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

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horizon RESEARCH, INC.

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Additional Information

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

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Introduction

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

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

1. To what extent do computer science, mathematics, and science instruction reflect what is known about effective teaching?

2. What are the characteristics of the computer science/mathematics/science teaching force in terms of race, gender, age, content background, beliefs about teaching and learning, and perceptions of preparedness?

3. What are the most commonly used textbooks/programs, and how are they used?

4. What influences teachers' decisions about content and pedagogy?

5. What formal and informal opportunities do computer science/mathematics/science teachers have for ongoing development of their knowledge and skills?

6. How are resources for computer science/mathematics/science education, including well-prepared teachers and course offerings, distributed among schools in different types of communities and different socioeconomic levels?

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

This report focuses on trends in mathematics education between 2012 and 2018. Although a few items were revised between administrations of the surveys, large portions of the instruments

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

remained the same. Only items that were substantively the same in 2012 and 2018 are included in this report; items with minor changes are described in table notes. All possible differences, both for individual items and for composite variables,[2] between 2012 and 2018 were tested for statistical significance. Statistically significant changes ($p < 0.05$) between 2012 and 2018 are denoted by an asterisk in each table.

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

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

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

Teacher Background and Beliefs

Overview

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

Teacher Characteristics

As can be seen in Table 2.1, the proportion of mathematics teachers in 2018 who were female decreases as grade level increases, from 94 percent in elementary grades to 60 percent at the high school level. However, the 2018 data are no different from the 2012 data.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Female	92 (1.0)	94 (1.0)
Male	8 (1.0)	6 (1.0)
Middle		
Female	76 (1.9)	70 (2.2)
Male	24 (1.9)	30 (2.2)
High		
Female	56 (1.7)	60 (1.5)
Male	44 (1.7)	40 (1.5)

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

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

Table 2.2
Race/Ethnicity of the Mathematics Teaching Force, by Grade Range

	PERCENT OF TEACHERS[a]	
	2012	2018
Elementary		
White*	93 (1.0)	89 (1.3)
Hispanic or Latino	9 (1.3)	10 (1.4)
Black or African American	5 (0.9)	7 (1.0)
Asian	2 (0.4)	3 (0.7)
American Indian or Alaskan Native	1 (0.4)	1 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.3)	0 (0.3)
Middle		
White	90 (1.3)	89 (1.4)
Hispanic or Latino	5 (0.7)	8 (1.5)
Black or African American	6 (0.9)	8 (1.2)
Asian	4 (1.0)	3 (0.8)
American Indian or Alaskan Native	2 (0.4)	1 (0.5)
Native Hawaiian or Other Pacific Islander	0 (0.2)	1 (0.8)
High		
White	93 (1.0)	91 (1.0)
Hispanic or Latino	5 (0.6)	7 (1.1)
Black or African American	4 (0.6)	5 (0.8)
Asian	3 (0.6)	4 (0.6)
American Indian or Alaskan Native	1 (0.4)	2 (0.3)
Native Hawaiian or Other Pacific Islander	0 (0.1)	1 (0.3)

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

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

The majority of the mathematics teaching force was older than 40 in 2018, with roughly a quarter or fewer of mathematics teachers in each grade range being older than 50 (see Table 2.3). About a fifth of mathematics teachers were age 30 or younger. Since 2012, the distribution of elementary mathematics teachers by age has changed substantially, suggesting an influx of younger teachers as older teachers have retired.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary*		
≤ 30	17 (1.2)	20 (1.6)
31–40	26 (1.4)	27 (1.8)
41–50	27 (1.6)	29 (2.1)
51+	30 (1.6)	23 (1.5)
Middle		
≤ 30	18 (1.3)	17 (1.7)
31–40	26 (2.1)	31 (2.2)
41–50	30 (2.2)	29 (2.4)
51+	25 (1.7)	22 (2.1)
High		
≤ 30	17 (1.2)	20 (1.5)
31–40	25 (1.3)	27 (1.3)
41–50	27 (1.2)	28 (1.5)
51+	30 (1.3)	26 (1.1)

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

Teachers' experience teaching mathematics at the K–12 level was similar across grade ranges, but the distribution of teachers by years of teaching experience has changed since 2012 among high school mathematics teachers (see Table 2.4). The change appears to be due to more teachers with 3–5 years of experience in 2018 and fewer teachers with 6–10 years experience.

Table 2.4
Years of Experience Teaching Mathematics, by Grade Range

	PERCENT OF TEACHERS	
	2012	**2018**
Elementary		
0–2 years	12 (1.1)	14 (1.4)
3–5 years	15 (1.4)	17 (1.4)
6–10 years	22 (1.3)	18 (1.4)
11–20 years	30 (1.6)	33 (1.8)
≥ 21 years	21 (1.6)	17 (1.7)
Middle		
0–2 years	14 (1.4)	18 (2.2)
3–5 years	17 (1.3)	19 (2.1)
6–10 years	25 (1.8)	20 (1.9)
11–20 years	29 (1.9)	32 (2.3)
≥ 21 years	15 (1.6)	11 (1.1)
High*		
0–2 years	10 (0.8)	11 (1.0)
3–5 years	14 (1.1)	18 (1.6)
6–10 years	22 (1.3)	17 (1.2)
11–20 years	33 (1.4)	34 (1.6)
≥ 21 years	21 (1.1)	20 (1.3)

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

In terms of years of experience teaching at their school, there was an evident shift in the distribution of mathematics across all grade ranges between 2012 and 2018 (see Table 2.5). In 2018, 27–37 percent of mathematics teachers were in their first two years at their school compared to 20–23 percent in 2012.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary*		
0–2 years	20 (1.5)	27 (1.8)
3–5 years	21 (1.4)	22 (1.5)
6–10 years	26 (1.3)	19 (1.4)
11–20 years	22 (1.3)	26 (1.5)
≥ 21 years	11 (1.2)	6 (0.9)
Middle*		
0–2 years	23 (1.7)	37 (2.5)
3–5 years	23 (1.7)	19 (2.0)
6–10 years	23 (1.8)	19 (2.1)
11–20 years	23 (2.1)	19 (1.8)
≥ 21 years	8 (1.3)	6 (0.9)
High*		
0–2 years	21 (1.3)	30 (1.7)
3–5 years	23 (1.2)	22 (1.9)
6–10 years	25 (1.3)	19 (1.3)
11–20 years	23 (1.3)	22 (1.7)
≥ 21 years	8 (0.7)	8 (0.8)

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

Teacher Preparation

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

As can be seen in Table 2.6, very few elementary teachers, in both 2012 and 2018, had college or graduate degrees in mathematics, which is not surprising given that the vast majority teach all core subjects. The percentage of teachers with one or more degrees in mathematics increases with increasing grade range, with 55 percent of high school mathematics teachers in 2018 having a major in this field. If the definition of degree in discipline is expanded to include degrees in mathematics education, the percentage increases to 79 percent of high school mathematics teachers. Further, in 2018, both middle and high school mathematics teachers were more likely to have a degree in mathematics or mathematics education compared to 2012.

