were designated for use in the large majority (88–91 percent) of mathematics classes. Other types of materials that were designated less often (in fewer than half of mathematics classes) include locally developed units or lessons, lessons from free and paid websites, and online units that students work through at their own pace.

Table 14
Mathematics Classes for Which Various Types of Instructional Resources Were Designated in 2018,[a] by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks	89 (1.4)	88 (1.9)	91 (1.3)
State, county, district, or diocese-developed units or lessons[*1]	44 (2.2)	37 (2.5)	32 (1.9)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	28 (1.8)	30 (2.5)	24 (1.7)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)[*2]	31 (2.0)	22 (2.0)	15 (1.5)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)[*3]	33 (2.0)	33 (2.9)	13 (1.7)

*1 There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

*3 There is a statistically significant difference between high school classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

a Includes only those teachers who indicated that their randomly selected mathematics class had an instructional material designated by the state, district, or diocese.

The instructional materials that mathematics classes used at least once a week in 2018 are displayed in Table 15. Teacher-created materials were used at least once a week in a large majority of secondary classes and just under half of elementary classes. Commercially published textbook usage was also fairly common, with about two-thirds of secondary mathematics classes and three-fourths of elementary mathematics classes using them at least once a week. Other instructional materials, such as lessons from free and fee-based websites and locally developed units or lessons, were also regularly used in about a quarter to as much as one-half of mathematics classes across grade levels.

Table 15
Mathematics Classes Basing Instruction on Various Instructional Resources at Least Once a Week in 2018, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Units or lessons you created (either by yourself or with others)*1	44 (2.0)	65 (2.5)	78 (1.5)
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks*2	76 (2.0)	65 (2.5)	61 (1.7)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	30 (1.8)	31 (1.9)	35 (1.6)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)*3	37 (1.9)	39 (2.4)	27 (1.4)
State, county, district, or diocese-developed units or lessons*2	41 (1.8)	26 (1.9)	23 (1.3)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*1	54 (2.1)	34 (2.4)	19 (1.2)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*1	36 (2.1)	24 (1.9)	12 (1.2)

*1 There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*3 There is a statistically significant difference between high school classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

Table 16 displays the publishers and titles of textbooks that were most commonly used in mathematics classes and courses in 2018.

Table 16
Most Commonly Used Mathematics Textbooks in 2018 in Each Grade Range and Course

	PUBLISHER	TITLE
Elementary		
Mathematics	Houghton Mifflin Harcourt	*Go Math!*
	Pearson	*Envision Math*
	McGraw-Hill Education	*My Math*
Middle		
6th Grade Mathematics	Houghton Mifflin Harcourt	*Go Math!*
	Pearson	*Envision Math*
	McGraw-Hill Education	*Math Course 1*
7th Grade Mathematics	Houghton Mifflin Harcourt	*Go Math!*
	Houghton Mifflin Harcourt	*Big Ideas Math*
	McGraw-Hill Education	*Math Course 2*
8th Grade Mathematics	Houghton Mifflin Harcourt	*Go Math!*
Algebra 1, Grade 7 or 8	Pearson	*Algebra 1*
	Houghton Mifflin Harcourt	*Algebra 1*
	McGraw-Hill Education	*Algebra 1*
High		
Non-College Prep Mathematics	McGraw-Hill Education	*Algebra 1*
Formal/College Prep Mathematics Level 1	Pearson	*Algebra 1*
	Houghton Mifflin Harcourt	*Algebra 1*
	McGraw-Hill Education	*Algebra 1*
	Houghton Mifflin Harcourt	*Big Ideas Math*
Formal/College Prep Mathematics Level 2	Houghton Mifflin Harcourt	*Geometry*
	Pearson	*Geometry*
	McGraw-Hill Education	*Geometry*
Formal/College Prep Mathematics Level 3	Houghton Mifflin Harcourt	*Algebra 2*
	McGraw-Hill Education	*Algebra 2*
	Pearson	*Algebra 2*
Formal/College Prep Mathematics Level 4	McGraw-Hill Education	*Precalculus*
Courses that might qualify for college credit	Macmillan	*The Practice of Statistics*
	Pearson	*Calculus: Graphical, Numerical, Algebraic*
	Cengage	*Calculus of a Single Variable*

Table 17 shows textbook publication year data for mathematics. The majority of mathematics classes in 2018 were using textbooks published after the release of the CCSSM in 2010. However, about 1 in 6 elementary and middle grades classes and 1 in 3 high school classes were using textbooks from 2010 or earlier. There is also a significant difference among grade ranges in the publication year of their mathematics textbooks, apparently due to high school classes using older books than elementary and middle school classes.

Table 17
Publication Year of Mathematics Textbooks, by Grade Range

	PERCENT OF CLASSES[*1]		
	ELEMENTARY	MIDDLE	HIGH
2010 or earlier (Prior to the release of the CCSSM)	14 (2.0)	17 (2.6)	33 (2.1)
2011	16 (2.2)	8 (1.6)	13 (1.4)
2012	15 (2.1)	12 (2.5)	15 (2.0)
2013	7 (1.5)	19 (2.2)	9 (1.3)
2014	19 (2.2)	17 (2.2)	12 (1.8)
2015	20 (2.5)	14 (1.8)	9 (1.2)
2016	6 (1.4)	7 (2.2)	6 (0.8)
2017	3 (1.0)	6 (1.4)	4 (1.0)
2018	1 (0.5)	1 (0.3)	1 (0.4)

[*1] There is a statistically significant difference among classes in all grade levels (Chi-square test of independence, $p < 0.05$).

Classroom Coverage of Content and Practices in *Common Core State Standards for Mathematics* and *A Framework for K–12 Science Education*

Both the 2012 NSSME and 2018 NSSME+ contained several items about classroom instruction that provide insight into the extent to which the content and practices described in the CCSSM and *Framework* are covered in classrooms. First, the program questionnaires asked a series of questions about the influence of state standards on teachers and their teaching. Although not a direct indicator of classroom coverage of specific content and practices, these items do provide a general sense of the extent to which teachers are basing their instruction on state standards (the majority of which are based on the CCSSM and *Framework*).

Second, the teacher questionnaires included several items about science and mathematics instruction in a randomly selected class. One item asked about the emphasis teachers give to various student objectives; another asked about the frequency with which they use a variety of instructional activities. The surveys at both time points also asked teachers about the activities included in their most recent lesson. Additionally, the 2018 NSSME+ included questions about how often students are engaged in practices of science and mathematics described in the *Framework* and CCSSM. This section of the report describes instruction in science and mathematics classes using data from these items.

Science Instruction

It is clear that state standards had a major influence on science instruction in 2018, as they did in 2012 (see Table 18). In about 80 percent of schools across grade bands, program representatives agreed that most science teachers in their school teach to the state standards. The large majority of schools also had school-wide efforts to align science instruction with state science standards, although there has been a slight decrease on this item at the elementary grades since 2012.

Table 18
Influence[a] of State Science Standards in Schools, by Year

	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.[*1]	80 (2.3)	71 (2.8)
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)
High		
Most science teachers in this school teach to the state standards.	81 (3.8)	84 (2.7)
There is a school-wide effort to align science instruction with the state science standards.	82 (3.1)	78 (3.2)

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

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

The teacher questionnaires provide much more data about classroom instruction. Table 19 displays the percentages of classes that had a heavy emphasis on each of several science objectives, most of which are aligned with *Framework* recommendations. In 2018, understanding science concepts was by far the most emphasized instructional objective, receiving heavy emphasis in about three-quarters of secondary science classes and half of elementary science classes (though a decrease since 2012 at the elementary and high school levels). Learning how to do science, such as developing scientific questions and designing investigations, key components of the *Framework*, received heavy emphasis in only about a quarter of elementary classrooms, and just under half of secondary classrooms in 2018. Other objectives aligned with the *Framework*, such as learning how to do engineering and learning about real-life applications of science and engineering were emphasized in far fewer classrooms, regardless of grade level.

Table 19
Science Classes With a Heavy Emphasis on Various Instructional Objectives, by Year

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Understanding science concepts*1	59 (2.2)	47 (1.7)
Increasing students' interest in science/engineering[a]	n/a	27 (2.2)
Learning science vocabulary and/or facts[a]	n/a	27 (1.9)
Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	n/a	26 (2.0)
Developing students' confidence that they can successfully pursue careers in science/ engineering	n/a	23 (2.0)
Learning about real-life applications of science/engineering[a]	n/a	20 (2.1)
Learning test-taking skills/strategies	22 (1.6)	20 (1.5)
Learning about different fields of science/engineering	n/a	8 (1.9)
Learning how to do engineering (e.g., identify criteria and constraints, design solutions, optimize solutions)	n/a	8 (1.8)
Middle		
Understanding science concepts	80 (2.1)	77 (1.8)
Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	n/a	46 (2.1)
Learning science vocabulary and/or facts[a]	n/a	37 (2.2)
Increasing students' interest in science/engineering[a]	n/a	35 (2.1)
Developing students' confidence that they can successfully pursue careers in science/ engineering	n/a	30 (1.9)
Learning about real-life applications of science/engineering[a]	n/a	28 (2.0)
Learning test-taking skills/strategies	24 (1.7)	23 (1.8)
Learning how to do engineering (e.g., identify criteria and constraints, design solutions, optimize solutions)	n/a	10 (1.2)
Learning about different fields of science/engineering	n/a	7 (1.2)
High		
Understanding science concepts*1	80 (1.2)	76 (1.8)
Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	n/a	41 (1.3)
Developing students' confidence that they can successfully pursue careers in science/ engineering	n/a	35 (1.5)
Learning science vocabulary and/or facts[a]	n/a	32 (1.6)
Increasing students' interest in science/engineering[a]	n/a	31 (1.5)
Learning about real-life applications of science/engineering[a]	n/a	29 (1.2)
Learning test-taking skills/strategies	22 (1.2)	23 (1.4)
Learning about different fields of science/engineering	n/a	7 (0.8)
Learning how to do engineering (e.g., identify criteria and constraints, design solutions, optimize solutions)	n/a	5 (0.7)

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

a Although a similar item was included on the 2012 survey, the wording changed enough that it likely impacted teachers' responses, and comparisons across years could be misleading. Thus, the 2012 data are not shown.

The teacher questionnaires also asked how often teachers used each of a number of instructional practices in their randomly selected class, some of which may indicate *Framework*-aligned instruction was taking place. For example, engaging the whole class in discussions could indicate aligned instruction, and in 2018 took place in over three-quarters of science classes across grade levels (see Table 20). Other activities indicating potential alignment included having students do hands-on activities (occurring in 53–68 percent of classes) and having students write reflections (occurring in 28–47 percent of classes). However, teachers explaining ideas to the whole class, which is not indicative of *Framework*-aligned instruction, occurred at least once a week in about 9 out of 10 science classes.

The use of all of the instructional practices listed in Table 20 was fairly similar in both 2012 and 2018 at the elementary level. At the middle and high school levels, there was more variation between the two years. For example, the frequency of the teacher explaining science ideas to the whole class at least once a week decreased at both grade levels, and the frequency of engaging the class in project-based learning activities increased Additionally, in middle school classes, there was an increase in frequency of students working in small groups. Students writing reflections and focusing on literacy skills increased in frequency at the high school level. Across all grade ranges, there was a sizable decrease in the percentage of classes having students read from a textbook during class time.

Table 20
Science Classes in Which Teachers Reported Doing Various Activities at Least Once a Week During Science Lessons in their Classrooms, by Year

	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)*1	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) 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*1	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)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	10 (1.1)
Middle		
Explain science ideas to the whole class*1	96 (0.9)	92 (1.0)
Engage the whole class in discussions	92 (1.0)	89 (1.2)
Have students work in small groups*1	79 (1.9)	87 (1.5)
Have students do hands-on/laboratory activities	62 (2.4)	63 (2.0)
Have students write their reflections (e.g., in their journals) in class or for homework	44 (2.1)	47 (2.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	44 (2.2)	46 (2.3)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*1	56 (2.3)	39 (2.6)
Engage the class in project-based learning (PBL) activities*1	23 (1.9)	31 (2.3)
Have students practice for standardized tests	23 (1.9)	19 (1.7)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	10 (1.2)
High		
Explain science ideas to the whole class*1	95 (0.8)	92 (0.9)
Have students work in small groups	83 (1.2)	84 (1.5)
Engage the whole class in discussions*1	83 (1.0)	78 (1.3)
Have students do hands-on/laboratory activities	70 (1.5)	68 (1.6)
Focus on literacy skills (e.g., informational reading or writing strategies)*1	25 (1.5)	33 (1.6)
Have students write their reflections (e.g., in their journals) in class or for homework*1	21 (1.3)	28 (1.4)
Engage the class in project-based learning (PBL) activities*1	18 (1.2)	28 (1.7)
Have students read from a textbook, module, or other material in class, either aloud or to themselves*1	37 (1.6)	26 (1.7)
Have students practice for standardized tests	20 (1.2)	20 (1.5)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	15 (1.3)

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

The surveys also asked teachers about activities that took place during their most recent lesson in the randomly selected class. As can be seen in Table 21, the most recent science lessons were similar to science instruction overall, with some practices indicating potential alignment of instruction with the *Framework* and others not. Whole class discussions, teachers explaining science ideas, and small group work occurred in the majority of the most recent science lessons. Compared with 2012, the percentage of science classes in which students participated in whole class discussions and in which the teacher explained ideas decreased at all grade ranges. Similarly, there was a decrease at all grade ranges in the percentage of science classes in which students completed textbook/worksheet problems in the most recent lesson.

Table 21
Science Classes That Participated in Various Activities in Most Recent Lesson, by Year

	PERCENT OF CLASSES	
	2012	**2018**
Elementary		
Whole class discussion*1	91 (1.1)	86 (1.2)
Teacher explaining a science idea to the whole class*1	89 (1.2)	83 (1.5)
Students working in small groups	n/a	78 (1.5)
Students doing hands-on/laboratory activities	52 (1.9)	47 (2.1)
Students reading about science*1	53 (2.2)	45 (2.1)
Students writing about science	n/a	45 (2.3)
Teacher conducting a demonstration while students watched	40 (2.0)	37 (2.1)
Students completing textbook/worksheet problems*1	43 (1.8)	35 (1.8)
Test or quiz	12 (1.2)	9 (1.1)
Practicing for standardized tests*1	5 (0.8)	2 (0.6)
Middle		
Students working in small groups	n/a	85 (1.3)
Teacher explaining a science idea to the whole class*1	89 (1.4)	74 (2.2)
Whole class discussion*1	77 (1.8)	67 (2.3)
Students reading about science	50 (2.1)	48 (2.6)
Students doing hands-on/laboratory activities	50 (2.3)	46 (2.0)
Students writing about science	n/a	46 (2.6)
Students completing textbook/worksheet problems*1	51 (2.2)	39 (2.2)
Teacher conducting a demonstration while students watched	32 (2.4)	30 (2.1)
Test or quiz*1	22 (2.0)	14 (1.5)
Practicing for standardized tests	9 (1.2)	8 (1.0)
High		
Teacher explaining a science idea to the whole class*1	90 (0.9)	81 (1.3)
Students working in small groups	n/a	81 (1.4)
Whole class discussion*1	67 (1.4)	59 (1.6)
Students completing textbook/worksheet problems*1	59 (1.6)	44 (1.6)
Students doing hands-on/laboratory activities	39 (1.5)	40 (1.6)
Students writing about science	n/a	34 (1.8)
Teacher conducting a demonstration while students watched	32 (1.4)	31 (1.6)
Students reading about science*1	35 (1.5)	29 (1.6)
Test or quiz*1	20 (1.4)	16 (1.2)
Practicing for standardized tests	10 (0.8)	8 (0.9)

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

Additionally, the 2018 NSSME+ asked teachers how often students in science classes engaged in the practices of science as described in the *Framework*, such as formulating scientific questions, designing and implementing investigations, developing models and explanations, and engaging in argumentation. As can be seen in Table 22, students were often engaged in aspects of science related to conducting investigations and analyzing data. For example, about half of middle and high school classes had students organize and represent data, make and support claims with evidence, conduct scientific investigations, and analyze data at least once a week. At the elementary level, about a third of classes engaged students in these activities weekly.