Table 2.6
Mathematics Teacher Degrees, by Grade Range

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Mathematics*	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*	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*	73 (1.7)	79 (1.7)

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

Table 2.7 shows the percentage of elementary mathematics teachers with at least one college course in each of a number of areas. In 2018, the vast majority of teachers completed college coursework in mathematics for elementary school teachers and roughly half had college courses in algebra and statistics. In contrast, about a quarter of elementary mathematics teachers had a course in computer science.

Since 2012, these percentages have changed substantially in a number of areas. Elementary teachers were less likely in 2018 than 2012 to have had a course in mathematic content for elementary teachers, college algebra, integrated mathematics, and computer science. Interestingly, they were more likely in 2018 to have had at least one course in college geometry and other upper division mathematics.

Table 2.7
Elementary Mathematics Teachers Completing Various College Courses

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

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

The National Council of Teachers of Mathematics (NCTM) has recommended that elementary mathematics teachers take college coursework in a number of different areas, including number and operations (for which "mathematics content for elementary teachers" can serve as a proxy), algebra, geometry, probability, and statistics.[3] As can be seen in Table 2.8, only 7 percent of elementary mathematics teachers in 2018 had courses in all five areas; the typical elementary teacher had coursework in only one or two areas. Compared to 2012, there was a shift in the distribution of teachers by coursework, apparently due to a higher percentage in 2018 having taken courses in 3–4 of the 5 areas (39 vs. 32 percent) and a lower percentage having taken all 5 courses (7 vs. 10 percent) and in 1–2 areas (53 vs. 57 percent).

Table 2.8
Elementary Mathematics Teachers' Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS*	
	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)

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

Table 2.9 shows the percentage of middle school mathematics teachers with coursework in each of a number of areas. In 2018, about three-quarters of mathematics teachers at the middle grades had a course in statistics and two-thirds had a course in calculus. Relative to 2012, substantially

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

more middle school mathematics teachers had a course in probability, integrated mathematics, advanced calculus, number theory, differential equations, analytic geometry, and other upper division mathematics.

Table 2.9
Middle School Mathematics Teachers Completing Various College Courses

	PERCENT OF TEACHERS	
	2012	2018
Mathematics		
Statistics	69 (2.1)	74 (1.9)
Calculus	63 (2.3)	65 (2.3)
Mathematics content for middle school teachers	56 (2.3)	62 (2.6)
Probability*	39 (2.2)	52 (2.5)
Integrated mathematics*	40 (2.0)	50 (2.5)
Advanced calculus*	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)*	32 (2.0)	41 (2.4)
Differential equations*	22 (1.5)	36 (1.9)
Analytic/coordinate geometry (e.g., transformations or isometries, conic sections)*	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*	19 (1.5)	28 (2.2)
Other		
Computer science*	61 (2.1)	42 (2.2)
Engineering	9 (1.2)	9 (1.1)

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

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.[4] As can be seen in Table 2.10, more than half of middle grades mathematics teachers in 2018 had college courses in all or nearly all of these areas. Compared to 2012, there was a shift in the distribution of teachers by coursework, suggesting that teachers were more likely to have taken at least 4 of the 6 recommended courses in 2018.

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

Table 2.10
Middle School Mathematics Teachers' Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS*	
	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)

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

At the high school level, nearly all mathematics teachers completed a calculus course in 2018, and 85 percent took an advanced calculus course (see Table 2.11). Other college courses completed by a majority of high school mathematics teachers include statistics, linear algebra, and probability. Similar to middle grades teachers, between 2012 and 2018 there was an increase in the percentage of high school teachers who completed coursework in various areas, such as probability (56 vs. 75 percent), analytic geometry (53 vs. 66 percent), discrete mathematics (52 vs. 61 percent), and other upper division mathematics (43 vs. 58 percent).

Table 2.11
High School Mathematics Teachers Completing Various College Courses

	PERCENT OF TEACHERS	
	2012	2018
Mathematics		
Calculus	93 (0.9)	92 (1.4)
Statistics*	83 (1.5)	89 (1.1)
Advanced calculus*	79 (1.6)	85 (1.4)
Linear algebra (e.g., vectors, matrices, eigenvalues)	80 (1.7)	84 (1.5)
Probability*	56 (1.7)	75 (1.3)
Abstract algebra (e.g., groups, rings, ideals, fields)*	67 (1.7)	73 (1.5)
Mathematics content for high school teachers	71 (1.8)	69 (1.9)
Differential equations*	62 (1.7)	68 (1.6)
Analytic/coordinate geometry (e.g., transformations or isometries, conic sections)*	53 (1.7)	66 (1.8)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)*	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)*	54 (1.9)	58 (1.7)
Real analysis*	44 (1.7)	49 (1.6)
Integrated mathematics*	34 (1.7)	47 (1.8)
Other upper division mathematics*	43 (1.5)	58 (1.9)
Other		
Computer science*	77 (1.7)	62 (1.7)
Engineering	19 (1.4)	18 (1.3)

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

NCTM recommends that teachers have coursework in seven areas: algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics.[5] In 2018, approximately three-quarters of high school teachers met or came close to having taken courses in all seven areas, completing at least five (see Table 2.12). Here again, the distribution of teachers by coursework indicates a shift in more teachers completing the recommended coursework in 2018 than 2012.

Table 2.12
High School Mathematics Teachers' Coursework Related to NCTM Preparation Standards

	PERCENT OF TEACHERS*	
	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)

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

Teachers were also asked about their path to certification. As can be seen in Table 2.13, elementary mathematics teachers in 2018 were more likely than those at the high school level to have had an undergraduate program leading to a bachelor's degree and a teaching credential. High school mathematics teachers were more likely than their elementary school counterparts to have completed a post-baccalaureate credentialing program that did not include a master's degree. Despite the increasing opportunities available for certification (e.g., alternative teaching certification), these data have not changed since 2012.

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

Table 2.13
Mathematics Teachers' Paths to Certification, by Grade Range†

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
An undergraduate program leading to a bachelor's degree and a teaching credential	63 (2.2)	65 (2.2)
A post-baccalaureate credentialing program (no master's degree awarded)	14 (1.9)	10 (1.5)
A master's program that also led to a teaching credential	22 (2.0)	23 (2.1)
Has not earned a teaching credential	1 (0.4)	2 (0.6)
Middle		
An undergraduate program leading to a bachelor's degree and a teaching credential	55 (3.1)	61 (2.6)
A post-baccalaureate credentialing program (no master's degree awarded)	17 (2.1)	14 (1.9)
A master's program that also led to a teaching credential	25 (2.7)	20 (1.6)
Has not earned a teaching credential	3 (1.1)	4 (1.1)
High		
An undergraduate program leading to a bachelor's degree and a teaching credential	48 (2.3)	57 (2.3)
A post-baccalaureate credentialing program (no master's degree awarded)	20 (1.8)	16 (1.2)
A master's program that also led to a teaching credential	22 (1.6)	21 (1.6)
Has not earned a teaching credential	10 (1.9)	7 (1.5)

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

Teacher Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning. Tables 2.14–2.16 show the percentage of mathematics teachers in each grade range agreeing with each of the statements that were asked in both 2012 and 2018. Large majorities of teachers across years and grade ranges agreed with two statements that align closely with what is known about how students learn: (1) students should have opportunities to share their thinking during class and (2) addressing topics in depth is better, even if that means covering fewer topics. Although the extent of agreement with these statements at the elementary level has not changed since 2012, both middle and high school mathematics teachers were more likely to agree with the latter of the two statements in 2018 compared to 2012.

Unfortunately, agreement with statements that do not align with best practice have remained fairly common and stable, especially at the middle grades. Although, the percentage of elementary and high school teachers agreeing with certain statements has dropped between 2012 and 2018. For example, in 2012, 48 percent of elementary teachers agreed that teachers should explain an idea to students before having them investigate the idea. In 2018, only 34 percent of elementary teachers agreed with this statement. High school mathematics teachers were also less likely to agree with this statement in 2018 than in 2012.

Table 2.14
Elementary School Mathematics Teachers Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	2018
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	97 (0.5)	96 (0.9)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	78 (1.5)	77 (2.0)
Traditional Beliefs		
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.*	90 (1.1)	82 (1.6)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	52 (1.7)	53 (2.5)
Students learn mathematics best in classes with students of similar abilities.	51 (1.7)	49 (2.3)
Teachers should explain an idea to students before having them investigate the idea.*	48 (1.8)	34 (2.1)

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

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

Table 2.15
Middle School Mathematics Teachers Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	2018
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	95 (0.8)	95 (0.7)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics*	82 (1.8)	89 (1.5)
Traditional Beliefs		
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	83 (1.5)	78 (3.1)
Students learn mathematics best in classes with students of similar abilities.	69 (2.2)	66 (2.7)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	40 (2.1)	43 (2.7)
Teachers should explain an idea to students before having them investigate the idea.	37 (1.8)	31 (2.9)

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

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

Table 2.16
High School Mathematics Teachers
Agreeing[a] With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS	
	2012	2018
Reform-Oriented Beliefs		
Most class periods should provide opportunities for students to share their thinking and reasoning.	93 (0.8)	94 (0.9)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics*	78 (1.2)	83 (1.7)
Traditional Beliefs		
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	81 (1.0)	78 (1.8)
Students learn mathematics best in classes with students of similar abilities.*	77 (1.1)	70 (1.8)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.*	39 (1.7)	44 (2.1)
Teachers should explain an idea to students before having them investigate the idea.*	38 (1.6)	32 (2.3)

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

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

The items related to traditional beliefs were combined into a composite variable. The composite scores, shown in Table 2.17, indicate that elementary, middle, and high school mathematics teachers held moderately traditional beliefs, but also that elementary school teachers' beliefs have become slightly less traditional since 2012.

Table 2.17
Mean Scores for Mathematics Teachers'
Traditional Beliefs Composite,[a] by Grade Range

	MEAN SCORE	
	2012	2018
Elementary*	63 (0.6)	59 (0.9)
Middle	62 (0.7)	60 (1.1)
High	62 (0.5)	61 (0.9)

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

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

Teachers' Perceptions of Preparedness

Elementary teachers are typically assigned to teach multiple subjects to a single group of students, including not only mathematics, but other areas as well. As can be seen in Table 2.18, approximately three-quarters of teachers of self-contained elementary classes felt very well prepared to teach mathematics. Compared to 2012, elementary teachers feeling of preparedness to teach mathematics did not change.

Table 2.18
Elementary Teachers Feeling Very Well Prepared to Teach Each Subject

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

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

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

Table 2.19 provides more specific data on elementary teachers' perceptions of their preparedness to teach each of a number of mathematics topics at their assigned grade level. Three quarters of teachers in 2018 felt very well prepared to teach number and operations, while about a half felt very well prepared to teach measurement and data representation and geometry. These perceptions of preparedness have remained stable since 2012.

Table 2.19
Elementary Teachers Feeling Very Well Prepared to Teach Various Mathematics Topics†

	PERCENT OF TEACHERS	
	2012	2018
Number and operations	77 (1.4)	74 (1.7)
Measurement and data representation	56 (2.0)	53 (1.8)
Geometry	54 (1.9)	49 (2.2)
Early algebra	46 (2.0)	41 (1.9)

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

For secondary teachers, the questionnaire included a series of items about a single, randomly selected mathematics class in the respondent's schedule. Middle and high school mathematics teachers were shown a list of topics based on the subject of that class and asked how well prepared they felt to teach each of those topics at the grade levels they teach. As can be seen in Table 2.20, middle school teachers' feelings of preparedness have changed minimally since 2012. The three exceptions in the percentages that felt very well prepared are decreases—in measurement (66 to 61 percent), statistics and probability (48 to 40 percent), and discrete mathematics (18 to 12 percent).

Table 2.20
Middle School Mathematics Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF TEACHERS	
	2012	2018
The number system and operations	88 (1.4)	85 (1.4)
Algebraic thinking	76 (1.9)	78 (1.7)
Measurement*	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*	48 (2.2)	40 (2.4)
Discrete mathematics*	18 (1.5)	12 (1.4)

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

Table 2.21 provides analogous data for high school mathematics teachers. Between 2012 and 2018 there was a decrease in the percentages of teachers who felt very well prepared to teach measurement (79 to 74 percent), geometry (70 to 65 percent), and discrete mathematics (25 to 21 percent).

Table 2.21
High School Mathematics Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF TEACHERS	
	2012	2018
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*	79 (1.2)	74 (1.3)
Geometry*	70 (1.4)	65 (1.4)
Modeling	58 (2.0)	59 (1.8)
Statistics and probability	30 (1.2)	31 (1.7)
Discrete mathematics*	25 (1.2)	21 (1.3)

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

Table 2.22 displays mean scores for the composite variable Perceptions of Content Preparedness, which was defined based on the content of the randomly selected mathematics class. The mean scores indicate that: (1) teachers across the grade ranges generally felt well prepared to teach mathematics and (2) elementary and middle school teachers felt slightly less well prepared in 2018 than they did in 2012.

Table 2.22
Mean Scores for Mathematics Teachers' Perceptions of Content Preparedness Composite, by Grade Range

	MEAN SCORE	
	2012	2018
Elementary*	82 (0.7)	79 (0.7)
Middle*	81 (0.6)	78 (0.7)
High	83 (0.5)	82 (0.6)

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

Another series of items focused on teacher preparedness for a number of tasks associated with instruction. Specifically, teachers responded to several items about how well prepared they felt to monitor and address student understanding, focusing on a specific unit in the randomly selected class. As can be seen in Table 2.23, elementary and middle school teachers in 2018 were less likely to feel very well prepared than those in 2012 to: (1) implement the instructional materials designated for the class and (2) find out what students thought or already knew about key mathematical ideas. There was also a decrease in the percentage of middle school teachers who felt very well prepared to assess student understanding at the conclusion of unit between 2012 and 2018. There were no substantial changes among high school teachers.