Across all grade bands, students tended to not be engaged very often in aspects of science related to evaluating the strengths/limitations of evidence and the practice of argumentation. For example, fewer than a quarter of secondary science classes had students, at least once a week, pose questions about scientific arguments, evaluate the credibility of scientific information, identify strengths and limitations of a scientific model, evaluate the strengths and weaknesses of competing scientific explanations, determine what details about an investigation might persuade a targeted audience about a scientific claim, or construct a persuasive case.

Table 22
Science Classes in Which Teachers Reported Students Engaging in Various Aspects of Science Practices at Least Once a Week in 2018, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Organize and/or represent data using tables, charts, or graphs in order to facilitate analysis of the data*1	34 (2.1)	49 (2.3)	58 (1.5)
Make and support claims with evidence*2	32 (2.0)	51 (2.1)	50 (1.5)
Conduct a scientific investigation*2	36 (2.2)	48 (2.2)	50 (1.6)
Analyze data using grade-appropriate methods in order to identify patterns, trends, or relationships*2	27 (1.9)	43 (2.4)	47 (1.4)
Determine what data would need to be collected in order to answer a scientific question*2	29 (2.1)	39 (2.1)	39 (1.4)
Generate scientific questions	38 (2.2)	44 (2.2)	38 (1.8)
Compare data from multiple trials or across student groups for consistency in order to identify potential sources of error or inconsistencies in the data*2	19 (2.2)	31 (2.3)	36 (1.5)
Develop scientific models—physical, graphical, or mathematical representations of real-world phenomena*2	19 (1.7)	34 (2.3)	34 (1.5)
Use multiple sources of evidence to develop an explanation*2	26 (2.0)	37 (2.3)	33 (1.6)
Develop procedures for a scientific investigation to answer a scientific question	29 (2.2)	35 (2.1)	32 (1.4)
Select and use grade-appropriate mathematical and/or statistical techniques to analyze data*1	15 (1.4)	21 (1.8)	30 (1.6)
Determine whether or not a question is scientific*2	19 (1.6)	31 (1.8)	28 (1.5)
Revise their explanations based on additional evidence*2	22 (2.0)	30 (2.1)	28 (1.4)
Summarize patterns, similarities, and differences in scientific information obtained from multiple sources*2	18 (2.2)	25 (2.0)	28 (1.5)
Use data and reasoning to defend, verbally or in writing, a claim or refute alternative scientific claims*2	17 (1.6)	28 (1.8)	27 (1.7)
Consider how missing data or measurement error can affect the interpretation of data*1	14 (1.5)	21 (2.1)	27 (1.5)
Use mathematical and/or computational models to generate data to support a scientific claim*1	12 (1.2)	19 (1.4)	26 (1.3)
Pose questions that elicit relevant details about the important aspects of a scientific argument*2	14 (1.4)	24 (1.8)	23 (1.6)
Evaluate the credibility of scientific information—e.g., its reliability, validity, consistency, logical coherence, lack of bias, or methodological strengths and weaknesses*2	8 (1.1)	19 (1.7)	23 (1.4)
Identify the strengths and limitations of a scientific model—in terms of accuracy, clarity, generalizability, accessibility to others, strength of evidence supporting it*2	12 (1.8)	22 (2.0)	22 (1.1)
Evaluate the strengths and weaknesses of competing scientific explanations*2	12 (1.3)	19 (1.7)	20 (1.6)
Determine what details about an investigation might persuade a targeted audience about a scientific claim*2	11 (1.2)	15 (1.6)	17 (1.3)
Construct a persuasive case, verbally or in writing, for the best scientific model or explanation for a real-world phenomenon*2	10 (1.1)	17 (1.5)	15 (1.1)

*1 There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

Engagement in these same science practices at the K–12 level in 2018 was mostly similar regardless of state NGSS adoption status; however, science classes in non-adoption states were less likely than classes in late-adoption states to compare data from multiple sources, develop scientific models, and use mathematical and/or computational models to support scientific claims (see Table 23).

Table 23
Science Classes in Which Teachers Reported Students Engaging in Various Aspects of Science Practices at Least Once a Week in 2018, by State NGSS-Adoption Status

	PERCENT OF CLASSES		
	NON-ADOPTERS	LATE ADOPTERS	EARLY ADOPTERS
Organize and/or represent data using tables, charts, or graphs in order to facilitate analysis of the data	42 (2.2)	45 (2.0)	44 (2.1)
Make and support claims with evidence	34 (1.8)	45 (2.1)	43 (2.1)
Conduct a scientific investigation	38 (2.2)	45 (2.3)	43 (2.6)
Analyze data using grade-appropriate methods in order to identify patterns, trends, or relationships	33 (1.6)	38 (2.3)	36 (2.0)
Determine what data would need to be collected in order to answer a scientific question	32 (2.3)	36 (2.3)	34 (2.3)
Generate scientific questions	38 (2.2)	42 (2.2)	36 (2.0)
Compare data from multiple trials or across student groups for consistency in order to identify potential sources of error or inconsistencies in the data*[1]	23 (1.6)	30 (2.3)	25 (1.8)
Develop scientific models—physical, graphical, or mathematical representations of real-world phenomena*[1]	22 (1.6)	29 (2.2)	27 (1.8)
Use multiple sources of evidence to develop an explanation	27 (1.8)	32 (2.4)	33 (2.3)
Develop procedures for a scientific investigation to answer a scientific question	30 (2.1)	33 (2.3)	30 (2.0)
Select and use grade-appropriate mathematical and/or statistical techniques to analyze data	19 (1.6)	22 (1.7)	19 (1.6)
Determine whether or not a question is scientific	26 (2.1)	23 (1.5)	23 (1.7)
Revise their explanations based on additional evidence	23 (1.9)	27 (2.2)	25 (2.0)
Summarize patterns, similarities, and differences in scientific information obtained from multiple sources	21 (1.6)	23 (2.3)	23 (1.5)
Use data and reasoning to defend, verbally or in writing, a claim or refute alternative scientific claims	21 (1.7)	22 (1.6)	22 (1.8)
Consider how missing data or measurement error can affect the interpretation of data	20 (1.7)	19 (1.6)	19 (1.8)
Use mathematical and/or computational models to generate data to support a scientific claim*[1]	15 (1.3)	20 (1.4)	16 (1.6)
Pose questions that elicit relevant details about the important aspects of a scientific argument	18 (1.4)	20 (1.3)	16 (1.7)
Evaluate the credibility of scientific information—e.g., its reliability, validity, consistency, logical coherence, lack of bias, or methodological strengths and weaknesses	14 (1.5)	17 (1.3)	13 (1.4)
Identify the strengths and limitations of a scientific model—in terms of accuracy, clarity, generalizability, accessibility to others, strength of evidence supporting it	15 (1.4)	19 (2.3)	15 (1.3)
Evaluate the strengths and weaknesses of competing scientific explanations	16 (1.9)	16 (1.3)	15 (1.5)
Determine what details about an investigation might persuade a targeted audience about a scientific claim	12 (1.3)	15 (1.5)	12 (1.3)
Construct a persuasive case, verbally or in writing, for the best scientific model or explanation for a real-world phenomenon	12 (1.1)	14 (1.2)	13 (1.6)

*[1] There is a statistically significant difference between classes in non-adoption states and classes in late adoption states (two-tailed independent samples t-test, $p < 0.05$).

Mathematics Instruction

The mathematics version of the questionnaires had similar items to those on the science questionnaires. The data in this section give some indication of how well mathematics instruction is aligned with the CCSSM. As in science, state standards are influential in mathematics (see Table 24). In both 2012 and 2018, about 9 in 10 program coordinators across grade ranges agreed that most teachers in the school teach to the mathematics standards and that there is a school-wide effort to align mathematics instruction to state standards.

Table 24
Influence[a] of State Mathematics Standards in Schools, by Year[†]

	PERCENT OF SCHOOLS	
	2012	**2018**
Elementary		
Most mathematics teachers in this school teach to the state standards.	91 (1.8)	93 (1.5)
There is a school-wide effort to align mathematics instruction with the state mathematics standards.	91 (2.1)	90 (1.7)
Middle		
Most mathematics teachers in this school teach to the state standards.	90 (2.3)	93 (1.8)
There is a school-wide effort to align mathematics instruction with the state mathematics standards.	91 (2.6)	90 (2.2)
High		
Most mathematics teachers in this school teach to the state standards.	84 (3.3)	87 (2.3)
There is a school-wide effort to align mathematics instruction with the state mathematics standards.	85 (3.2)	87 (2.1)

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

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

About 7 out of 10 elementary, middle, and high school mathematics classes focused heavily on having students understand mathematical ideas in both 2012 and 2018 (see Table 25). Learning how to do mathematics received heavy emphasis in about 6 out of 10 classes regardless of grade level in 2018. Other CCSSM-aligned objectives such as increasing students' interest in mathematics, developing students' confidence that they can successfully pursue mathematical careers, and learning about real-life applications of mathematics received heavy emphasis in roughly a third of classes in 2018. However, there were decreases in elementary mathematics classes with a heavy emphasis on increasing students' interest in mathematics and learning about real-life applications from 2012 to 2018.

Table 25
Mathematics Classes With a Heavy Emphasis on Various Instructional Objectives, by Year

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Understanding mathematical ideas	69 (1.4)	67 (1.7)
Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	n/a	62 (1.9)
Learning mathematical procedures and/or algorithms*1	44 (1.9)	52 (1.7)
Increasing students' interest in mathematics*1	50 (1.7)	41 (1.9)
Developing students' confidence that they can successfully pursue careers in mathematics	n/a	37 (1.7)
Learning mathematics vocabulary	n/a	36 (1.7)
Learning about real-life applications of mathematics*1	45 (1.7)	34 (1.9)
Learning to perform computations with speed and accuracy	36 (1.9)	33 (2.1)
Learning test taking skills/strategies*1	37 (1.5)	30 (1.8)
Middle		
Understanding mathematical ideas	70 (2.0)	71 (1.9)
Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	n/a	61 (2.1)
Learning mathematical procedures and/or algorithms	49 (2.2)	53 (2.6)
Developing students' confidence that they can successfully pursue careers in mathematics	n/a	41 (2.0)
Learning about real-life applications of mathematics	42 (1.9)	37 (1.9)
Increasing students' interest in mathematics	37 (1.9)	34 (2.0)
Learning mathematics vocabulary	n/a	27 (1.9)
Learning test taking skills/strategies*1	36 (2.5)	23 (1.5)
Learning to perform computations with speed and accuracy	24 (1.8)	20 (1.6)
High		
Understanding mathematical ideas	69 (1.4)	69 (1.7)
Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	n/a	63 (1.6)
Learning mathematical procedures and/or algorithms*1	48 (1.5)	55 (1.8)
Developing students' confidence that they can successfully pursue careers in mathematics	n/a	37 (1.5)
Learning about real-life applications of mathematics	29 (1.3)	32 (1.4)
Learning mathematics vocabulary	n/a	29 (1.5)
Increasing students' interest in mathematics	27 (1.4)	26 (1.3)
Learning test taking skills/strategies*1	28 (1.3)	25 (1.3)
Learning to perform computations with speed and accuracy	18 (1.2)	21 (1.3)

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

Table 26 displays the various activities taking place in mathematics classes at least once a week. Common practices in 2012 and 2018 included teachers explaining mathematical ideas to students (not an indicator of CCSSM-aligned instruction) and engaging students in whole group discussion (potentially an indicator of CCSSM-aligned instruction). In 2018, a large majority of elementary mathematics classes were provided manipulatives to use in problem-solving/ investigations, a practice aligned with CCSSM guidance. However, far fewer middle and high school classes (29 and 20 percent, respectively) were provided with manipulatives. Students reading from the textbook, a practice unlikely to indicate CCSSM-aligned instruction, took place in only 16–28 percent of mathematics classes across grade levels. The percentage of classes in which students read from a textbook on a weekly basis decreased between 2012 and 2018 at all grade ranges. One noticeable increase, at all grade ranges, from 2012 to 2018 is the percentage of classes having students write reflections.

Table 26
Mathematics Classes in Which Teachers Reported Doing Various Activities at Least Once a Week During Mathematics Lessons in Their Classrooms, by Year

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Explain mathematical ideas to the whole class*1	97 (0.5)	95 (0.9)
Engage the whole class in discussions	96 (0.8)	95 (0.8)
Have students work in small groups*1	85 (1.2)	88 (1.2)
Provide manipulatives for students to use in problem-solving/investigations*1	82 (1.2)	78 (1.4)
Focus on literacy skills (e.g., informational reading or writing strategies)	40 (2.0)	41 (2.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*1	26 (1.7)	41 (1.8)
Have students read from a textbook or other material in class, either aloud or to themselves*1	41 (1.8)	28 (1.7)
Have students practice for standardized tests*1	31 (1.6)	26 (1.7)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	13 (1.6)
Middle		
Explain mathematical ideas to the whole class*1	98 (0.5)	95 (1.0)
Engage the whole class in discussions	93 (1.1)	91 (1.1)
Have students work in small groups*1	70 (2.1)	77 (2.2)
Have students practice for standardized tests*1	40 (2.4)	32 (2.1)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*1	21 (1.6)	30 (1.8)
Provide manipulatives for students to use in problem-solving/investigations	33 (1.9)	29 (2.1)
Have students read from a textbook or other material in class, either aloud or to themselves*1	34 (2.3)	24 (2.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	23 (1.9)	20 (1.6)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	10 (1.2)
High		
Explain mathematical ideas to the whole class	95 (0.7)	95 (0.7)
Engage the whole class in discussions	84 (1.1)	84 (1.2)
Have students work in small groups*1	63 (1.7)	71 (1.7)
Have students practice for standardized tests	32 (1.5)	29 (1.5)
Provide manipulatives for students to use in problem-solving/investigations	18 (1.0)	20 (1.3)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*1	11 (1.0)	19 (1.4)
Focus on literacy skills (e.g., informational reading or writing strategies)*1	14 (1.0)	17 (1.2)
Have students read from a textbook or other material in class, either aloud or to themselves*1	25 (1.4)	16 (1.5)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	n/a	11 (1.2)

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

The most recent lesson in the vast majority of mathematics classes at all grade ranges in 2018 included lecture, whole class discussion, and small group work (see Table 27). Lessons in the majority of mathematics classes across grades also included teachers conducting demonstrations and students completing textbook/worksheet problems. From 2012 to 2018, there was a decrease in the percentage of mathematics lessons across grade ranges in which the teacher explained mathematics ideas to the class. There was also a decrease in the percentage of elementary and middle grades mathematics lessons in which students did hands-on/manipulative activities.