Table 2.23
Mathematics Classes in Which Teachers Feel Very Well Prepared for Various Tasks in the Most Recent Unit, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Assess student understanding at the conclusion of this unit	66 (1.7)	64 (1.9)
Implement the instructional materials to be used during this unit*,[a]	62 (2.0)	55 (1.8)
Monitor student understanding during this unit	62 (1.6)	60 (1.8)
Anticipate difficulties that students may 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*	48 (1.8)	42 (2.1)
Middle		
Assess student understanding at the conclusion of this unit*	72 (2.3)	62 (2.3)
Implement the instructional materials to be used during this unit*	63 (2.3)	55 (2.0)
Monitor student understanding during this unit	62 (2.1)	57 (1.9)
Anticipate difficulties that students may 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*	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 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 may 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)

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

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

These items were combined to create a composite variable named Perceptions of Preparedness to Implement Instruction in Particular Unit. Similar to their perceptions of content preparedness, mathematics teachers felt relatively well prepared to implement instruction in a particular unit (see Table 2.24). However, there was a slight decrease in feelings of preparedness among elementary and middle school teachers between 2012 and 2018.

Table 2.24
Mean Scores for Mathematics Teachers' Perceptions of Preparedness to Implement Instruction in Particular Unit Composite, by Grade Range

	MEAN SCORE	
	2012	2018
Elementary*	83 (0.5)	81 (0.8)
Middle*	84 (0.8)	81 (0.8)
High	85 (0.5)	84 (0.5)

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

Summary

In terms of gender and race/ethnicity, the mathematics teaching force remained stable between 2012 and 2018. The vast majority of elementary teachers were female and White. The fact that teacher race/ethnicity has not changed considerably since 2012, even while student demographics have, means that students were increasingly unlikely to be taught by teachers who reflect the nation's population. From 2012 to 2018, there was a shift in the distribution of elementary teachers' age, suggesting an influx of younger teachers, as older teachers have retired.

Although the data reveal no changes in teachers' pathways to certification, they do point to substantial increases in the percentage of secondary teachers with a degree in mathematics or mathematics education. Related, secondary teachers were more likely to have completed coursework in a number of areas (e.g., probability, advanced calculus, differential equations) in 2018 than they did in 2012. In contrast, there was a decrease in the percentage of elementary teachers with a degree in mathematics, though the percentages were small in both years.

The data also indicate some shifts away from traditional beliefs about mathematics instruction, particularly among elementary and high school teachers. For example, between 2012 and 2018, the percentage of elementary teachers agreeing that teachers should explain ideas to students before having them investigate the idea evidence decreased.

In terms of content preparedness, teachers across all grade ranges generally felt well prepared to teach mathematics. However, elementary and middle school teachers felt slightly less well prepared in 2018 than their counterparts did in 2012. A similar trend is evident in teachers' perceptions of pedagogical preparedness. There was a slight decrease in preparedness among elementary and middle school teachers, in particular in implementing the instructional materials designated for the class and finding out what students thought or already knew about key mathematical ideas.

Mathematics Professional Development

Overview

Mathematics teachers, like all professionals, need opportunities to keep up with advances in their field, including both disciplinary content and how to help their students learn important mathematics content. The 2018 NSSME+ collected data on teachers' participation in in-service education and other professional activities, as well as data on study groups, and one-on-one coaching provided by schools and districts. These data are discussed in this chapter, comparing them to data from 2012.

Teacher Professional Development

One important measure of teachers' continuing education is how long it has been since they participated in professional development. In 2018, 84–89 percent of mathematics teachers, depending on grade range, had participated in mathematics-focused professional development (i.e., focused on mathematics content or the teaching of mathematics) within the preceding three years (see Table 3.1). These data have not changed since 2012.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
In the last 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 last 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 last 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 statistically significant differences in the distributions of responses between teachers in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

In 2018, about 4 in 10 secondary mathematics teachers had participated in more than 35 hours of mathematics professional development in the preceding three years; whereas only 1 in 10 elementary teachers participated in that same amount (see Table 3.2). Between 2012 and 2018, there was a shift in the distribution of responses among elementary and high school teachers. For high school teachers, it appears as if this shift was mostly in more teachers having participated in more than 35 hours of professional development in 2018.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary*		
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*		
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)

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

Teachers who had recently participated in professional development were asked about the type of activities. As can be seen in in Table 3.3 there was a slight increase in the percentage of elementary mathematics teachers who attended a professional development program/workshop between 2012 and 2018 (91 vs. 94 percent). However, across grade ranges, teachers were less likely in 2018 than in 2012 to have participated in a professional learning community, lesson study, or teacher study group. Also, high school mathematics teachers, were less likely to receive feedback from a coach or mentor, dropping from 54 percent in 2012 to 44 percent 2018.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Attended a professional development program/workshop*	91 (1.0)	94 (1.1)
Participated in a professional learning community/lesson study/teacher study group*	66 (1.7)	53 (2.6)
Received assistance or feedback from a formally designated coach/mentor	46 (2.2)	47 (2.4)
Attended a national, state, or regional mathematics teacher association meeting	10 (1.0)	13 (1.7)
Middle		
Attended a professional development program/workshop	92 (1.4)	93 (1.4)
Participated in a professional learning community/lesson study/teacher study group*	76 (2.2)	68 (3.1)
Received assistance or feedback from a formally designated coach/mentor	57 (3.0)	56 (3.2)
Attended a national, state, or regional mathematics teacher association meeting	32 (2.5)	26 (2.4)
High		
Attended a professional development program/workshop	89 (1.0)	91 (1.4)
Participated in a professional learning community/lesson study/teacher study group*	73 (2.1)	64 (2.1)
Received assistance or feedback from a formally designated coach/mentor*	54 (2.2)	44 (2.4)
Attended a national, state, or regional mathematics teacher association meeting	38 (1.5)	34 (2.4)

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

Teachers who had participated in professional development in the preceding three years were also asked a series of questions about the characteristics of those experiences. The questions were designed to align with best practice in professional development,[6] such as having opportunities to: (1) participate with other teachers from their school and those who have similar teaching assignments; (2) engage in investigations, both to learn disciplinary content and to experience investigations; and (3) to apply what they have learned in their classrooms and subsequently discuss how it went.

As can be seen in Table 3.4, elementary mathematics teachers were more likely in 2018 to have opportunities to work closely with other teachers from their school (54 percent in 2012 vs. 69 percent in 2018) and with other teachers who taught the same grade or subject, whether or not they were from their school (49 percent in 2012 vs. 56 percent in 2018). The characteristics of professional development experiences for secondary mathematics teachers were largely unchanged.

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

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

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

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Worked closely with other teachers from their school*	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*	49 (2.3)	56 (2.1)
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)
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 engage in mathematics investigations	51 (3.1)	47 (2.8)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	44 (3.1)	49 (3.2)
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)
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 engage in mathematics investigations	41 (2.0)	43 (1.9)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)*	36 (2.4)	44 (2.0)
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)

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

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

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

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary	59 (1.1)	60 (1.2)
Middle	62 (1.4)	63 (1.3)
High	60 (1.3)	61 (0.9)

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

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

Another series of items asked about the focus of professional development opportunities teachers have had in the preceding three years. As can be seen in Table 3.6, roughly half of mathematics teachers' recent professional development heavily emphasized monitoring student understanding during mathematics instruction and learning about difficulties students may have with particular mathematics ideas and procedures. Among the few changes, professional development opportunities for teachers across the grade ranges were far less likely in 2018 to learn how to use hands-on manipulatives/activities for mathematics instruction. Elementary and high school teachers were also less likely to have professional development opportunities that emphasized implementing the mathematics textbook to be used in their classroom.