Table 27
Mathematics Classes That Participated in Various Activities in Most Recent Lesson, by Year

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Teacher explaining a mathematical idea to the whole class*[1]	93 (0.9)	89 (1.3)
Whole class discussion	89 (1.1)	87 (1.5)
Students working in small groups	n/a	87 (1.4)
Teacher conducting a demonstration while students watched	74 (1.5)	78 (1.9)
Students completing textbook/worksheet problems*[1]	80 (1.5)	77 (1.6)
Students doing hands-on/manipulative activities*[1]	77 (1.4)	65 (2.1)
Students writing about mathematics	n/a	27 (1.6)
Test or quiz	19 (1.3)	18 (1.8)
Students reading about mathematics	19 (1.3)	17 (1.4)
Practicing for standardized tests	14 (1.3)	13 (1.7)
Middle		
Teacher explaining a mathematical idea to the whole class*[1]	93 (1.0)	88 (1.6)
Students working in small groups	n/a	83 (1.7)
Whole class discussion*[1]	85 (1.4)	78 (1.5)
Students completing textbook/worksheet problems	78 (1.8)	76 (1.7)
Teacher conducting a demonstration while students watched	71 (2.0)	65 (2.1)
Students doing hands-on/manipulative activities*[1]	37 (1.6)	24 (1.8)
Students writing about mathematics	n/a	19 (1.6)
Practicing for standardized tests*[1]	23 (1.9)	17 (1.5)
Test or quiz	19 (1.6)	15 (1.5)
Students reading about mathematics*[1]	23 (1.7)	15 (1.5)
High		
Teacher explaining a mathematical idea to the whole class*[1]	95 (0.7)	91 (1.0)
Students completing textbook/worksheet problems*[1]	83 (1.0)	78 (1.4)
Students working in small groups	n/a	78 (1.2)
Whole class discussion*[1]	75 (1.3)	70 (1.4)
Teacher conducting a demonstration while students watched	65 (1.2)	64 (1.3)
Test or quiz	20 (1.3)	19 (1.2)
Students doing hands-on/manipulative activities	21 (1.3)	17 (1.5)
Students reading about mathematics	17 (1.2)	15 (1.3)
Practicing for standardized tests	16 (1.1)	15 (1.0)
Students writing about mathematics	n/a	14 (1.1)

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

Teachers were also asked how often they engage students in aspects of the Standards for Mathematical Practice described in the CCSSM, such as making sense of problems, constructing arguments, critiquing the reasoning of others, and modeling with mathematics. As can be seen in

Table 28, students determining whether their answer makes sense took place at least once a week in more than 80 percent of mathematics classes in 2018, regardless of grade level. About three-quarters of classes across grade levels were engaged in several other practices on a weekly basis, including providing mathematical reasoning, using representations, working through challenging problems, identifying the relevant information in problems, and identifying patterns that may be helpful to solve a problem. However, given the importance of students critiquing different approaches to solving mathematics problems, it is somewhat surprising that only two-thirds or fewer classes had students analyze the mathematical thinking of others or compare and contrast different solution strategies on a weekly basis.

Table 28

Mathematics Classes in Which Teachers Reported Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week in 2018, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determine whether their answer makes sense	85 (1.5)	85 (1.9)	84 (1.2)
Provide mathematical reasoning to explain, justify, or prove their thinking*[1]	85 (1.5)	83 (1.7)	76 (1.3)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it*[2]	88 (1.1)	75 (2.1)	75 (1.5)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	81 (1.5)	81 (1.8)	79 (1.3)
Identify relevant information and relationships that could be used to solve a mathematics problem*[3]	72 (1.8)	79 (2.0)	73 (1.7)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	78 (1.5)	77 (1.8)	74 (1.3)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others*[4]	69 (2.2)	69 (1.8)	63 (1.5)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements*[4]	72 (1.8)	74 (1.5)	67 (1.6)
Determine what tools are appropriate for solving a mathematics problem*[2]	71 (1.8)	62 (2.2)	59 (1.7)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	74 (1.6)	75 (1.9)	71 (1.3)
Develop a mathematical model to solve a mathematics problem*[5]	75 (1.8)	70 (2.0)	64 (1.8)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	62 (1.8)	66 (2.0)	61 (1.8)
Figure out what a challenging problem is asking*[1]	78 (1.8)	73 (2.1)	63 (1.5)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed*[2]	75 (2.0)	65 (2.1)	61 (1.7)
Work on generating a rule or formula*[3]	59 (1.9)	70 (1.9)	61 (1.5)
Analyze the mathematical reasoning of others*[1]	65 (1.9)	61 (2.3)	53 (1.3)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations	60 (1.9)	55 (2.2)	54 (1.7)

*[1] There is a statistically significant difference between high school classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*[2] There is a statistically significant difference between elementary classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*[3] There is a statistically significant difference between middle school classes and classes in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*[4] There is a statistically significant difference between middle school classes and high school classes (two-tailed independent samples t-test, $p < 0.05$).

*[5] There is a statistically significant difference among classes in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

Teachers' Science and Mathematics Content Knowledge for Teaching

Although teachers' science and mathematics content knowledge for teaching was not directly measured by the 2012 NSSME or 2018 NSSME+, the teacher questionnaires included several items that could serve as proxy measures. One such proxy is the subject of their college degrees, and others include the courses they took in college and their areas of certification. Data collected from the surveys also provide information about how the courses teachers took align with recommendations from the National Science Teaching Association (NSTA) and the National Council of Teachers of Mathematics (NCTM). Finally, teachers were asked if they had full-time job experience in their field prior to teaching, which may indicate additional content knowledge obtained outside of college courses.

Teachers' perceptions of preparedness can also be used as a proxy measure. The surveys asked teachers about their preparedness to teach each of a number of science or mathematics topics related to their teaching assignment. In addition to disciplinary content knowledge, content knowledge for teaching[7] includes an understanding of how students develop an understanding of the content, including effective approaches for teaching the content and common ways in which students will struggle. To this end, the surveys asked teachers about their preparedness to implement a variety of instructional practices related to content knowledge for teaching, such as anticipating difficulties students will have with a topic they teach.

Science Teachers' Content Preparedness

As can be seen in Table 29, in both 2012 and 2018, the percentages of teachers with a degree in science or science education increased with increasing grade range. For example, in 2018, very few elementary teachers had college degrees in science or science education, while nearly all high school teachers did. A similar trend was seen in 2012, though there were more secondary teachers with degrees in these areas in 2018 than in 2012. In 2018, 54 percent of middle grades science teachers and 91 percent of high school science teachers had degrees in science/science education compared to 41 and 82 percent of science teachers, respectively, in 2012.

7 Ball, D. L., Thames, M. H., and Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389–407.

Table 29
Science Teacher Degrees, by Year

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

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

Table 30 shows the percentage of science teachers at each grade range with at least one college course in each of a number of science disciplines. Not surprisingly, in both 2012 and 2018, secondary teachers had taken more college science coursework than elementary teachers. A large percentage of science teachers at each grade level had taken at least one course in the life sciences and about two-thirds had coursework in Earth/space science; however, the percentage of teachers with coursework in other core science subjects decreased dramatically as grade range decreases. Very few teachers at any grade range and at either time point had coursework in engineering. For the most part, the percentages of teachers with at least one of each course are very similar in 2012 and 2018, and there are no clear patterns when differences exist. (Data tables showing specific courses completed by teachers within each science discipline can be found in the STQ section of the 2012 and 2018 compendia of tables.[8])

[8] Fulkerson, W. O., Campbell, K. M., and Hudson, S. B. (2013). *2012 National Survey of Science and Mathematics Education: Compendium of tables*. Chapel Hill, NC: Horizon Research, Inc.

Craven, L. M., Bruce, A. D., and Plumley, C. L. (2019). *2018 NSSME+ compendium of tables*. Chapel Hill, NC: Horizon Research, Inc.

Table 30
Science Teachers with College Coursework in Various Science Disciplines, by Year

	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*1	33 (1.8)	40 (1.8)
Physics	32 (1.7)	31 (1.7)
Engineering*1	1 (0.4)	3 (0.5)
Middle		
Biology/Life Science*1	96 (0.9)	91 (1.5)
Earth/Space Science	75 (2.3)	72 (2.4)
Chemistry*1	72 (2.3)	80 (2.2)
Environmental Science	57 (2.5)	58 (2.3)
Physics*1	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)

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

Elementary teachers are typically responsible for instruction across science disciplines, thus NSTA recommends they take at least one college course each in life science, Earth science, and physical science. As can be seen in Table 31, about a third of elementary science teachers in 2018 had taken courses in all three of these areas. At the other end of the spectrum, 7 percent did not have any college coursework in these areas. Elementary teachers' preparation to teach science, as defined by the NSTA recommendations, did not change significantly between 2012 and 2018.

Table 31
Elementary Science Teachers' Coursework Related to NSTA Preparation Standards, by Year†

	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	38 (1.7)	36 (1.6)
Course in 1 of the 3 areas	20 (1.4)	23 (1.5)
Courses in 0 of the 3 areas	6 (0.9)	7 (1.0)

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

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

NSTA recommends coursework in life and Earth sciences as well as chemistry and physics for middle school teachers of general or integrated science. Just under half of middle grades teachers assigned to these classes met that standard in 2018, and about 30 percent had coursework in 3 of the 4 areas (see Table 32). The difference between 2012 and 2018 appears to be due largely to a change in the percentage of teachers with coursework in 2 of the 4 areas.

Table 32
Middle School General/Integrated Science Teachers' Coursework Related to NSTA Preparation Standards, by Year

	PERCENT OF TEACHERS*1	
	2012	2018
Courses in chemistry, Earth science, life science, and physics	45 (2.4)	49 (2.8)
Courses in 3 of the 4 areas	28 (2.3)	29 (3.0)
Courses in 2 of the 4 areas	22 (2.4)	12 (1.9)
Course in 1 of the 4 areas	5 (0.9)	4 (0.9)
Courses in 0 of the 4 areas	1 (0.7)	6 (2.3)

*1 There is a statistically significant difference between teachers in 2012 and teachers 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 33 shows the percentages of these teachers, by specific science course, with a degree in the topic of the courses they teach. In 2018, fewer than half of middle school science teachers had a degree in the area they taught (40 percent of life science/biology teachers, 7 percent of physical science teachers, and 5 percent of Earth science teachers had a degree in their respective areas). At the high school level, 63 percent of high school life science/biology teachers and 42 percent of chemistry teachers had a degree in their area. Only small percentages of teachers of other science areas had a degree in their field. The percentages of middle and high school life science/biology teachers with a degree in the field increased between 2012 and 2018. The percentage of high school chemistry teachers with a degree in field also increased between 2012 and 2018. There were no other significant differences in teachers' degrees between those years.

Table 33
Secondary Science Teachers With a Degree in the Topic of Their Teaching Assignment,[a] by Year

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Life science/biology*1	27 (4.1)	40 (4.5)
Physical science	8 (3.3)	7 (3.3)
Earth science	9 (2.6)	5 (1.3)
High		
Life science/biology*1	53 (2.4)	63 (2.5)
Chemistry*1	25 (1.8)	42 (2.7)
Physics	20 (2.4)	24 (2.6)
Earth science	14 (3.0)	15 (2.9)
Environmental science	9 (2.7)	11 (3.4)

*1 There is a statistically significant difference between teachers in 2012 and teachers 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.

Recognizing that teaching is not always an individual's first career, the survey also included an item asking whether teachers had a full-time job in their designated field after completing their undergraduate degree and prior to teaching. A job in science or engineering would most likely require knowledge of the content, so a full-time science/engineering job prior to teaching may indicate additional content knowledge beyond that from college courses. As can be seen in Table 34, the likelihood of science teachers having prior career experience in their field substantially increased with increasing grade range, with 3 percent of elementary teachers and 36 percent of high school teachers having full-time job experience prior to teaching.

Table 34
Science Teachers With Full-Time Job Experience in Their Designated Field Prior to Teaching, by Grade Range

	PERCENT OF TEACHERS*1
Elementary	3 (0.7)
Middle	23 (2.8)
High	36 (2.1)

*1 There is a statistically significant difference among teachers in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

Science Teachers' Perceptions of Preparedness

Overall, the data on college degrees and course taking indicate that a large proportion of science teachers, particularly at the lower grade ranges, do not have strong college preparation in science. Another proxy for teachers' content knowledge for teaching is their feelings of preparedness to teach their discipline. As can be seen in Table 35, in 2018, the majority of elementary teachers felt at least fairly well prepared to teach life, Earth/space, and physical science (72, 67, and 54 percent, respectively). In Earth/space and physical science, there was a small downward shift from 2012 to 2018. Engineering stands out as the area where elementary teachers feel least prepared, although there has been an increase in feelings of preparedness in this area since 2012. In 2012, 73 percent felt not adequately prepared to teach engineering; in 2018, only 51 percent indicated they felt not adequately prepared.

Table 35
Elementary Teachers' Perceptions of Their Preparedness to Teach Various Science Disciplines

	PERCENT OF TEACHERS	
	2012	2018
Life science		
Very well prepared	29 (1.6)	24 (1.5)
Fairly well prepared	46 (1.9)	49 (1.8)
Somewhat prepared	21 (1.6)	24 (1.8)
Not adequately prepared	4 (0.6)	3 (0.7)
Earth/Space science[*1]		
Very well prepared	26 (1.4)	20 (1.5)
Fairly well prepared	45 (1.8)	47 (1.7)
Somewhat prepared	26 (1.8)	27 (1.5)
Not adequately prepared	4 (0.6)	6 (0.8)
Physical science[*1]		
Very well prepared	17 (1.2)	13 (1.1)
Fairly well prepared	42 (1.9)	41 (2.1)
Somewhat prepared	33 (2.1)	35 (1.6)
Not adequately prepared	8 (1.0)	11 (1.3)
Engineering[*1]		
Very well prepared	4 (0.6)	3 (0.6)
Fairly well prepared	5 (0.8)	14 (1.2)
Somewhat prepared	18 (1.6)	33 (1.8)
Not adequately prepared	73 (1.7)	51 (2.2)

[*1] There is a statistically significant difference between teachers in 2012 and teachers in 2018 (Chi-square test of independence, $p < 0.05$).

Table 36 displays the percentage of middle school science teachers feeling very well prepared to teach each of a number of science topics to their randomly selected class (because most middle school teachers feel at least fairly well prepared, only the very well prepared data are shown). Middle school teachers' perceptions of preparedness vary widely depending on the topic, although fewer than half indicated feeling very well prepared for most of the topics. The 2018 data are similar to those from 2012, though there are a few differences. Fewer middle school teachers felt very prepared to teach Earth's features and physical processes and climate and weather in 2018 than in 2012.

Table 36
Middle School Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Year

	PERCENT OF TEACHERS[a]	
	2012	**2018**
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)
Earth/Space Science		
Earth's features and physical processes[*1]	51 (2.9)	42 (2.2)
The solar system and the universe	36 (2.6)	32 (2.0)
Climate and weather[*1]	42 (3.0)	31 (2.3)
Engineering		
Developing possible solutions	n/a	14 (1.8)
Defining engineering problems	n/a	12 (1.6)
Optimizing a design solution	n/a	10 (1.6)
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 (e.g., special relativity)	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)

[*1] There is a statistically significant difference between teachers in 2012 and teachers 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.

Not surprisingly, more high school teachers than middle school teachers felt very well prepared to teach these science topics. High school science teachers' feelings of preparedness also varied by topic, with two-thirds to three-fourths feeling very well prepared to teach the majority of the topics in 2018 (see Table 37). Engineering is a significant exception, with only around 1 in 10 high school science teachers feeling very well prepared. Additionally, more high school science teachers indicated feeling very well prepared to teach several topics in 2018 than in 2012, for example evolution and properties of solutions.

Table 37
High School Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Year

	PERCENT OF TEACHERS[a]	
	2012	2018
Biology/Life Science		
Cell biology	68 (2.2)	74 (2.6)
Structures and functions of organisms	64 (2.5)	70 (3.3)
Genetics	63 (2.5)	70 (3.2)
Ecology/ecosystems[*1]	56 (2.4)	65 (2.5)
Evolution[*1]	52 (2.5)	63 (2.5)
Chemistry		
The Periodic Table[*1]	82 (2.2)	89 (2.4)
States, classes, and properties of matter[*1]	80 (2.4)	88 (2.4)
Elements, compounds, and mixtures	83 (2.2)	87 (3.0)
Atomic structure	80 (2.3)	87 (2.9)
Chemical bonding, equations, nomenclature, and reactions	77 (2.5)	83 (3.3)
Properties of solutions[*1]	66 (2.5)	76 (3.1)
Earth/Space Science		
Earth's features and physical processes[*1]	47 (3.1)	64 (7.0)
The solar system and the universe[*1]	41 (3.2)	60 (7.0)
Climate and weather[*1]	39 (3.8)	60 (7.0)
Engineering		
Defining engineering problems	n/a	7 (0.7)
Developing possible solutions	n/a	8 (0.8)
Optimizing a design solution	n/a	6 (0.7)
Physics		
Forces and motion	71 (3.0)	79 (4.2)
Energy transfers, transformations, and conservation	62 (3.3)	72 (4.6)
Properties and behaviors of waves	51 (3.1)	57 (4.8)
Electricity and magnetism	43 (2.8)	45 (4.4)
Modern physics (e.g., special relativity)	19 (2.1)	19 (2.7)
Environmental and resource issues (e.g., land and water use, energy resources and consumption, sources and impacts of pollution)[*1]	37 (3.8)	63 (6.7)

[*1] There is a statistically significant difference between teachers in 2012 and teachers 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.

The last proxy measure, included in both the 2012 NSSME and 2018 NSSME+, is teachers' perceptions of preparedness to implement a number of tasks related to teaching the content of a unit (they were asked to think specifically about their most recent unit). As with the other proxy measures, these data indicate increased preparedness for teaching science as grade range increases (see Table 38). For example, in 2018, only about a third of elementary science classes were taught by teachers who indicated feeling very well prepared to assess students' understanding at the end of the unit; over half of secondary science classes were taught by teachers who indicated feeling very well prepared for this task. In the middle and high school grades, the percentage of classes taught by teachers feeling very well prepared for each task was similar between 2012 and 2018. However, in the elementary grades, a greater proportion of classes were taught by teachers feeling prepared for each of the tasks in 2012 than in 2018.

Table 38
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 Year

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Monitor student understanding during this unit*1	46 (2.2)	33 (1.9)
Assess student understanding at the conclusion of this unit*1	46 (2.2)	32 (1.8)
Implement the instructional materials (e.g., textbook, module) to be used during this unit*1	39 (2.7)	32 (2.0)
Find out what students thought or already knew about the key science ideas*1	38 (1.8)	31 (2.2)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit*1	28 (1.8)	22 (1.9)
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 (e.g., textbook, module) to be used during this unit	51 (2.9)	45 (2.4)
Find out what students thought or already knew about the key science ideas	41 (2.4)	39 (2.1)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	39 (2.3)	37 (2.1)
High		
Assess student understanding at the conclusion of this unit*1	64 (1.6)	59 (1.8)
Monitor student understanding during this unit	57 (1.6)	53 (1.8)
Implement the instructional materials (e.g., textbook, module) to be used during this unit	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*1	42 (1.4)	38 (1.6)

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

Mathematics Teachers' Content Preparedness

Table 39 displays mathematics teachers' degrees. In both 2012 and 2018, very few elementary teachers had college degrees in mathematics, or mathematics education, although, as in science, the percentage of teachers with a degree in mathematics/mathematics education increases with increasing grade range. There was an increase in the percentage of secondary mathematics teachers with degrees in these areas in 2018 compared to 2012. In 2018, 45 percent of middle grades mathematics teachers and 79 percent of high school mathematics teachers had a degree in mathematics/mathematics education, compared with 35 and 73 percent, respectively, in 2012.

Table 39
Mathematics Teacher Degrees, by Year

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Mathematics*1	4 (0.5)	1 (0.4)
Mathematics Education	2 (0.3)	2 (0.7)
Mathematics or Mathematics Education	4 (0.6)	3 (0.9)
Middle		
Mathematics	23 (1.7)	26 (2.0)
Mathematics Education	26 (2.0)	28 (2.4)
Mathematics or Mathematics Education*1	35 (2.2)	45 (2.7)
High		
Mathematics	52 (1.5)	55 (1.6)
Mathematics Education	54 (1.7)	53 (2.0)
Mathematics or Mathematics Education*1	73 (1.7)	79 (1.7)

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

Although the majority of elementary teachers did not have a degree in mathematics, most had at least one college mathematics course. The 2018 data show that nearly all elementary teachers had completed college coursework in mathematics for elementary school teachers (see Table 40). About half had completed college algebra and statistics, and about a third had completed integrated mathematics and college geometry. In many areas, elementary mathematics teachers' college mathematics coursework was similar in 2018 to 2012; however the percentages who had taken college algebra and integrated mathematics decreased between 2012 and 2018, and the percentage who had taken college geometry increased. A rather surprising difference is in elementary teachers' computer science coursework. In 2012, 50 percent of elementary teachers had taken a college course in computer science compared with only 27 percent in 2018. The reason for this decrease is not clear; teachers may have misunderstood what was meant by "computer science" in 2012 and considered courses in other areas (e.g., keyboarding) when answering.

Table 40
Elementary Mathematics Teachers Completing Various College Courses, by Year

	PERCENT OF TEACHERS	
	2012	2018
Mathematics		
Mathematics content for elementary school teachers*1	95 (0.7)	92 (1.1)
College algebra/trigonometry/functions*1	55 (1.6)	49 (2.1)
Statistics	46 (1.6)	47 (1.9)
Integrated mathematics*1	43 (1.7)	34 (1.6)
College geometry*1	24 (1.5)	32 (2.1)
Probability	24 (1.5)	25 (1.6)
Calculus	19 (1.4)	18 (1.4)
Discrete mathematics	n/a	6 (0.8)
Other upper division mathematics*1	10 (1.0)	14 (1.3)
Other		
Computer science*1	50 (2.1)	27 (1.7)
Engineering	1 (0.4)	2 (0.5)

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

NCTM has recommended that elementary mathematics teachers take college coursework in a number of different areas, including number and operations (for which "mathematics for elementary teachers" can serve as a proxy), algebra, geometry, probability, and statistics. As can be seen in Table 41, only about 10 percent of elementary mathematics teachers in 2018 had taken courses in all of these five areas, and the typical elementary teacher had coursework in only 1 or 2 of these areas. The 2018 data are significantly different than the 2012 data, but there is no clear pattern for why in the results.

Table 41
Elementary Mathematics Teachers' Coursework Related to NCTM Preparation Standards, by Year

	PERCENT OF TEACHERS*1	
	2012	2018
Courses in algebra, geometry, number and operations, probability, and statistics	10 (1.2)	7 (0.9)
Courses in 3–4 of the 5 areas	32 (1.6)	39 (1.9)
Courses in 1–2 of the 5 areas	57 (1.8)	53 (2.0)
Courses in 0 of the 5 areas	1 (0.3)	2 (0.5)

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

Table 42 shows the percentages of middle and high school mathematics teachers with coursework in each of a number of areas. In both years, high school teachers were more likely than middle school teachers to have completed almost all of the mathematics courses listed. Middle and high school mathematics teachers in 2018 were more prepared their counterparts in 2012, with a larger percentage in 2018 having completed advanced calculus, differential equations, analytic geometry, integrated mathematics, and probability. As with elementary mathematics teachers, the percentage of secondary mathematics teachers who had completed computer science coursework decreased between 2012 and 2018.

Table 42
Secondary Mathematics Teachers Completing Various College Courses, by Year

	PERCENT OF TEACHERS	
	2012	2018
Middle		
Statistics	69 (2.1)	74 (1.9)
Calculus	63 (2.3)	65 (2.3)
Mathematics content for middle/high school teachers	56 (2.3)	62 (2.6)
Probability*1	39 (2.2)	52 (2.5)
Integrated mathematics*1	40 (2.0)	50 (2.5)
Advanced calculus*1	37 (2.1)	47 (2.0)
Linear algebra (e.g., vectors, matrices, eigenvalues)	39 (1.9)	42 (2.0)
Number theory (e.g., divisibility theorems, properties of prime numbers)*1	32 (2.0)	41 (2.4)
Differential equations*1	22 (1.5)	36 (1.9)
Analytic/coordinate geometry (e.g., transformations or isometries, conic sections)*1	26 (1.9)	33 (2.0)
Abstract algebra (e.g., groups, rings, ideals, fields)	28 (1.6)	31 (1.7)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)	26 (1.7)	31 (2.4)
Axiomatic geometry (Euclidean or non-Euclidean)	21 (1.6)	24 (1.9)
Real analysis	18 (1.7)	19 (1.7)
Other upper division mathematics*1	19 (1.5)	28 (2.2)
Computer science*1	61 (2.1)	42 (2.2)
Engineering	9 (1.2)	9 (1.1)
High		
Calculus	93 (0.9)	92 (1.4)
Statistics*1	83 (1.5)	89 (1.1)
Advanced calculus*1	79 (1.6)	85 (1.4)
Linear algebra (e.g., vectors, matrices, eigenvalues)	80 (1.7)	84 (1.5)
Probability*1	56 (1.7)	75 (1.3)
Abstract algebra (e.g., groups, rings, ideals, fields)*1	67 (1.7)	73 (1.5)
Mathematics content for middle/high school teachers	71 (1.8)	69 (1.9)
Differential equations*1	62 (1.7)	68 (1.6)
Analytic/coordinate geometry (e.g., transformations or isometries, conic sections)*1	53 (1.7)	66 (1.8)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)*1	52 (1.8)	61 (1.6)
Axiomatic geometry (Euclidean or non-Euclidean)	55 (1.7)	59 (1.9)
Number theory (e.g., divisibility theorems, properties of prime numbers)*1	54 (1.9)	58 (1.7)
Real analysis*1	44 (1.7)	49 (1.6)
Integrated mathematics*1	34 (1.7)	47 (1.8)
Other upper division mathematics*1	43 (1.5)	58 (1.9)
Computer science*1	77 (1.7)	62 (1.7)
Engineering	19 (1.4)	18 (1.3)

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

At the middle grades level, NCTM recommends that teachers have more extensive college coursework, including courses in number theory (for which "mathematics for middle school teachers" can serve as a proxy), algebra, geometry, probability, statistics, and calculus. As can be seen in Table 43, 21 percent of middle school mathematics teachers had courses in all six areas in 2018, and 37 percent had four or five of the courses. There was a difference in middle school teachers' course preparation between 2012 and 2018, likely due to a larger percentage having completed all 6 courses, and a smaller percentage completing just 1 of the 6.

Table 43
Middle School Mathematics Teachers' Coursework Related to NCTM Preparation Standards, by Year

	PERCENT OF TEACHERS*1	
	2012	2018
Courses in algebra, calculus, geometry, number theory, probability, and statistics	14 (1.4)	21 (2.0)
Courses in 4–5 of the 6 areas	35 (2.0)	37 (2.4)
Courses in 2–3 of the 6 areas	31 (2.1)	27 (1.9)
Course in 1 of the 6 areas	15 (1.6)	9 (1.3)
Courses in 0 of the 6 areas	6 (1.0)	6 (1.6)

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

Table 44 provides analogous data for high school mathematics teachers, in this case based on a total of seven areas recommended for coursework by NCTM (algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics). In 2018, about three-quarters of high school mathematics teachers had coursework in at least five of the areas, compared to two-thirds of teachers in 2012.

Table 44
High School Mathematics Teachers' Coursework Related to NCTM Preparation Standards, by Year

	PERCENT OF TEACHERS*1	
	2012	2018
Courses in algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics	26 (1.5)	36 (1.6)
Courses in 5–6 of the 7 areas	40 (1.6)	40 (1.6)
Courses in 3–4 of the 7 areas	22 (1.6)	16 (1.7)
Courses in 1–2 of the 7 areas	10 (1.4)	6 (0.9)
Courses in 0 of the 7 areas	2 (0.7)	1 (0.5)

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

Mathematics teachers were asked if they had full-time job experience in a mathematics-related field prior to teaching. Table 45 shows that although the percentage of teachers with full-time job experience prior to teaching increased with grade level, fewer than 20 percent had a job in a mathematics-related field before becoming a teacher.

Table 45
Mathematics Teachers With Full-Time Job Experience in Their Designated Field Prior to Teaching, by Grade Range

	PERCENT OF TEACHERS
Elementary	7 (1.1)
Middle	12 (1.4)
High	19 (1.4)

*1 There is a statistically significant difference among teachers in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

Mathematics Teachers' Perceptions of Preparedness

In contrast to elementary teachers' feelings of preparedness to teach science, the majority of elementary teachers felt fairly well or very well prepared to teach mathematics in 2018 (see Table 46). About three-quarters indicated feeling very well prepared to teach number and operations, and about half felt very well prepared to teach measurement and data representation as well as geometry. Teachers' perceptions of their preparedness to teach these mathematics topics were very similar in 2012.

Table 46
Elementary Teachers' Perceptions of Their Preparedness to Teach Various Mathematics Topics†

	PERCENT OF TEACHERS	
	2012	2018
Number and operations		
Very well prepared	77 (1.4)	74 (1.7)
Fairly well prepared	21 (1.3)	23 (1.7)
Somewhat prepared	2 (0.4)	2 (0.5)
Not adequately prepared	0 (0.1)	0 (0.1)
Measurement and data representation		
Very well prepared	56 (2.0)	53 (1.8)
Fairly well prepared	33 (1.9)	37 (1.8)
Somewhat prepared	9 (1.1)	8 (1.1)
Not adequately prepared	1 (0.4)	3 (0.5)
Geometry		
Very well prepared	54 (1.9)	49 (2.2)
Fairly well prepared	33 (1.7)	35 (1.8)
Somewhat prepared	10 (1.0)	12 (1.3)
Not adequately prepared	3 (0.6)	4 (0.7)
Early algebra		
Very well prepared	46 (2.0)	41 (1.9)
Fairly well prepared	36 (1.7)	36 (2.1)
Somewhat prepared	13 (1.1)	17 (1.2)
Not adequately prepared	5 (0.7)	6 (0.9)

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

Table 47 provides data on secondary mathematics teachers' perceptions of preparedness to teach each of a number of mathematics topics. In 2018, about 80 percent of middle school and 90 percent of high school mathematics teachers felt very well prepared to teach algebraic thinking as well as number and operations. Overall, secondary teachers did not feel prepared to teach discrete mathematics (12 percent of middle school and 21 percent of high school mathematics teachers feeling very well prepared) or computer science/programming (4 percent of middle school and 5 percent of high school mathematics teachers feeling very well prepared). Secondary mathematics teachers' feelings of preparedness were very similar in 2012, although there were decreases in the percentages of both middle and high school teachers who felt very well prepared in measurement and discrete mathematics in 2018.

Table 47
Secondary Mathematics Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics, by Year

	PERCENT OF TEACHERS	
	2012	2018
Middle		
The number system and operations	88 (1.4)	85 (1.4)
Algebraic thinking	76 (1.9)	78 (1.7)
Measurement*1	66 (2.1)	61 (2.0)
Geometry	62 (2.0)	59 (2.3)
Functions	60 (1.9)	57 (2.0)
Modeling	49 (2.3)	46 (2.4)
Statistics and probability*1	48 (2.2)	40 (2.4)
Discrete mathematics*1	18 (1.5)	12 (1.4)
Computer science/Programming	n/a	4 (0.7)
High		
Algebraic thinking	91 (0.9)	89 (0.9)
The number system and operations	90 (1.1)	89 (0.9)
Functions	84 (1.5)	84 (1.4)
Measurement*1	79 (1.2)	74 (1.3)
Geometry*1	70 (1.4)	65 (1.4)
Modeling	58 (2.0)	59 (1.8)
Statistics and probability	30 (1.2)	31 (1.7)
Discrete mathematics*1	25 (1.2)	21 (1.3)
Computer science/Programming	n/a	5 (0.8)

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

Table 48 displays the percentage of mathematics classes taught by teachers at each grade range feeling very well prepared for various content-related tasks in their most recent unit. In 2018, about two-thirds of classes across grade ranges were taught by teachers who felt very well prepared to assess students' understanding at the conclusion of the recent unit. The percentage of high school classes taught by teachers feeling very well prepared for each task is fairly similar in 2012 and 2018. There are more differences between 2012 and 2018 in elementary and middle school classes, including a greater proportion of classes in both grade ranges taught by mathematics teachers feeling very well prepared to find out what students already knew and implement instructional materials in 2012 than 2018.