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

	PERCENT OF TEACHERS	
	2012	2018
Elementary		
Learning how to use hands-on activities/manipulatives for mathematics instruction*	80 (2.3)	59 (2.5)
Monitoring student understanding during mathematics instruction	56 (2.5)	56 (2.1)
Deepening their own mathematics content knowledge*	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*	55 (3.0)	40 (2.6)
Middle		
Learning how to use hands-on activities/manipulatives for mathematics instruction*	67 (3.4)	45 (3.4)
Monitoring student understanding during mathematics instruction	55 (3.9)	55 (2.7)
Deepening their own mathematics content knowledge	44 (3.4)	44 (3.4)
Learning about difficulties that students may have with particular mathematical ideas and procedures	51 (3.4)	51 (3.1)
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)
High		
Learning how to use hands-on activities/manipulatives for mathematics instruction*	55 (2.3)	40 (2.2)
Monitoring student understanding during mathematics instruction	49 (2.1)	53 (1.8)
Deepening their own mathematics content knowledge	35 (1.9)	39 (2.1)
Learning about difficulties that students may have with particular mathematical ideas and procedures	46 (2.3)	46 (2.0)
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*	32 (1.9)	25 (2.1)

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

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

Professional Development Offerings at the School Level

The data presented in this chapter thus far were drawn from the mathematics teacher questionnaires. The 2018 NSSME+ also included a School Program Questionnaire for mathematics, completed by a person knowledgeable about school mathematics programs, policies, and practices. School representatives were asked whether professional development workshops in mathematics had been offered by their school and/or district, possibly in conjunction with other school districts, colleges/universities, museums, professional associations, or commercial vendors. There were no changes on this item between 2012 and 2018, with 46–69 percent of schools, depending on grade range, having locally offered workshops on mathematics in 2018 (see Table 3.7).

Table 3.7
Mathematics Professional Development
Workshops Offered Locally in the Last Three Years, by Grade Range†

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

Mathematics program representatives who indicated that workshops had been offered locally in the preceding three years were asked about the extent to which that professional development emphasized each of a number of areas. The data in Table 3.8 suggest that the emphasis of professional development had remained fairly stable since 2012, with the exception of three areas. The emphasis on deepening teachers' understanding of state mathematics standards decreased from 2012 to 2018 (76 vs. 66 percent). In contrast, there was an increase in emphasis on deepening teachers' understanding of how students think about various mathematical ideas (39 vs. 57 percent) and how to monitor student understanding during mathematics instruction (43 vs. 52 percent). Taken together, these data suggest more emphasis in 2018 on attention to student thinking in professional development opportunities.

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

	PERCENT OF SCHOOLS	
	2012	**2018**
Deepening teachers' understanding of the state mathematics standards*	76 (2.5)	66 (2.7)
Deepening teachers' understanding of mathematics concepts[b]	60 (3.0)	61 (2.6)
Deepening teachers' understanding of how students think about various mathematical ideas*	39 (2.8)	57 (2.9)
How to monitor student understanding during mathematics instruction*	43 (2.7)	52 (2.9)
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 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)

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

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

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

One concern about professional development workshops is that teachers may not be given adequate assistance in applying what they learned to their own instruction. Teacher study groups (professional learning communities, lesson study, etc.) have the potential to help teachers focus on instruction. School mathematics program representatives were asked whether their school has offered teacher study groups in the preceding three years where teachers met on a regular basis to discuss mathematics teaching and learning. As can be seen in Table 3.9, about half of schools offered such opportunities in 2018. With the exception of elementary schools for which there was an increase in availability (46 vs. 55 percent), the data were unchanged between 2012 and 2018.

This finding seems to conflict with data in Table 3.3, which show considerable decreases in teachers participating in such groups. It may be that teacher participation dropped even as availability remained steady, although, as shown in Table 3.10, participation in study groups tended to be required.

Table 3.9
Mathematics Teacher Study Groups Offered at Schools in the Last Three Years, by Grade Range

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

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

Table 3.10–3.14 present additional information provided by school program representatives about school-based teacher study groups focused on mathematics. As can be seen in Table 3.10, there was a shift in the distribution among schools regarding the duration of study groups and the frequency of meetings. Compared to 2012, there appears to have been an increase in schools having study groups meet the entire year and having a specified frequency of meetings. However, there was still considerable variation in the frequency of these study group meetings in 2018.

Table 3.10
Participation, Duration, and Frequency of Mathematics Teacher Study Groups

	PERCENT OF SCHOOLS[a]	
	2012	2018
Participation Required		
Yes	78 (2.3)	81 (2.4)
No	22 (2.3)	19 (2.4)
Duration of Study Group*		
No specified duration	34 (2.7)	21 (2.4)
Less than one semester	3 (1.0)	2 (1.0)
One semester	3 (1.1)	5 (1.2)
Entire school year	60 (2.7)	72 (2.5)
Frequency of Meetings*		
No specified frequency	34 (2.7)	21 (2.4)
Less than once a month	12 (2.1)	15 (2.2)
Once a month	22 (1.9)	23 (2.2)
Twice a month	10 (1.5)	14 (1.8)
More than twice a month	22 (2.3)	27 (2.4)

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

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

Data about whether schools have had designated leaders for the teacher study groups and where those leaders come from are presented in Table 3.11. Of the schools that offered study groups, about two-thirds had designated leaders, who most often came from within the school (55 percent). There were no changes on these items from 2012 to 2018.

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

	PERCENT OF SCHOOLS[a]	
	2012	**2018**
No designated leader	35 (2.8)	36 (2.6)
The school	56 (3.0)	55 (2.5)
Elsewhere in the district/diocese[b]	18 (2.3)	21 (2.5)
College/University	1 (0.4)	1 (0.5)
External consultants	6 (1.7)	8 (1.7)

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

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

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

Information about the composition of teacher study groups is shown in Table 3.12. Most schools that had mathematics-focused study groups included teachers from multiple grade levels as well as school and/or district administrators. Compared to 2012, school study groups in 2018 were more likely to be organized by grade level (66 vs. 51 percent), and less likely to be limited to teachers from the school (58 vs. 76 percent). Otherwise, no changes in how schools structured study groups are apparent.

Table 3.12
Composition of Mathematics Teacher Study Groups

	PERCENT OF SCHOOLS[a]	
	2012	**2018**
Organized by grade level*	51 (2.8)	66 (2.6)
Include teachers from multiple grade levels	61 (2.3)	59 (2.5)
Limited to teachers from this school*	76 (2.8)	58 (3.2)
Include school and/or district/diocese administrators	50 (2.7)	55 (2.8)
Include teachers from other schools in the district/diocese[b]	23 (2.7)	24 (2.7)
Include higher education faculty or other "consultants"	15 (2.0)	18 (2.2)
Include teachers from other schools outside of your district/diocese	4 (1.7)	4 (1.4)
Include parents/guardians or other community members	3 (1.0)	1 (0.6)

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

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

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

School mathematics program representatives were also asked about the activities typically included in mathematics-focused teacher study groups. With only one exception, these activities remained stable since 2012 (see Table 3.13). In 2018, study groups were considerably more likely to examine classroom artifacts than in 2012 (42 vs. 34 percent). The three most common activities in 2018 were analyzing assessment results, planning lessons together, and analyzing mathematics instructional materials (e.g., textbooks).

Table 3.13
Description of Activities in Typical Mathematics Teacher Study Groups

	PERCENT OF SCHOOLS[a]	
	2012	2018
Analyze student mathematics assessment results	83 (2.4)	81 (2.5)
Plan mathematics lessons together	62 (3.2)	63 (2.5)
Analyze mathematics instructional materials (e.g., textbooks)	65 (2.7)	60 (3.3)
Examine classroom artifacts (e.g., student work samples, videos of classroom instruction)*	34 (2.7)	42 (2.7)
Engage in mathematics investigations	30 (2.3)	36 (2.7)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).
[a] Includes only those schools that offered teacher study groups in the last three years.

Further, school program representatives were asked about the extent to which the teacher study groups had addressed each of a number of topics. Similar to the data on school professional development workshops, teacher study groups had more of an emphasis on attention to student thinking in 2018 than in 2012 (see Table 3.14). Deepening teachers' understanding of how students think about various mathematical ideas was heavily emphasized in 53 percent of schools in 2018 compared to 40 percent in 2012. A similar increase is seen regarding an emphasis on how to adapt mathematics instruction to address student misconceptions.

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

	PERCENT OF SCHOOLS	
	2012	2018
Deepening teachers' understanding of the state mathematics standards*	76 (2.5)	61 (2.7)
Deepening teachers' understanding of how students think about various mathematical ideas*	40 (3.3)	53 (2.9)
How to monitor student understanding during mathematics instruction	47 (3.1)	52 (2.8)
How to adapt mathematics instruction to address student misconceptions*	42 (3.1)	51 (2.9)
How to use particular mathematics instructional materials (e.g., textbooks)	52 (3.7)	49 (2.9)
Deepening teachers' understanding of mathematics concepts[b]	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)

* There is a statistically significant difference between schools in 2012 and those in 2018 (two-tailed independent samples t-test, $p < 0.05$).
[a] Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."
[b] In 2012, this item read "mathematics content" instead of "mathematics concepts."

Although there is general agreement that teachers can benefit from participating in professional development workshops and study groups, it is often difficult to find time for them to do so, in particular for teachers of self-contained elementary classes who are responsible for all subjects. School representatives were given a list of ways in which time might be provided for teachers to participate in professional development (regardless of whether it is offered by the school or district) and asked to indicate which are used in their school. Across grade levels, it became more likely in 2018 for schools to use professional days or teacher work days before or after the students' school year (see Table 3.15). For example, at the elementary level, there was an increase from 43 percent in 2012 to 53 percent in 2018. Among elementary and high schools, it was also more likely to use professional days or teacher work days during the students' school year. In addition, between 2012 and 2018 there was an increase in elementary and middle schools using teachers' common planning time for mathematics professional development (47 vs. 58 percent and 39 vs. 48 percent, respectively).

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

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Professional days/teacher work days during the students' school year*	54 (3.0)	70 (2.8)
Common planning time for teachers*	47 (2.8)	58 (2.8)
Professional days/teacher work days before and/or after the students' school year*	43 (2.7)	53 (3.0)
Substitute teachers to cover teachers' classes while they attend professional development*	41 (3.4)	36 (3.0)
Early dismissal and/or late start for students	28 (2.7)	35 (2.9)
Middle		
Professional days/teacher work days during the students' school year	59 (3.4)	69 (3.3)
Common planning time for teachers*	39 (2.9)	48 (3.2)
Professional days/teacher work days before and/or after the students' school year*	45 (2.7)	54 (3.0)
Substitute teachers to cover teachers' classes while they attend professional development	40 (3.3)	36 (3.2)
Early dismissal and/or late start for students	32 (2.7)	36 (3.3)
High		
Professional days/teacher work days during the students' school year*	53 (4.2)	67 (3.3)
Common planning time for teachers	30 (2.8)	36 (3.2)
Professional days/teacher work days before and/or after the students' school year*	40 (3.4)	57 (3.1)
Substitute teachers to cover teachers' classes while they attend professional development*	50 (4.5)	39 (3.1)
Early dismissal and/or late start for students	34 (3.3)	39 (3.0)

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

Professional development workshops and teacher study groups can provide important opportunities for teachers to deepen their disciplinary and pedagogical content knowledge, and to develop skill in using that knowledge for key tasks of teaching, such as analyzing student work to determine what a student does and does not understand. When resources allow, one-on-one coaching can be a powerful tool to help teachers improve their practice. School program representatives were asked whether any teachers in their school had access to one-on-one coaching focused on improving their mathematics instruction. With the exception of elementary schools, the data were largely unchanged since 2012 (see Table 3.16). Elementary schools providing one-on-one mathematics coaching increased from 27 percent in 2012 to 43 percent in 2018.

Table 3.16
Schools Providing One-on-One Mathematics-Focused Coaching, by Grade Range

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

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

In schools where mathematics teachers had access to one-on-one coaching, program representatives were asked who provided the coaching services. As can be seen in Table 3.17, there was a shift in 2018, apparently due to more schools using a combination of administrators and teachers/coaches.

Table 3.17
Teaching Professionals Providing One-on-One Mathematics-Focused Coaching

	PERCENT OF SCHOOLS*[,a]	
	2012	2018
Both administrators and teachers/coaches[b]	68 (3.5)	79 (2.8)
Teachers/coaches only[b]	21 (2.8)	17 (2.5)
Administrators only	11 (2.4)	4 (1.3)

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

a Includes only those schools that provide mathematics-focused coaching.

b Includes teachers/coaches of all levels of teaching responsibility: full-time, part-time, and not teaching.

Although most schools had both teachers/coaches and administrators provide coaching, it appears that teachers/coaches were responsible for the bulk of it. Table 3.18 shows the percentages of schools with coaching provided by different professionals. These data indicate that, compared to 2012, schools in 2018 were relying more on individuals who did not have classroom teaching responsibilities. For example, of schools that provided one-on-one coaching in 2012, 40 percent relied on teachers/coaches with no teaching duties, compared to 56 percent in 2018. Further, the percentage of schools relying on assistant principals for coaching increased from 9 to 19 percent.

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

	PERCENT OF SCHOOLS[b]	
	2012	2018
Teachers/coaches who do not have classroom teaching responsibilities*	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 the school	16 (3.3)	25 (2.9)
An assistant principal at the school*	9 (2.0)	19 (2.1)
Teachers/coaches who have part-time classroom teaching responsibilities	14 (2.4)	15 (2.8)

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

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

b Includes only those schools that provide mathematics-focused coaching.