Table 48
Mathematics Classes in Which Teachers Felt Very Well Prepared for Various Tasks in the Most Recent Unit, by Year

	PERCENT OF CLASSES	
	2012	**2018**
Elementary		
Assess student understanding at the conclusion of this unit	66 (1.7)	64 (1.9)
Monitor student understanding during this unit	62 (1.6)	60 (1.8)
Implement the instructional materials (e.g., mathematics textbook) to be used during this unit*1	62 (2.0)	55 (1.8)
Anticipate difficulties that students will have with particular mathematical ideas and procedures in this unit	46 (1.8)	43 (1.7)
Find out what students thought or already knew about the key mathematical ideas*1	48 (1.8)	42 (2.1)
Middle		
Assess student understanding at the conclusion of this unit*1	72 (2.3)	62 (2.3)
Monitor student understanding during this unit	62 (2.1)	57 (1.9)
Implement the instructional materials (e.g., mathematics textbook) to be used during this unit*1	63 (2.3)	55 (2.0)
Anticipate difficulties that students will have with particular mathematical ideas and procedures in this unit	54 (2.4)	50 (2.1)
Find out what students thought or already knew about the key mathematical ideas*1	49 (2.3)	38 (2.2)
High		
Assess student understanding at the conclusion of this unit	72 (1.5)	68 (1.4)
Implement the instructional materials (e.g., mathematics textbook) to be used during this unit	61 (1.8)	61 (1.6)
Monitor student understanding during this unit	65 (1.7)	60 (1.6)
Anticipate difficulties that students will have with particular mathematical ideas and procedures in this unit	60 (1.3)	59 (1.6)
Find out what students thought or already knew about the key mathematical ideas	48 (1.5)	47 (1.5)

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

Teachers' Participation in STEM-Specific Professional Development Activities

The 2012 NSSME and 2018 NSSME+ contained several items about school- and/or district-offered professional growth opportunities (e.g., workshops, professional learning communities or PLCs, coaching) as well as teachers' participation in STEM-specific professional development activities. Program representatives were asked whether professional development workshops in the designated discipline were offered by schools and/or districts. Representatives who indicated that their school and/or district had offered in-service professional development in the previous three years were asked about the focus of those workshops.

Similarly, program representatives were asked whether their school offered teacher study groups (e.g., professional learning communities or PLCs) in the previous three years where teachers met on a regular basis to discuss science/mathematics teaching and learning. If so, they were asked about the composition of the groups, if there was a specified schedule for when they meet, and the frequency and duration of meetings. Program representatives also answered questions about the emphases of these groups and the activities typically included. Finally, school program representatives were asked whether any teachers in their school had access to one-on-one coaching focused on improving their science/mathematics instruction and, if so, who provided the coaching.

The teacher questionnaires included several items measuring individual teacher's professional development experiences. Teachers were asked when they last participated in professional development. Those who participated in professional development in the previous three years were asked about the format of those activities and the total amount of time they had spent on professional development related to science/mathematics teaching. They were also asked about the characteristics (e.g., worked closely with other teachers, had opportunities to experience lessons as students) and emphases (e.g., deepening their content knowledge, assessing student understanding) of their professional development opportunities. Finally, because serving in a leadership role can be a form of professional development, teachers were asked about their leadership responsibilities in the previous three years.

Nature of School-/District-Offered Science Professional Development

As can be seen in Table 49, science professional development workshops were more prevalent in elementary schools than high schools in 2018. The percentage of schools offering science workshops was similar in 2012 and 2018 across grade levels.

Table 49
Science Professional Development Workshops Offered Locally in the Previous Three Years, by Year†

	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 significant differences between schools in 2012 and schools in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Program representatives indicating that science workshops were offered locally were asked about the extent to which that professional development addressed each of a number of areas. In 2018, 57–66 percent of schools had locally offered professional development that emphasized deepening teachers' understanding of: (1) state science and engineering standards, (2) how science is done, and (3) science concepts (see Table 50). The emphases of locally offered professional development in 2012 were fairly similar to those in 2018, though deepening teachers' understanding of how students think about science ideas received more emphasis in 2018 than 2012.

Table 50
Locally Offered Science Professional Development Workshops in the Previous Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Year

	PERCENT OF SCHOOLS	
	2012	2018
Deepening teachers' understanding of the state science/engineering standards	64 (2.9)	66 (2.9)
Deepening teachers' understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	58 (2.7)
Deepening teachers' understanding of science concepts	52 (3.2)	57 (3.1)
How to engage students in doing science (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	54 (2.8)
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*1	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)
Deepening teachers' understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	44 (3.5)
How to monitor student understanding during science instruction	33 (2.6)	40 (3.1)
How to incorporate real-world issues (e.g., current events, community concerns) into science instruction	n/a	38 (2.6)
How to engage students in doing engineering (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	37 (2.9)
How to integrate science, engineering, mathematics, and/or computer science	n/a	36 (3.0)
How to adapt science instruction to address student misconceptions	31 (2.7)	35 (3.2)
How to connect instruction to science/engineering career opportunities	n/a	33 (2.9)
How to differentiate science instruction to meet the needs of diverse learners	n/a	28 (2.8)
How to develop students' confidence that they can successfully pursue careers in science/engineering	n/a	25 (2.7)
How to incorporate students' cultural backgrounds into science instruction	n/a	17 (2.1)

*1 There is a statistically significant difference between schools in 2012 and schools 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."

One concern about professional development workshops is that teachers may not be given adequate assistance in applying what they are learning to their own instruction. Teacher study groups (professional learning communities, lesson study, etc.) have the potential to help teachers transfer what they are learning to their instruction. School science program representatives were asked whether their school offered teacher study groups in the previous three years in which teachers met on a regular basis to discuss science teaching and learning. As can be seen in Table 51, science-focused teacher study groups were offered in only 45 percent of middle and high schools and 28 percent of elementary schools in 2018. The percentage of schools offering science teacher study groups in the previous three years was similar in 2012 and 2018.

Table 51
Science Teacher Study Groups
Offered at Schools in the Previous Three Years, by Year

	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 significant differences between schools in 2012 and schools in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).

Over two-thirds of schools that offered science teacher study groups in 2018 required participation (see Table 52). The percentage of schools requiring participation increased with grade level. Participation requirements were similar in 2012 and 2018.

Table 52
Required Participation in Science Teacher Study Groups, by Year†

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary	62 (5.6)	67 (5.2)
Middle	76 (4.9)	79 (3.7)
High	80 (5.2)	89 (2.0)

† There are no significant differences between schools in 2012 and schools in 2018 (two-tailed independent samples t-test, $p \geq 0.05$).
[a] Includes only schools indicating that they offered teacher study groups in the previous three years.

Table 53 displays data about the duration of school-based science study groups. In 2018, nearly half of elementary schools with science teacher study groups had no specified schedule. The majority of middle and high schools with study groups had ones that met for the entire year. There was a significant difference in the duration of high school science study groups between 2012 and 2018, with fewer schools having no specified duration.

Table 53
Duration of Science-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	**2018**
Elementary		
No specified duration	47 (4.8)	49 (5.2)
Less than one semester	2 (1.2)	4 (2.0)
One semester	6 (2.1)	12 (3.8)
The entire school year	45 (5.1)	35 (5.0)
Middle		
No specified duration	39 (4.4)	30 (4.3)
Less than one semester	2 (0.9)	3 (1.3)
One semester	2 (0.8)	8 (3.0)
The entire school year	57 (4.6)	59 (4.5)
High[*1]		
No specified duration	32 (5.2)	16 (2.6)
Less than one semester	1 (0.6)	2 (1.0)
One semester	1 (0.7)	6 (3.0)
The entire school year	65 (5.1)	76 (4.0)

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

a Includes only schools indicating that they offered teacher study groups in the previous three years.

Program representatives were also asked to describe the schedule of the teacher study groups in their schools. As can be seen in Table 54, in 2018 almost half of elementary schools with science-focused teacher study groups did not have a specified schedule for their meetings. The majority of middle and high schools with science study groups had ones that met at least once a month, with about 30 percent of meeting more than twice a month. The frequency of meetings in elementary and middle schools was similar in 2012 and 2018. At the high school level, more schools had a specified schedule in 2018.

Table 54
Frequency of Science-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	**2018**
Elementary		
No specified frequency	47 (4.8)	49 (5.2)
Less than once a month	18 (4.3)	18 (4.1)
Once a month	20 (3.8)	14 (3.8)
Twice a month	4 (1.7)	8 (2.9)
More than twice a month	11 (3.7)	11 (3.0)
Middle		
No specified frequency	39 (4.4)	30 (4.3)
Less than once a month	11 (2.6)	16 (3.5)
Once a month	22 (3.3)	18 (3.3)
Twice a month	8 (1.6)	10 (2.5)
More than twice a month	20 (3.5)	27 (3.0)
High[*1]		
No specified frequency	32 (5.2)	16 (2.6)
Less than once a month	11 (2.3)	14 (3.6)
Once a month	19 (3.5)	24 (4.2)
Twice a month	10 (1.7)	15 (2.4)
More than twice a month	28 (5.3)	31 (3.9)

[*1] There is a statistically significant difference between schools in 2012 and schools in 2018 (Chi-square test of independence, $p < 0.05$).

[a] Includes only schools indicating that they offered teacher study groups in the previous three years.

In 2018, it was common, particularly at the middle and high school levels, for science teacher study groups to include teachers from multiple grade levels and to be limited to teachers from the school (see Table 55). About half of elementary and middle schools with science teacher study groups included school or district administrators; parents and other community members were typically not part of study groups. The composition of science study groups was similar in 2012 and 2018 across grade levels, although there were more middle schools organizing their science study groups by grade level in 2018 than 2012.

Table 55
Composition of Science-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary		
Include teachers from multiple grade levels	62 (5.4)	58 (4.9)
Organized by grade level	56 (5.4)	57 (4.9)
Include school and/or district/diocese administrators	52 (6.1)	48 (5.2)
Limited to teachers from this school	58 (6.8)	44 (5.5)
Include teachers from other schools in the district/diocese[b]	45 (6.6)	33 (5.1)
Include teachers who teach different science/engineering subjects	n/a	25 (4.5)
Include higher education faculty or other "consultants"	13 (3.9)	11 (3.8)
Include teachers from other schools outside of your district/diocese	12 (5.2)	7 (3.2)
Include parents/guardians or other community members	0 (0.1)	0 (0.4)
Middle		
Include teachers from multiple grade levels	76 (3.6)	72 (3.7)
Limited to teachers from this school	64 (5.7)	55 (4.8)
Organized by grade level[*1]	41 (4.3)	55 (4.4)
Include teachers who teach different science/engineering subjects	n/a	49 (4.5)
Include school and/or district/diocese administrators	43 (5.1)	48 (4.1)
Include teachers from other schools in the district/diocese[b]	38 (5.2)	25 (4.0)
Include higher education faculty or other "consultants"	10 (2.8)	14 (3.2)
Include teachers from other schools outside of your district/diocese	12 (5.4)	3 (2.1)
Include parents/guardians or other community members	0 (0.2)	0 (0.4)
High		
Include teachers from multiple grade levels	74 (3.5)	68 (4.5)
Limited to teachers from this school	72 (7.2)	67 (4.5)
Include teachers who teach different science/engineering subjects	n/a	67 (4.8)
Include school and/or district/diocese administrators	38 (5.1)	40 (3.8)
Organized by grade level	26 (4.7)	34 (3.8)
Include teachers from other schools in the district/diocese[b]	27 (6.0)	20 (3.7)
Include higher education faculty or other "consultants"	4 (0.9)	9 (2.3)
Include teachers from other schools outside of your district/diocese	9 (5.9)	3 (1.9)
Include parents/guardians or other community members	1 (0.4)	1 (0.8)

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

[a] Includes only schools indicating that they offered science-focused teacher study groups in the previous three years.

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

Program representatives were also asked about the activities typically included in science teacher study groups. Planning lessons together, analyzing student assessment results, and analyzing instructional materials were common activities in 2018 regardless of grade level (see Table 56). The typical activities were similar in both 2012 and 2018 across grade ranges, although fewer middle schools reported that teachers analyzed instructional materials during their study groups in 2018 than in 2012.

Table 56
Description of Activities in TypicalScience-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	**2018**
Elementary		
Teachers plan science/engineering lessons together	64 (5.3)	64 (5.1)
Teachers analyze science/engineering instructional materials (e.g., textbooks or modules)	66 (5.6)	50 (4.8)
Teachers analyze student science assessment results	65 (5.7)	50 (5.6)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	34 (5.8)	35 (5.2)
Teachers engage in science investigations	28 (5.1)	35 (5.8)
Teachers engage in engineering design challenges	n/a	24 (5.1)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	24 (4.9)
Teachers provide feedback on each other's science/engineering instruction	n/a	18 (4.0)
Teachers observe each other's science/engineering instruction (either in-person or through video recording)	n/a	15 (3.9)
Middle		
Teachers analyze student science assessment results	82 (3.5)	73 (3.8)
Teachers plan science/engineering lessons together	67 (4.9)	67 (4.0)
Teachers analyze science/engineering instructional materials (e.g., textbooks or modules)*1	68 (4.6)	50 (4.0)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	40 (5.5)	44 (4.1)
Teachers engage in science investigations	27 (4.6)	32 (4.7)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	26 (3.2)
Teachers provide feedback on each other's science/engineering instruction	n/a	25 (3.5)
Teachers observe each other's science/engineering instruction (either in-person or through video recording)	n/a	19 (3.5)
Teachers engage in engineering design challenges	n/a	16 (3.4)
High		
Teachers analyze student science assessment results	87 (2.4)	79 (3.3)
Teachers plan science/engineering lessons together	65 (5.9)	70 (3.8)
Teachers analyze science/engineering instructional materials (e.g., textbooks or modules)	63 (4.6)	53 (4.7)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	40 (6.2)	39 (3.7)
Teachers provide feedback on each other's science/engineering instruction	n/a	29 (3.8)
Teachers engage in science investigations	21 (5.2)	28 (3.9)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	21 (3.2)
Teachers observe each other's science/engineering instruction (either in-person or through video recording)	n/a	19 (2.6)
Teachers engage in engineering design challenges	n/a	13 (3.0)

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

a Includes only schools indicating that they offered science-focused teacher study groups in the previous three years.

As can be seen in Table 57, deepening teachers' understanding of state science and engineering standards and learning how to engage students in doing science commonly received substantial emphasis in science teacher study groups in 2018. The emphases of science-focused teacher study groups were relatively similar in 2012 and 2018, although there was a decrease in deepening teachers' understanding of science concepts.

Table 57
Science Teacher Study Groups Offered in the Previous Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Year

	PERCENT OF SCHOOLS[b]	
	2012	2018
Deepening teachers' understanding of the state science/engineering standards	69 (3.3)	66 (3.2)
How to engage students in doing science (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	56 (2.9)
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)
Deepening teachers' understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	46 (3.1)
Deepening teachers' understanding of how students think about various science ideas	41 (3.8)	44 (3.1)
How to monitor student understanding during science/engineering instruction	33 (2.6)	44 (3.0)
How to incorporate real-world issues (e.g., current events, community concerns) into science instruction	n/a	43 (2.7)
Deepening teachers' understanding of science concepts[*1]	50 (3.6)	41 (3.0)
How to adapt science instruction to address student misconceptions	41 (3.5)	38 (2.9)
How to differentiate science instruction to meet the needs of diverse learners	n/a	38 (3.0)
How to integrate science, engineering, mathematics, and/or computer science	n/a	38 (2.9)
How to engage students in doing engineering (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	36 (2.8)
Deepening teachers' understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	33 (3.2)
How to connect instruction to science/engineering career opportunities	n/a	27 (2.9)
How to develop students' confidence that they can successfully pursue careers in science/engineering	n/a	25 (2.8)
How to incorporate students' cultural backgrounds into science instruction	n/a	18 (2.5)

[*1] There is a statistically significant difference between schools in 2012 and schools 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 schools indicating that they offered science-focused teacher study groups in the previous three years.