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

In addition, school mathematics program representatives were asked about the services provided to teachers in need of special assistance. In 2018, 46–51 percent of schools, depending on grade range, provided guidance from a formally designated mentor or coach (see Table 3.19). Interestingly, and perhaps discouragingly, there was a sharp decrease among secondary schools in this approach to supporting teachers who need extra help. For example, at the high school level, the percentage of schools offering such assistance decreased from 66 percent in 2012 to 48 percent in 2018.

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

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Guidance from a formally designated mentor or coach	56 (3.5)	51 (2.8)
Seminars, classes, and/or study groups*	53 (3.2)	40 (2.9)
A higher level of supervision than for other teachers	25 (2.5)	31 (2.8)
Middle		
Guidance from a formally designated mentor or coach*	59 (3.4)	46 (3.4)
Seminars, classes, and/or study groups*	49 (3.4)	35 (3.3)
A higher level of supervision than for other teachers	30 (2.7)	27 (2.8)
High		
Guidance from a formally designated mentor or coach*	66 (3.6)	48 (3.8)
A higher level of supervision than for other teachers	36 (3.7)	32 (2.9)
Seminars, classes, and/or study groups*	43 (3.6)	22 (2.5)

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

Responses to whether schools/districts provide mathematics workshops, teacher study groups, and one-on-one coaching were combined to look at the proportion of schools that did not offer any of these types of professional development. In 2018, 16–28 percent of schools, depending on grade range, did not offer some form of professional development in the preceding three years, which was similar to 2012 (see Table 3.20).

Table 3.20
Schools Not Offering Any Type of Mathematics Professional Development in the Last Three Years, by Grade Range†

	PERCENT OF SCHOOLS	
	2012	2018
Elementary	20 (2.5)	16 (2.3)
Middle	23 (3.2)	22 (2.9)
High	24 (3.4)	28 (3.1)

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

Summary

Between 2012 and 2018, the amount of professional development teachers participated in was largely unchanged. Although the vast majority of K–12 teachers had attended mathematics-focused professional development in the preceding three years, only about 4 in 10 secondary teachers and 1 in 10 elementary teachers had participated in more than 35 hours.

Regarding characteristics of professional development, there were some notable changes from 2012 to 2018. Among elementary teachers who had professional development, there was an increase in working with other teachers during their professional development experiences. For example, the percentage who worked closely with other teachers from their school in mathematics-related professional development increased from 54 to 69 percent.

The workshop was still by far the most common type of professional development, but across the grade ranges, there were sharp decreases in the percentages of teachers participating in professional learning communities, lesson study groups, and other kinds of teacher study groups. Common emphases of professional development remained relatively stable between 2012 and 2018. Roughly half of mathematics teachers' professional development heavily emphasized monitoring student understanding during mathematics instruction and learning about difficulties students may have with particular mathematics ideas and procedures. However, learning how to use hands-on manipulatives/activities for mathematics instruction was less emphasized in 2018 than in 2012.

There were some prominent changes from 2012 and 2018 regarding professional development opportunities offered at the school level. For example, elementary schools were more likely in 2018 to offer mathematics-focused teacher study groups and one-on-one coaching. Among schools that offered study groups in 2018, it was more likely that those groups met the entire year and had a specified frequency of meetings compared to 2012. Also, teacher study groups were more likely to be organized by grade level and had an increased emphasis on attention to student thinking.

Across grade ranges, the data show an increase in schools using professional days or work days for professional development. For example, among high schools, the percentage using this practice increased from 40 to 57 percent. At the elementary and middle grades, there was an increase in using common planning time for professional development.

Mathematics Courses

Overview

The 2018 NSSME+ collected data on mathematics course offerings in the nation's schools. In addition, teachers provided information about time spent on mathematics instruction in the elementary grades, titles and duration of secondary mathematics courses, and data about the students in a randomly selected class, including the number, gender and racial/ethnic composition. These data are presented in the following sections, comparing them to 2012.

Time Spent in Elementary Mathematics Instruction

Self-contained elementary teachers were asked how often they teach mathematics. In 2018, almost all grades K–3 classes and grades 4–6 classes received mathematics instruction all or most days, every week of the school year (see Table 4.21). The frequency of mathematics instruction has not changed since 2012.

Table 4.1
Frequency With Which Self-Contained Elementary Teachers Teach Mathematics†

	PERCENT OF CLASSES	
	2012	2018
Grades K–3		
All/Most days, every week	99 (0.4)	99 (0.2)
Three or fewer days, every week	1 (0.3)	1 (0.2)
Some weeks, but not every week	1 (0.3)	0 (0.1)
Grades 4–6		
All/Most days, every week	98 (0.9)	99 (0.4)
Three or fewer days, every week	2 (0.9)	1 (0.4)
Some weeks, but not every week	0 ---[a]	0 ---[a]

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

[a] No grades 4–6 teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

The survey also asked the approximate number of minutes typically spent teaching mathematics, science, social studies, and reading/language arts in self-contained classes. The average number of minutes per day typically spent on instruction in each subject in grades K–3 and 4–6 is shown in Table 4.2. To facilitate comparisons among the subject areas, only teachers who teach all four of these subjects to one class of students were included in this analysis. In grades K–3 classes, the average number of minutes per day on mathematics instruction increased from 54 in 2012 to 57 in 2018. Though small, this increase resulted in several additional hours of instruction over a school year. In contrast, there was no change in the average number of minutes per day on mathematics in grades 4–6.

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

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

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

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

Mathematics Course Offerings

Middle and high school program representatives were asked about mathematics course offerings in their school. Middle schools were asked how many 8th grade students would complete Algebra 1 and Geometry prior to 9th grade. As can be seen in Table 4.3, these data remained stable from 2012 to 2018, with roughly three-fourths of middle schools having had some students complete Algebra 1, and about one-fourth having had some students complete Geometry.

Table 4.3
Middle Schools With Various Percentages of 8th Graders Completing Algebra 1 and Geometry Prior to 9th Grade†

	PERCENT OF SCHOOLS	
	2012	**2018**
Algebra 1		
0 percent of students	25 (3.5)	26 (3.9)
1–10 percent of students	4 (1.0)	6 (1.4)
11–20 percent of students	10 (1.7)	12 (1.8)
21–30 percent of students	14 (1.7)	13 (1.9)
31–40 percent of students	11 (2.4)	11 (1.6)
41–50 percent of students	9 (2.3)	8 (2.0)
51–60 percent of students	7 (2.1)	5 (1.9)
61–70 percent of students	4 (1.5)	4 (1.6)
71–80 percent of students	6 (1.9)	2 (1.1)
81–90 percent of students	2 (0.9)	3 (1.1)
Over 90 percent of students	9 (1.8)	11 (2.7)
Geometry		
0 percent of students	72 (2.5)	74 (3.1)
1–10 percent of students	13 (1.4)	13 (1.5)
11–20 percent of students	7 (1.4)	4 (1.5)
21–30 percent of students	2 (0.5)	2 (0.5)
31–40 percent of students	3 (1.9)	0 (0.2)
41–50 percent of students	2 (1.0)	1 (0.5)
51–60 percent of students	2 (0.9)	0 (0.1)
61–70 percent of students	0 ---[a]	1 (0.9)
71–80 percent of students	1 (0.5)	1 (0.5)
81–90 percent of students	0 ---[a]	1 (0.6)
Over 90 percent of students	0 (0.1)	4 (2.2)

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

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

Table 4.4 shows mathematics courses that were offered in high schools. Again, the data have remained unchanged since 2012. Nearly all high schools offered a level 1 formal/college prep mathematics course such as Algebra 1 or Integrated Math 1. The vast majority of high schools also offered a second, third, and fourth formal/college prep mathematics course. Almost three-fourths of high schools offered mathematics courses that might qualify for college credit such as AP Calculus or AP Statistics.