In addition to asking about the availability of workshops and teacher study groups, the program questionnaires asked about content-focused coaching in schools. As can be seen in Table 58, about a quarter of schools offered one-on-one coaching in science in 2018. There were significant increases between 2012 and 2018 at the elementary and high school levels in this type of support.

Table 58
Schools Providing One-on-One Science Coaching, by Year

	PERCENT OF SCHOOLS	
	2012	2018
Elementary*1	17 (1.9)	27 (2.7)
Middle	17 (2.1)	23 (2.7)
High*1	22 (2.0)	30 (3.0)

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

In 2018, not only was one-on-one coaching uncommon, but the proportion of teachers receiving coaching in science was small—only about 10 percent of science teachers across grade bands (see Table 59). The percentage of teachers receiving science coaching decreased at the middle and high school levels between 2012 and 2018.

Table 59
Average Percentage of Teachers in Schools Receiving One-on-One Science Coaching, by Year

	AVERAGE PERCENTAGE OF TEACHERS	
	2012	2018
Elementary	18 (5.9)	7 (1.1)
Middle*1	27 (7.4)	9 (1.1)
High*1	21 (4.5)	11 (1.6)

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

In schools where teachers have access to one-on-one science coaching, program representatives were asked who provides the coaching services. As can be seen in Table 60, roughly forty percent of schools offering coaching employed district administrators, such as science supervisors, and teachers/coaches with or without full-time classroom teaching responsibilities as science coaches in 2018. Between 2012 and 2018, there was an increase in the percentage of schools employing science coaches without classroom teaching responsibilities. Additionally, more schools had assistant principals and district administrators serving as science coaches in 2018 than 2012.

Table 60
Teaching Professionals Providing
One-on-One Science-Focused Coaching to a Substantial Extent,[a] by Year

	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[*1]	21 (3.2)	37 (3.5)
District/Diocese administrators including science supervisors/coordinators[*1,c]	20 (2.9)	36 (4.6)
The principal of your school	14 (4.1)	21 (3.2)
An assistant principal at your school[*1]	7 (1.9)	18 (2.9)
Teachers/coaches who have part-time classroom teaching responsibilities	17 (3.1)	16 (2.8)

*1 There is a statistically significant difference between schools in 2012 and schools 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.

Science Teachers' Descriptions of Science Professional Development

Although understanding what professional development opportunities are offered by schools and districts is important, individual teacher experiences are likely to vary, even within schools. Consequently, both the 2012 NSSME and 2018 NSSME+ included several items asking teachers about their professional development experiences. As can be seen in Table 61, in 2018 the large majority of middle and high school science teachers had participated in science-focused professional development in the previous three years. At the elementary level, slightly more than half of teachers attended science professional development in the previous three years, and almost a quarter had never attended science professional development. Middle and high school teachers' most recent participation in science-focused professional development was similar in 2012 and 2018. However, there was a significant change at the elementary level, likely due to an increase in the percentage of teachers who had never participated in science-focused professional development.

Table 61
Most Recent Participation in Science-Focused Professional Development, by Year

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary[*1]		
In the previous 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 previous 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 previous 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)

[*1] There is a statistically significant difference between teachers in 2012 and teachers in 2018 (Chi-square test of independence, $p < 0.05$).

Teachers who had participated in professional development in the previous three years were asked to describe its nature. Data about the format of science teachers' professional development activities are shown in Table 62. In 2018, the vast majority of science teachers who had participated in professional development in the previous three years, regardless of grade range, had attended a workshop. The next most common type of professional development was professional learning community/teacher study group, with about 40 percent of elementary teachers and roughly 60 percent of secondary teachers having this type of experience. The percentage of science teachers at all grade ranges who had participated in professional learning communities or other types of teacher study groups decreased between 2012 and 2018. Additionally, the percentage of middle and high school teachers who had received assistance or feedback from a formally designated coach decreased between the two time points.

Table 62
Science Teachers Participating in Various Professional Development Activities in the Previous Three Years, by Year

	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*1	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)
Completed an online course/webinar	n/a	9 (1.5)
Took a formal course for college credit	n/a	5 (1.3)
Middle		
Attended a professional development program/workshop	91 (1.7)	94 (1.2)
Participated in a professional learning community/lesson study/teacher study group*1	75 (2.5)	61 (3.1)
Attended a national, state, or regional science teacher association meeting	35 (2.8)	37 (3.2)
Received assistance or feedback from a formally designated coach/mentor*1	47 (3.5)	33 (3.4)
Completed an online course/webinar	n/a	29 (3.0)
Took a formal course for college credit	n/a	9 (1.5)
High		
Attended a professional development program/workshop	90 (1.2)	91 (1.5)
Participated in a professional learning community/lesson study/teacher study group*1	73 (1.6)	55 (1.7)
Attended a national, state, or regional science teacher association meeting	44 (1.7)	40 (2.0)
Received assistance or feedback from a formally designated coach/mentor*1	54 (2.4)	35 (2.1)
Completed an online course/webinar	n/a	34 (2.2)
Took a formal course for college credit	n/a	16 (1.4)

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

Although some involvement in professional development may be better than none, a brief exposure of a few hours over several years is not likely to be sufficient to enhance teachers' knowledge and skills in meaningful ways. Consequently, teachers were asked about the total amount of time they had spent in professional development over the previous three years. As can be seen in Table 63, more than 40 percent of elementary teachers in 2018 had no science professional development in the previous three years, and only five percent had more than 35 hours. Middle and high school teachers had more professional development hours than elementary teachers, although the vast majority had fewer than 35 total hours. The data from 2012 and 2018 are very similar.

Table 63
Time Science Teachers Spent on Science-Focused Professional Development in the Previous Three Years, by Year†

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
None	41 (2.0)	43 (2.2)
Less than 6 hours	24 (1.6)	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 significant differences between teachers in 2012 and teachers in 2018 (Chi-square test of independence, $p \geq 0.05$).

It is widely agreed upon that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include engaging teachers in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; to examine student work and other classroom artifacts for evidence of what students do and do not understand; and to apply what they have learned in their classrooms and subsequently discuss how it went.[9]

As can be seen in Table 64, more than half of science teachers in 2018, regardless of grade level, had attended professional development in which they were able to work with other teachers from their school to a substantial extent. It was also fairly common during professional development for science teachers to work closely with teachers who taught the same grade or subject and to experience lessons as their students would. Only about a quarter of elementary and middle school teachers, and about a third of high school teachers, had substantial opportunities to rehearse instructional practices during their science professional development. Middle and high school science teachers' professional development experiences were fairly similar in 2012 and

[9] 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.

2018. There was more variation in the characteristics of elementary science teachers' professional development over time. Elementary teachers were more likely to work closely with other teachers from their school and with other teachers at their same grade level in 2018 than 2012. However, elementary teachers were less likely to have opportunities to engage in science investigations/engineering design challenges in 2018 than 2012.

Table 64
Science Teachers Whose Professional Development in the Previous Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by Year

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Worked closely with other teachers from their school*[1]	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*[1]	37 (3.4)	47 (3.2)
Had opportunities to experience lessons, as their students would, from the textbook/modules they use in their classroom	n/a	43 (3.1)
Had opportunities to engage in science investigations/engineering design challenges*[1]	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)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	n/a	23 (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	52 (3.0)	46 (3.5)
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)
Had opportunities to experience lessons, as their students would, from the textbook/modules they use in their classroom	n/a	40 (3.0)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	40 (3.4)	38 (3.1)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	n/a	27 (2.6)
High		
Worked closely with other teachers from their school*[1]	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 experience lessons, as their students would, from the textbook/modules they use in their classroom	n/a	45 (2.4)
Had opportunities to engage in science investigations/engineering design challenges	45 (2.8)	45 (2.4)
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)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	33 (2.4)	39 (2.3)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	n/a	35 (2.3)

*[1] There is a statistically significant difference between teachers in 2012 and teachers 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."

Table 65 displays science teachers' reports of the emphases of their professional development. Deepening understanding of how science is done was the most common emphasis of secondary science professional development, with more than half of middle and high school science teachers in 2018 indicating that their professional development in the previous three years had this emphasis. Monitoring student understanding during science instruction was the most common emphasis of elementary science professional development, although still less than half of elementary teachers in 2018 indicated their professional development in the previous three years had this emphasis. Incorporating students' cultural backgrounds into science instruction was emphasized less often in professional development at all grade ranges; only about a quarter of teachers reported that this topic received heavy emphasis in their recent experiences.

Where trend data exist, elementary and middle school science teachers' reports of the emphases of their professional development were very similar in 2012 and 2018. In contrast, the percentage of high school teachers with professional development that heavily emphasized monitoring student understanding, finding out what students already know prior to instruction, and learning about difficulties that students might have with particular science ideas decreased between 2012 and 2018.

Table 65
Science Teachers Reporting That Their Professional Development in the Previous Three Years Gave Heavy Emphasis[a] to Various Areas, by Year

	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)
Deepening their understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	39 (2.9)
Learning how to provide science instruction that integrates engineering, mathematics, and/or computer science	n/a	36 (3.0)
Finding out what students think or already know prior to instruction on a topic	41 (2.8)	35 (3.0)
Implementing the science textbook/module to be used in your classroom	39 (3.5)	34 (2.9)
Differentiating science instruction to meet the needs of diverse learners	n/a	33 (2.9)
Learning about difficulties that students may have with particular science ideas	30 (2.6)	26 (3.2)
Deepening their understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	25 (2.8)
Incorporating students' cultural backgrounds into science instruction	n/a	19 (2.5)
Middle		
Deepening their understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	59 (3.2)
Deepening their own science content knowledge	51 (4.0)	51 (3.3)
Learning how to provide science instruction that integrates engineering, mathematics, and/or computer science	n/a	49 (3.4)
Differentiating science instruction to meet the needs of diverse learners	n/a	49 (2.8)
Monitoring student understanding during science instruction	54 (3.3)	47 (3.7)
Finding out what students think or already know prior to instruction on a topic	46 (3.8)	42 (3.7)
Learning about difficulties that students may have with particular science ideas	42 (3.1)	35 (3.0)
Deepening their understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	34 (3.5)
Implementing the science textbook/module to be used in your classroom	30 (2.9)	30 (3.1)
Incorporating students' cultural backgrounds into science instruction	n/a	27 (2.3)
High		
Deepening their understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	n/a	51 (2.4)
Monitoring student understanding during science instruction[*1]	55 (2.2)	47 (2.0)
Differentiating science instruction to meet the needs of diverse learners	n/a	46 (2.0)
Deepening their own science content knowledge	48 (2.1)	45 (1.9)
Learning about difficulties that students may have with particular science ideas[*1]	49 (2.5)	40 (2.0)
Finding out what students think or already know prior to instruction on a topic[*1]	44 (2.3)	37 (2.0)
Learning how to provide science instruction that integrates engineering, mathematics, and/or computer science	n/a	34 (2.1)
Implementing the science textbook/module to be used in your classroom	29 (1.7)	29 (1.9)
Deepening their understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	n/a	23 (1.8)
Incorporating students' cultural backgrounds into science instruction	n/a	23 (2.1)

[*1] There is a statistically significant difference between teachers in 2012 and teachers 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."

Serving in a leadership role can serve as a form of professional development. As such, the survey included questions about teachers' recent leadership responsibilities. In 2018, about half of high school science teachers had served on a school or district committee, or observed another teacher's science lesson for the purpose of giving feedback in the previous three years (see Table 66). About a third of elementary science teachers and about a quarter of secondary teachers had supervised a student teacher in their classroom. Very few elementary teachers led a workshop for other teachers focused on science or served as a formal mentor for a science teacher; about a quarter of secondary science teachers had these types of leadership responsibilities.

Table 66
Science Teachers Having Various Leadership Responsibilities Within the Previous Three Years, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Served on a school or district/diocese-wide science committee*1	22 (1.9)	44 (3.1)	51 (2.0)
Observed another teacher's science lesson for the purpose of giving him/her feedback*2	11 (1.6)	44 (3.1)	50 (2.3)
Taught a science lesson for other teachers in their school to observe*2	8 (1.1)	37 (2.9)	38 (2.1)
Served as a lead teacher or department chair in science*2	14 (1.6)	37 (2.7)	33 (2.0)
Led or co-led a workshop or professional learning community for other teachers focused on science or science teaching*2	8 (1.4)	22 (2.3)	28 (1.7)
Served as a formal mentor or coach for a science teacher*1	4 (0.7)	21 (2.1)	27 (1.8)
Supervised a student teacher in their classroom*2	30 (2.2)	22 (2.2)	22 (2.3)

*1 There is a statistically significant difference among teachers in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between elementary teachers and teachers in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

Nature of School-/District-Offered Mathematics Professional Development

Table 67 shows the percentage of schools with mathematics professional development workshops offered locally in the previous three years. In 2018, professional development workshops were more likely to be offered at the elementary level than high school level. The percentage of schools offering workshops was similar in 2012 and 2018 across grade levels.

Table 67
Mathematics Professional Development Workshops Offered Locally in the Previous Three Years, by Year†

	PERCENT OF SCHOOLS	
	2012	2018
Elementary	65 (2.8)	69 (2.7)
Middle	60 (3.3)	61 (3.3)
High	51 (4.3)	46 (3.1)

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

Similar to science, locally offered mathematics workshops in 2018 tended to emphasize state standards and understanding concepts (see Table 68). The percentage of schools with access to locally offered professional development emphasizing state mathematics standards decreased between 2012 and 2018, perhaps because the CCSSM have been in place for nearly 10 years and needed less attention. In contrast, the percentage of schools with locally offered professional development emphasizing deepening teachers' understanding of how students think about various mathematical ideas and how to monitor student understanding increased between 2012 and 2018.

Table 68

Locally Offered Mathematics Professional Development Workshops in the Previous Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Year

	PERCENT OF SCHOOLS	
	2012	2018
Deepening teachers' understanding of the state mathematics standards[*1]	76 (2.5)	66 (2.7)
Deepening teachers' understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	62 (2.8)
Deepening teachers' understanding of mathematics concepts	60 (3.0)	61 (2.6)
Deepening teachers' understanding of how students think about various mathematical ideas[*1]	39 (2.8)	57 (2.9)
How to monitor student understanding during mathematics instruction[*1]	43 (2.7)	52 (2.9)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	52 (2.8)
How to use particular mathematics instructional materials (e.g., textbooks)	55 (3.1)	50 (2.9)
How to use technology in mathematics instruction	46 (2.9)	49 (2.4)
How to differentiate mathematics instruction to meet the needs of diverse learners	n/a	44 (2.8)
How to adapt mathematics instruction to address student misconceptions	38 (2.8)	43 (2.7)
How to use investigation-oriented tasks in mathematics instruction	36 (2.9)	41 (2.7)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction	n/a	31 (2.4)
How to integrate science, engineering, mathematics, and/or computer science	n/a	29 (2.7)
How to develop students' confidence that they can successfully pursue careers in mathematics	n/a	24 (2.3)
How to connect instruction to mathematics career opportunities	n/a	20 (2.3)
How to incorporate students' cultural backgrounds into mathematics instruction	n/a	13 (1.6)

[*1] There is a statistically significant difference between schools in 2012 and schools 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."

As can be seen in Table 69, more than half of schools in 2018, across grade levels, offered mathematics teacher study groups. Although there was no change in the prevalence of mathematics teacher study groups in middle and high schools between 2012 and 2018, there was an increase at the elementary level.

Table 69
Mathematics Teacher Study Groups
Offered at Schools in the Previous Three Years, by Year

	PERCENT OF SCHOOLS	
	2012	2018
Elementary*1	46 (3.0)	55 (3.2)
Middle	51 (3.7)	57 (3.3)
High	48 (4.4)	53 (2.8)

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

Schools that offered mathematics-focused study groups were asked if participation was required. More than three-quarters of schools that offered mathematics teacher study groups required participation in them in 2018 (see Table 70). Participation requirements were similar in 2012 and 2018, although there was an increase in elementary schools requiring participation.

Table 70
Required Participation in Mathematics Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary*1	70 (3.5)	82 (3.0)
Middle	79 (3.5)	83 (3.1)
High	77 (5.1)	77 (4.3)

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

a Includes only schools indicating that they offered teacher study groups in the previous three years.

Table 71 displays the duration of school-based mathematics study groups. In 2018, mathematics teacher study groups met for the entire year in two-thirds or more of schools that offered them, regardless of grade range. There was a significant difference in the duration of study groups at all grade ranges between 2012 and 2018, likely due to an increase in groups meeting for the entire school year.

Table 71
Duration of Mathematics-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary*1		
No specified duration	42 (3.8)	23 (3.2)
Less than one semester	3 (1.2)	2 (1.4)
One semester	4 (1.5)	6 (1.7)
The entire school year	52 (3.8)	68 (3.4)
Middle*1		
No specified duration	40 (4.1)	26 (3.8)
Less than one semester	3 (1.1)	1 (0.7)
One semester	3 (1.7)	2 (1.1)
The entire school year	54 (3.9)	70 (4.0)
High*1		
No specified duration	34 (4.6)	18 (3.2)
Less than one semester	4 (1.6)	2 (1.2)
One semester	2 (0.7)	3 (1.5)
The entire school year	60 (4.4)	77 (3.7)

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

a Includes only schools indicating that they offered teacher study groups in the previous three years.

Table 72 shows the frequency of meetings for mathematics-focused teacher study groups. Across grade levels in 2018, no one schedule seemed most common, although a majority of schools had groups that met at least once a month, and about a quarter had groups that met more than twice a month. The frequency of meetings was different between 2012 and 2018 at the elementary and high school levels. For both grade bands, the difference appears to be related to a decrease in the percentage of schools with no specified frequency for their mathematics teacher study groups.

Table 72
Frequency of Mathematics-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary[*1]		
No specified frequency	42 (3.8)	23 (3.2)
Less than once a month	14 (3.0)	18 (3.2)
Once a month	22 (2.7)	23 (3.0)
Twice a month	7 (2.1)	13 (2.6)
More than twice a month	15 (3.3)	22 (3.3)
Middle		
No specified frequency	40 (4.1)	26 (3.8)
Less than once a month	10 (2.0)	15 (3.4)
Once a month	17 (2.6)	19 (2.8)
Twice a month	9 (1.4)	12 (2.6)
More than twice a month	24 (3.7)	28 (3.3)
High[*1]		
No specified frequency	34 (4.6)	18 (3.2)
Less than once a month	9 (1.9)	12 (2.3)
Once a month	18 (2.9)	29 (3.5)
Twice a month	10 (1.7)	17 (2.5)
More than twice a month	29 (4.5)	25 (2.9)

[*1] There is a statistically significant difference between schools in 2012 and schools in 2018 (Chi-square test of independence, $p < 0.05$).
[a] Includes only schools indicating that they offered teacher study groups in the previous three years.

As shown in Table 73, in 2018, more than three-quarters of elementary schools and two-thirds of middle schools with mathematics-focused teacher study groups organized them by grade level. In contrast, only 36 percent of high schools organized their mathematics study groups by grade level, while 70 percent had mathematics teacher study groups that included teachers from multiple grade levels. The inclusion of parents/guardians and other community members or teachers from outside the district was typically rare regardless of grade range.

There were a small number of changes in these data between 2012 and 2018, though no overarching pattern is discernable. There was an increase in the percentage of schools with mathematics-focused teacher study groups organized by grade level at both the elementary and middle grades. There was a decrease in the percentage of middle schools with mathematics study groups that included teachers from multiple grade levels. The percentage of elementary schools with study groups composed of teachers from only their school also decreased between 2012 and 2018.

Table 73
Composition of Mathematics-Focused Teacher Study Groups, by Year

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary		
Organized by grade level[*1]	57 (4.5)	77 (3.1)
Include school and/or district/diocese administrators	55 (4.0)	61 (4.1)
Include teachers from multiple grade levels	57 (3.6)	54 (3.2)
Limited to teachers from this school[*1]	74 (4.3)	53 (4.3)
Include teachers from other schools in the district/diocese[b]	26 (4.1)	27 (3.7)
Include teachers who teach different mathematics subjects	n/a	24 (3.3)
Include higher education faculty or other "consultants"	18 (3.0)	17 (3.0)
Include teachers from other schools outside of your district/diocese	4 (2.6)	5 (1.9)
Include parents/guardians or other community members	4 (1.7)	2 (0.9)
Middle		
Organized by grade level[*1]	39 (3.8)	69 (3.5)
Include teachers from multiple grade levels[*1]	76 (2.7)	62 (3.8)
Limited to teachers from this school	73 (4.5)	61 (4.7)
Include school and/or district/diocese administrators	58 (3.3)	56 (3.7)
Include teachers who teach different mathematics subjects	n/a	47 (4.9)
Include teachers from other schools in the district/diocese[b]	27 (3.9)	23 (3.8)
Include higher education faculty or other "consultants"	15 (2.3)	19 (3.1)
Include teachers from other schools outside of your district/diocese	5 (3.1)	3 (2.0)
Include parents/guardians or other community members	2 (1.3)	1 (1.1)
High		
Include teachers who teach different mathematics subjects	n/a	72 (2.8)
Limited to teachers from this school	72 (6.7)	71 (4.5)
Include teachers from multiple grade levels	70 (3.5)	70 (4.4)
Include school and/or district/diocese administrators	47 (5.7)	38 (3.8)
Organized by grade level	27 (3.7)	36 (3.4)
Include higher education faculty or other "consultants"	10 (1.7)	16 (4.0)
Include teachers from other schools in the district/diocese[b]	24 (5.8)	14 (3.4)
Include teachers from other schools outside of your district/diocese	10 (5.6)	3 (1.8)
Include parents/guardians or other community members	1 (0.7)	1 (0.5)

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

[a] Includes only schools indicating that they offered mathematics-focused teacher study groups in the previous three years.

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

Program representatives were asked about the activities typically included in teacher study groups. The most common activities in mathematics teacher study groups in 2018, across grade levels, were planning lessons together, analyzing student assessment results, and analyzing instructional materials (see Table 74). The prevalence of various activities in mathematics teacher study groups was very similar in 2012 and 2018.

Table 74
Description of Activities in Typical Mathematics-Focused Teacher Study Groups, by Year†

	PERCENT OF SCHOOLS[a]	
	2012	2018
Elementary		
Teachers analyze student mathematics assessment results	81 (3.7)	81 (3.6)
Teachers analyze mathematics instructional materials (e.g., textbooks)	63 (3.8)	59 (4.4)
Teachers plan mathematics lessons together	60 (4.9)	59 (3.4)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	36 (4.3)	45 (3.8)
Teachers engage in mathematics investigations	29 (3.6)	34 (3.7)
Teachers provide feedback on each other's mathematics instruction	n/a	31 (4.0)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	29 (3.7)
Teachers observe each other's mathematics instruction (either in-person or through video recording)	n/a	26 (3.9)
Middle		
Teachers analyze student mathematics assessment results	85 (4.2)	79 (4.1)
Teachers analyze mathematics instructional materials (e.g., textbooks)	66 (4.0)	63 (4.4)
Teachers plan mathematics lessons together	54 (4.5)	63 (4.1)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	34 (3.9)	37 (3.9)
Teachers engage in mathematics investigations	29 (4.1)	37 (4.5)
Teachers provide feedback on each other's mathematics instruction	n/a	31 (4.2)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	26 (3.8)
Teachers observe each other's mathematics instruction (either in-person or through video recording)	n/a	25 (3.5)
High		
Teachers analyze student mathematics assessment results	81 (4.7)	76 (4.2)
Teachers analyze mathematics instructional materials (e.g., textbooks)	66 (5.3)	64 (4.0)
Teachers plan mathematics lessons together	62 (5.5)	63 (3.5)
Teachers engage in mathematics investigations	26 (5.6)	36 (4.5)
Teachers examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	26 (4.8)	32 (3.8)
Teachers provide feedback on each other's mathematics instruction	n/a	26 (3.7)
Teachers observe each other's mathematics instruction (either in-person or through video recording)	n/a	21 (2.8)
Teachers rehearse instructional practices (meaning: try out, receive feedback, and reflect on those practices)	n/a	21 (2.8)

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

[a] Includes only schools indicating that they offered mathematics-focused teacher study groups in the previous three years.

Table 75 shows the emphases of mathematics teacher study groups. As with science, deepening teachers' understanding of state standards received substantial emphasis in mathematics teacher study groups in the majority of schools. Deepening teachers' understanding of how students think about various mathematical ideas, how to monitor student understanding, and how to adapt mathematics instruction to address misconceptions all received substantial emphasis in more than half of schools with mathematics study groups. Although emphasized in more than 60 percent of schools' mathematics study groups, there was a decrease in emphasis on deepening teachers' understanding of state mathematics standards between 2012 and 2018. In contrast, there was an increase in emphasis on deepening teachers' understanding of how students think about mathematics ideas and how to adapt instruction to address students' misconceptions between the two years.

Table 75
Mathematics Teacher Study Groups Offered in the Previous Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Year

	PERCENT OF SCHOOLS[b]	
	2012	2018
Deepening teachers' understanding of the state mathematics standards[*1]	76 (2.5)	61 (2.7)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	59 (2.7)
Deepening teachers' understanding of how students think about various mathematical ideas[*1]	40 (3.3)	53 (2.9)
Deepening teachers' understanding of the how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	53 (2.7)
How to monitor student understanding during mathematics instruction	47 (3.1)	52 (2.8)
How to differentiate mathematics instruction to meet the needs of diverse learners	n/a	52 (2.5)
How to adapt mathematics instruction to address student misconceptions[*1]	42 (3.1)	51 (2.9)
How to use particular mathematics instructional materials (e.g., textbooks)	52 (3.7)	49 (2.9)
Deeping teachers' understanding of mathematics concepts	55 (3.0)	48 (3.0)
How to use technology in mathematics instruction	40 (3.6)	39 (2.4)
How to use investigation-oriented tasks in mathematics instruction	35 (3.3)	35 (2.8)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction	n/a	35 (2.7)
How to integrate science, engineering, mathematics, and/or computer science	n/a	26 (2.6)
How to connect instruction to mathematics career opportunities	n/a	21 (2.3)
How to develop students' confidence that they can successfully pursue careers in mathematics	n/a	21 (2.3)
How to incorporate students' cultural backgrounds into mathematics instruction	n/a	17 (2.1)

[*1] There is a statistically significant difference between schools in 2012 and schools 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 schools indicating that they offered mathematics-focused teacher study groups in the previous three years.

Schools providing one-on-one mathematics coaching is a relatively rare phenomenon. Only 29–43 percent, depending on grade range, offered mathematics coaching in 2018 (see Table 76). However, there was a significant increase in the percentage of elementary schools with one-on-one mathematics coaching between 2012 and 2018, from 27 to 43 percent.

Table 76
Schools Providing One-on-One Mathematics Coaching, by Year

	PERCENT OF SCHOOLS	
	2012	**2018**
Elementary*[1]	27 (2.3)	43 (2.8)
Middle	26 (2.6)	33 (2.6)
High	26 (2.4)	29 (2.8)

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

Still, in 2018, fewer than 20 percent of mathematics teachers received one-on-one coaching (see Table 77). The percentage of elementary teachers receiving mathematics coaching, like the percentage of schools offering it, increased between 2012 and 2018.

Table 77
Average Percentage of Teachers in Schools Receiving One-on-One Mathematics Coaching, by Year

	AVERAGE PERCENTAGE OF TEACHERS	
	2012	**2018**
Elementary*[1]	11 (2.8)	18 (1.7)
Middle	20 (3.6)	16 (1.5)
High	13 (3.2)	13 (2.2)

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

In schools where teachers have access to one-on-one content coaching, program representatives were asked who provides the coaching services. As can be seen in Table 78, teachers/coaches without other teaching responsibilities served in that role in more than half of schools, which represents an increase from 2012 to 2018. Additionally, a greater proportion of schools had assistant principals serving as mathematics coaches in 2018 than 2012.

Table 78
Teaching Professionals Providing One-on-One Mathematics-Focused Coaching to a Substantial Extent,[a] by Year

	PERCENT OF SCHOOLS[b]	
	2012	**2018**
Teachers/coaches who do not have classroom teaching responsibilities*[1]	40 (3.7)	56 (3.3)
District/Diocese administrators including mathematics supervisors/coordinators[c]	25 (3.2)	31 (2.9)
Teachers/coaches who have full-time classroom teaching responsibilities	28 (3.2)	28 (2.9)
The principal of your school	16 (3.3)	25 (2.9)
An assistant principal at your school*[1]	9 (2.0)	19 (2.1)
Teachers/coaches who have part-time classroom teaching responsibilities	14 (2.4)	15 (2.8)

*[1] There is a statistically significant difference between schools in 2012 and schools 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 mathematics-focused coaching.

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

Mathematics Teachers' Descriptions of Science Professional Development

Table 79 displays when teachers' most recently participated in mathematics-focused professional development. In 2018, the majority of teachers at all grade ranges had participated in mathematics-focused professional development in the previous three years. The 2018 data are very similar to those from 2012.

Table 79
Most Recent Participation in Mathematics-Focused Professional Development, by Year†

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
In the previous 3 years	87 (1.3)	84 (1.6)
4–6 years ago	7 (0.9)	7 (1.1)
7–10 years ago	1 (0.4)	1 (0.4)
More than 10 years ago	1 (0.3)	2 (0.5)
Never	3 (0.7)	5 (1.0)
Middle		
In the previous 3 years	89 (1.6)	89 (1.6)
4–6 years ago	4 (0.7)	5 (1.1)
7–10 years ago	1 (0.5)	2 (0.6)
More than 10 years ago	2 (0.6)	1 (0.3)
Never	4 (1.0)	4 (0.8)
High		
In the previous 3 years	88 (1.0)	89 (1.2)
4–6 years ago	6 (0.6)	5 (0.9)
7–10 years ago	2 (0.4)	1 (0.3)
More than 10 years ago	1 (0.3)	2 (0.7)
Never	4 (0.7)	3 (0.5)

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

Similar to science, in 2018 almost all mathematics teachers who had attended mathematics-focused professional development in the preceding three years had attended a workshop (see Table 80). Participating in a professional learning community and receiving feedback from a mentor were also common professional development activities. Similar to science, fewer mathematics teachers at all grade ranges participated in professional learning communities/ teacher study groups in 2018 than 2012. There was also a decrease in the percentage of high school teachers who received feedback from a mentor between 2012 and 2018.

Table 80
Mathematics Teachers Participating in Various Professional Development Activities in Previous Three Years, by Year

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Attended a professional development program/workshop*1	91 (1.0)	94 (1.1)
Participated in a professional learning community/lesson study/teacher study group*1	66 (1.7)	53 (2.6)
Received assistance or feedback from a formally designated coach/mentor	46 (2.2)	47 (2.4)
Completed an online course/webinar	n/a	19 (1.5)
Attended a national, state, or regional mathematics teacher association meeting	10 (1.0)	13 (1.7)
Took a formal course for college credit	n/a	5 (1.1)
Mathematics		
Attended a professional development program/workshop	92 (1.4)	93 (1.4)
Participated in a professional learning community/lesson study/teacher study group*1	76 (2.2)	68 (3.1)
Received assistance or feedback from a formally designated coach/mentor	57 (3.0)	56 (3.2)
Completed an online course/webinar	n/a	35 (2.9)
Attended a national, state, or regional mathematics teacher association meeting	32 (2.5)	26 (2.4)
Took a formal course for college credit	n/a	15 (2.1)
High		
Attended a professional development program/workshop	89 (1.0)	91 (1.4)
Participated in a professional learning community/lesson study/teacher study group*1	73 (2.17)	64 (2.1)
Received assistance or feedback from a formally designated coach/mentor*1	54 (2.2)	44 (2.4)
Attended a national, state, or regional mathematics teacher association meeting	38 (1.5)	34 (2.4)
Completed an online course/webinar	n/a	32 (2.0)
Took a formal course for college credit	n/a	19 (1.7)

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

Still, participation in mathematics-focused professional development was not extensive. In 2018, only about 1 in 10 elementary teachers and 4 in 10 secondary mathematics teachers had more than 35 hours of mathematics professional development over the previous three years (see Table 81). The time middle school teachers spent in mathematics professional development was similar in 2012 and 2018, but there were differences at the elementary and high school levels. The cause for the difference in the elementary grades is not entirely clear, but at the high school level it is appears to be due to an increase in teachers who participated in more than 35 hours of professional development between 2012 and 2018.

Table 81
Time Mathematics Teachers Spent on Mathematics-Focused Professional Development in the Previous Three Years, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary*1		
None	13 (1.3)	16 (1.6)
Less than 6 hours	21 (1.6)	17 (1.4)
6–15 hours	35 (1.6)	31 (1.6)
16–35 hours	20 (1.5)	22 (1.6)
More than 35 hours	11 (1.0)	13 (1.2)
Middle		
None	11 (1.6)	11 (1.7)
Less than 6 hours	11 (1.8)	8 (1.6)
6–15 hours	24 (2.1)	20 (2.2)
16–35 hours	23 (1.6)	24 (1.7)
More than 35 hours	31 (1.9)	37 (2.2)
High*1		
None	12 (1.0)	11 (1.2)
Less than 6 hours	11 (1.0)	7 (0.9)
6–15 hours	24 (1.4)	19 (1.5)
16–35 hours	22 (1.1)	22 (1.2)
More than 35 hours	32 (1.5)	41 (1.6)

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

In terms of features of their professional development, more than two-thirds of K–12 mathematics teachers in 2018 who attended professional development worked closely with other teachers from their school to a substantial extent, and more than half worked closely from other teachers in their same grade level or subject (see Table 82). Only about a third had substantial opportunities to rehearse instructional practices during their professional development. On the whole, mathematics teachers' professional development experiences were similar in 2012 and 2018, though there were a couple of differences over time. There was an increase between 2012 and 2018 in the percentage of elementary mathematics teachers whose professional development included working closely with other teachers from their school and with other teachers at their same grade level. There was also an increase in the percentage of high school mathematics teachers who had substantial opportunities to examine classroom artifacts during their professional development.

Table 82
Mathematics Teachers Whose Professional Development in the Previous Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by Year

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Worked closely with other teachers from their school[*1]	54 (2.3)	69 (2.5)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school[*1]	49 (2.3)	56 (2.1)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	n/a	48 (2.5)
Had opportunities to engage in mathematics investigations	46 (2.3)	46 (2.6)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	43 (2.4)	46 (2.6)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	46 (2.6)	44 (2.4)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	n/a	35 (2.2)
Middle		
Worked closely with other teachers from their school	70 (3.0)	72 (2.8)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	57 (3.2)	58 (3.2)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	44 (3.1)	49 (3.2)
Had opportunities to engage in mathematics investigations	51 (3.1)	47 (2.8)
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 (2.7)	46 (3.3)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	n/a	45 (3.6)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	n/a	34 (3.1)
High		
Worked closely with other teachers from their school	67 (2.3)	67 (2.2)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	56 (2.4)	57 (2.1)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	47 (2.4)	46 (2.2)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)[*1]	36 (2.4)	44 (2.0)
Had opportunities to engage in mathematics investigations	41 (2.0)	43 (1.9)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	n/a	42 (2.4)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	n/a	32 (2.0)

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

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

The surveys also asked about the foci of the professional development teachers attended. In 2018, learning how to use hands-on activities/manipulatives was a heavy emphasis of professional development across grade ranges (see Table 83). Monitoring student understanding during mathematics instruction was also a common emphasis across the grades K–12. Similar to science, incorporating students' cultural backgrounds into instruction was emphasized in only about a quarter of mathematics teachers' professional development. Between 2012 and 2018, at all grade ranges there was a decrease in the percentage of teachers whose professional development gave heavy emphasis to learning how to use hands-on activities/manipulatives. At the elementary and high school levels, there was also a decrease in the percentage of teachers who reported that their professional development gave heavy emphasis to implementing their mathematics textbook. More elementary teachers reported that their professional development emphasized deepening their mathematics content knowledge in 2018 than in 2012.

Table 83

Mathematics Teachers Reporting That Their Professional Development in the Previous Three Years Gave Heavy Emphasis[a] to Various Areas, by Year

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
Learning how to use hands-on activities/manipulatives for mathematics instruction*[1]	80 (2.3)	59 (2.5)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	58 (2.4)
Monitoring student understanding during mathematics instruction	56 (2.5)	56 (2.1)
Differentiating mathematics instruction to meet the needs of diverse learners	n/a	56 (2.7)
Deepening their own mathematics content knowledge*[1]	43 (2.6)	51 (2.5)
Learning about difficulties that students may have with particular mathematical ideas and procedures	49 (2.7)	47 (2.2)
Finding out what students think or already know prior to instruction on a topic	43 (2.4)	46 (2.4)
Implementing the mathematics textbook to be used in their classroom*[1]	55 (3.0)	40 (2.6)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	n/a	22 (2.4)
Incorporating students' cultural backgrounds into mathematics instruction	n/a	20 (1.9)
Middle		
Monitoring student understanding during mathematics instruction	55 (3.9)	55 (2.7)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	55 (3.1)
Differentiating mathematics instruction to meet the needs of diverse learners	n/a	55 (3.2)
Learning about difficulties that students may have with particular mathematical ideas and procedures	51 (3.4)	51 (3.1)
Learning how to use hands-on activities/manipulatives for mathematics instruction*[1]	67 (3.4)	45 (3.4)
Deepening their own mathematics content knowledge	44 (3.4)	44 (3.4)
Finding out what students think or already know prior to instruction on a topic	37 (3.5)	39 (3.4)
Implementing the mathematics textbook to be used in their classroom	39 (3.5)	38 (3.1)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	n/a	20 (2.5)
Incorporating students' cultural backgrounds into mathematics instruction	n/a	19 (3.0)
High		
Monitoring student understanding during mathematics instruction	49 (2.1)	53 (1.8)
Differentiating mathematics instruction to meet the needs of diverse learners	n/a	53 (2.0)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	n/a	49 (2.4)
Learning about difficulties that students may have with particular mathematical ideas and procedures	46 (2.3)	46 (2.0)
Learning how to use hands-on activities/manipulatives for mathematics instruction*[1]	55 (2.3)	40 (2.2)
Deepening their own mathematics content knowledge	35 (1.9)	39 (2.1)
Finding out what students think or already know prior to instruction on a topic	32 (1.9)	38 (2.2)
Implementing the mathematics textbook to be used in their classroom*[1]	32 (1.9)	25 (2.1)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	n/a	21 (1.8)
Incorporating students' cultural backgrounds into mathematics instruction	n/a	25 (2.3)

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

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

Table 84 displays mathematics teachers' leadership responsibilities. In general, secondary mathematics teachers had more leadership experiences than elementary mathematics teachers. For example, about a quarter of elementary teachers, and about half of secondary teachers, had observed another teacher's mathematics lesson for the purpose of giving feedback or served on a school/district mathematics committee in the previous three years. Additionally, about 30 percent of secondary teachers served as a lead teacher or department chair in mathematics, compared with 14 percent of elementary teachers.

Table 84
Mathematics Teachers Having Various Leadership Responsibilities Within the Previous Three Years, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Observed another teacher's mathematics lesson for the purpose of giving him/her feedback*1	27 (1.9)	47 (3.0)	53 (2.0)
Served on a school or district/diocese-wide mathematics committee*1	21 (1.6)	45 (2.9)	49 (2.1)
Taught a mathematics lesson for other teachers in their school to observe*1	28 (1.7)	43 (2.9)	41 (2.4)
Served as a formal mentor or coach for a mathematics teacher*2	6 (1.2)	21 (1.9)	29 (2.0)
Served as a lead teacher or department chair in mathematics*1	14 (1.6)	31 (2.3)	28 (1.8)
Led or co-led a workshop or professional learning community for other teachers focused on mathematics or mathematics teaching*1	10 (1.2)	23 (2.2)	26 (1.8)
Supervised a student teacher in their classroom	27 (2.2)	21 (2.1)	20 (1.8)

*1 There is a statistically significant difference between elementary teachers and teachers in each of the other two grade levels (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference among teachers in all grade levels (two-tailed independent samples t-test, $p < 0.05$).

SUMMARY

The NSSME provides high-quality, nationally representative data that can be used to measure several of the indicators for monitoring the status of K–12 STEM education. Data from the 2012 and 2018 iterations of the study were compared to look for progress on the indicators. For many items on the survey, there has been no change over this time period; however, there have been improvements on some indicators and declines on others.

Indicators 2 and 3 relate to science instruction in elementary schools. Data from the NSSME point to areas where there have been some improvements in elementary science practices since 2012; however, more work clearly needs to be done. Between 2012 and 2018, there were increases in elementary schools' offerings of science-related programs and practices to support and encourage students. For example, a larger percentage of schools offered family science and/or engineering nights, formal after-school science and/or engineering enrichment programs, and engineering clubs in 2018 than 2012. However, in terms of instructional time allocated to science, there has not been a change since 2012. In both 2012 and 2018, most elementary classes did not receive daily science instruction. The amount of instructional time devoted to science averaged about 25 minutes a day in 2018, which was very similar to the time spent in 2012.

Indicator 4 relates to the adoption of instructional materials aligned to CCSSM and the *Framework.* In 2018, the most commonly designated instructional materials in both science and mathematics classes were commercially published materials, such as textbooks and kits. About three-quarters of K–12 science classes in 2018 were using instructional materials published prior to the release of the NGSS and, thus, unlikely to be aligned with the *Framework.* In contrast, the majority of mathematics classes in 2018 were using textbooks published after the 2010 release of the CCSSM. Still, about 1 in 6 elementary and middle grades classes and 1 in 3 high school classes were using textbooks from 2010 or earlier.

Between 2012 and 2018, there were some changes in both positive and negative directions related to classroom coverage of the content and practices outlined in the NGSS and CCSSM (Indicator 5). In terms of classes' foci, there seemed to be a move away from the type of instruction envisioned by the NGSS and CCSSM. For example, although understanding science concepts was by far the most emphasized instructional objective in science classes, there was a decrease from 2012 to 2018 at the elementary and high school levels. There were also decreases in elementary mathematics classes with a heavy emphasis on increasing students' interest in mathematics and learning about real-life applications. In contrast, instructional practices in science and mathematics classes seemed to more closely align with the NGSS and CCSSM in 2018 than 2012. In science classes, there was a decrease in the teacher explaining science ideas to the whole class (i.e., lecture) and an increase in engaging the class in project-based learning activities. In mathematics, there was a decrease in percentage of classes in which students read from a textbook on a weekly basis and an increase in the percentage of classes having students write reflections. One thing that remained similar in both 2012 and 2018 was that the large majority of schools had school-wide efforts to align instruction with state science and mathematics standards.

Additionally, the 2018 NSSME+ asked teachers how often students engaged in the practices of science as described in the *Framework* and practices of mathematics described in the CCSSM. In science classes in 2018, students were often engaged in aspects of science related to conducting investigations and analyzing data, but not engaged very often in aspects of science related to evaluating the strengths/limitations of evidence and the practice of argumentation.

In mathematics classes, the majority of students determined whether their answer made sense at least once a week, regardless of grade level. Other practices commonly occurring at least once a week included students providing mathematical reasoning, using representations, working through challenging problems, identifying the relevant information in problems, and identifying patterns that may be helpful to solve a problem. Less common practices included students analyzing the mathematical thinking of others or comparing and contrasting different solution strategies on a weekly basis.

The 2012 NSSME and 2018 NSSME+ also collected data about teachers' college degrees and coursework, as well as their feelings of preparedness to teach science and mathematics. These data provide information related to Indicator 6: teachers' science and mathematics content knowledge for teaching. In general, science and mathematics teachers' preparedness to teach their respective disciplines was similar in 2012 and 2018. Elementary teachers in both years had taken far fewer science and mathematics courses than secondary teachers, and the percentage of teachers with college coursework in various topics was very similar. However, there were positive changes related to secondary teachers' degrees. For example, from 2012 to 2018, there was an increase in secondary science and mathematics teachers with a degree in their field of teaching. More specifically, there were increases in the percentages of secondary chemistry and life science/biology teachers with degrees in those fields.

Elementary teachers feelings of preparedness to teach science and mathematics have stayed fairly consistent between 2012 and 2018. They felt better prepared to teach mathematics than science, and the large majority of elementary teachers felt fairly well or very well prepared to teach all mathematics topics in both 2012 and 2018. Within science, elementary teachers felt best prepared to teach life science, and not as well prepared to teach Earth/space science or the physical sciences. There was also a small downward shift from 2012 to 2018 in feelings of preparedness to teach Earth/space science and physical science. Engineering stands out as the area where elementary teachers felt least prepared, although there was an increase in feelings of preparedness from 2012 to 2018.

Compared with elementary teachers, a much larger percentage of secondary science teachers felt very well prepared to teach science topics. For the most part, they felt similarly prepared to teach the majority of science topics in both 2012 and 2018. However, fewer middle school teachers felt very well prepared to teach some Earth/space science topics in 2018 than in 2012, while more high school science teachers indicated feeling very well prepared to teach several topics across science content areas in 2018 than in 2012, such as evolution and properties of solutions. The vast majority of secondary mathematics teachers felt very well prepared to teach the number system and operations, as well as algebraic thinking, in both 2012 and 2018. However, there were decreases in the percentages of both middle and high school teachers who felt very well prepared in measurement and discrete mathematics in 2018.

Finally, the surveys collected a large amount of data related to teachers' professional development experiences, which help inform progress on Indicator 7. Data related to science professional development remained largely unchanged between 2012 and 2018. In both years, workshops were the most commonly attended form of professional development. Further, the percentage of middle and high school science teachers who had participated in science-focused professional development in the previous three years was similar in both years. There was a significant change in elementary teachers' participation in science professional development between 2012 and 2018, which appears to be related to an increase in teachers who had never attended science professional development. The number of hours spent in science professional development was also similar in 2012 and 2018. Of the elementary teachers with science professional development in the preceding three years, only about 5 percent had more than 35 hours in 2012 and 2018. Middle and high school teachers during that time had more professional development hours than elementary teachers, although the vast majority had fewer than 35 total hours.

Elementary and middle school science teachers' reports of the emphases of their professional development were also very similar in 2012 and 2018; most commonly, science professional development for these grade levels emphasized deepening teachers' content knowledge and their understanding of how science is done. In contrast, the percentage of high school teachers with professional development that heavily emphasized monitoring student understanding, finding out what students already know prior to instruction, and learning about difficulties that students might have with particular science ideas decreased between 2012 and 2018.

Data related to mathematics professional development indicate some progress but also some challenges. In contrast to science, the majority of teachers at all grade ranges had participated in mathematics-focused professional development in the previous three years in both 2012 and 2018. Although there was no change in the prevalence of mathematics teacher study groups in middle and high schools between 2012 and 2018, there was an increase at the elementary level.

The emphases of mathematics professional development show some changes, though in both positive and negative directions. Between 2012 and 2018, at all grade ranges, there was a decrease in the percentage of teachers whose professional development gave heavy emphasis to learning how to use hands-on activities/manipulatives. At the elementary and high school levels, there was also a decrease in the percentage of teachers who reported that their professional development gave heavy emphasis to implementing their mathematics textbook. More elementary teachers reported that their professional development emphasized deepening their mathematics content knowledge in 2018 than in 2012.