Table 4.4
High Schools Offering Various Mathematics Courses†

	PERCENT OF SCHOOLS	
	2012	2018
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	78 (3.2)	79 (2.8)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	99 (0.7)	98 (1.0)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	90 (3.7)	93 (1.9)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	94 (3.5)	91 (2.2)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	85 (3.8)	90 (2.5)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	76 (4.0)	72 (3.5)

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

High schools were also asked whether they offer single-subject mathematics courses, integrated mathematics courses, or both. In 2018, almost all high schools (98 percent) offered single-discipline mathematics courses, with 80 percent offering only these types of courses (see Table 4.5). These data have not changed over time.

Table 4.5
Type of High School Mathematics Courses Offered†

	PERCENT OF SCHOOLS	
	2012	2018
Single-subject mathematics courses only	77 (3.4)	80 (2.2)
Integrated mathematics courses only	2 (0.5)	2 (0.7)
Both	22 (3.4)	18 (2.1)

† There is not a statistically significant difference in the distributions of responses between schools in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Table 4.6 shows the percentage of high schools offering each of the Advanced Placement (AP) mathematics courses, and Table 4.7 shows the percentage of grades 9–12 students in the nation at those schools (i.e., students with access to those courses). The percentages in the two tables are quite different because schools with larger enrollments are more likely to offer AP courses. Differences between 2012 and 2018 are apparent in two types of courses. The percentage of schools offering AP Calculus BC increased from 23 to 30 percent. The percentage of students with access to AP Calculus BC also increased from 47 to 56 percent. Second, there was an increase in the percentage of schools offering AP Statistics, from 27 to 34 percent, although the percentage of students with access to this course did not significantly increase.

Table 4.6
Access to AP Mathematics Courses, by Schools

	PERCENT OF HIGH SCHOOLS OFFERING	
	2012	**2018**
AP Calculus	**53 (3.5)**	**53 (3.2)**
AP Calculus AB	52 (3.5)	53 (3.2)
AP Calculus BC*	23 (2.5)	30 (2.4)
AP Statistics*	**27 (2.1)**	**34 (2.8)**

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

Table 4.7
Access to AP Mathematics Courses, by Students

	PERCENT OF HIGH SCHOOL STUDENTS WITH ACCESS	
	2012	**2018**
AP Calculus	**83 (1.5)**	**82 (1.6)**
AP Calculus AB	81 (1.6)	81 (1.7)
AP Calculus BC*	47 (2.1)	56 (2.5)
AP Statistics	**59 (1.9)**	**63 (2.4)**

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

About half of high schools offered at least one AP mathematics course (see Table 4.8). Comparing 2012 and 2018, there was a change in the distribution of responses, which appears to be due to an increase in the percentage of schools offering three AP courses, from 14 to 24 percent.

Table 4.8
Number of AP Mathematics Courses Offered at High Schools

	PERCENT OF SCHOOLS*	
	2012	**2018**
0 courses	49 (3.5)	46 (3.3)
1 course	20 (2.6)	14 (2.2)
2 courses	17 (2.7)	16 (2.4)
3 courses	14 (1.3)	24 (2.2)

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

The survey also asked if high schools offered International Baccalaureate (IB) mathematics courses. As can be seen in Table 4.9, very few schools offered the IB program in 2018, and fewer than 1 in 10 high school students had access to any of these mathematics courses (see Table 4.10). There were no changes in these data from 2012 to 2018.

Table 4.9
Access to IB Mathematics Courses, by Schools†

	PERCENT OF HIGH SCHOOLS OFFERING	
	2012	**2018**
IB Mathematical Studies Standard Level	3 (0.5)	3 (0.7)
IB Mathematics Standard Level	3 (0.6)	3 (0.6)
IB Mathematics Higher Level	2 (0.4)	3 (0.6)
IB Further Mathematics Standard Level	0 (0.2)	1 (0.2)

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

Table 4.10
Access to IB Mathematics Courses, by Students†

	PERCENT OF HIGH SCHOOL STUDENTS WITH ACCESS	
	2012	**2018**
IB Mathematical Studies Standard Level	8 (1.3)	8 (1.5)
IB Mathematics Standard Level	8 (1.3)	8 (1.5)
IB Mathematics Higher Level	4 (1.0)	7 (1.5)
IB Further Mathematics Standard Level	1 (0.3)	2 (0.7)

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

The survey asked high schools about opportunities provided to students to take mathematics courses not offered on site. As can be seen in Table 4.11, there have been a number of substantial increases in these opportunities since 2012. For example, students in 31 percent of schools could go to a college or university for mathematics courses in 2012 compared to 68 percent of schools in 2018. Concurrent college and high school/dual enrollment course offerings also increased from 40 percent in 2012 to 67 percent in 2018. Similarly, mathematics courses offered by telecommunications increased from 24 to 62 percent.

Table 4.11
Mathematics Programs and Practices Currently Being Implemented in High Schools

	PERCENT OF SCHOOLS	
	2012	2018
Calculus courses (beyond pre-calculus) are offered this school year or in alternating years, on or off site.	76 (3.5)	76 (3.8)
Students can go to a college or university for mathematics courses*	31 (3.0)	68 (3.1)
Concurrent college and high school credit/dual enrollment courses are offered this school year or in alternating years*	40 (3.4)	67 (3.0)
Mathematics courses offered by telecommunications*,a	24 (3.3)	62 (3.1)
Probability and/or statistics course are offered*	41 (3.0)	52 (3.2)
Algebra 1 course, or its equivalent, is offered over two years or as two separate block courses (e.g., Algebra A and Algebra B).	37 (3.7)	44 (3.0)
Students can go to a Career and Technical Education center for mathematics instruction.*	11 (1.6)	23 (2.3)
Students can go to another K–12 school for mathematics courses.*	5 (2.3)	11 (1.7)

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

[a] In 2018, this is a combination of two items representing program representatives that indicate either "This school provides students access to virtual mathematics courses offered by other schools/institutions (e.g., online, videoconference)" or "This school provides its own mathematics courses virtually (e.g., online, videoconference)."

In terms of the most commonly offered high school mathematics courses, there was no change from 2012 to 2018 (see Table 4.12). First, second, and third level formal/college prep courses were the most commonly offered, whereas courses that might qualify for college credit accounted for only 10 percent of classes in 2018.

Table 4.12
Most Commonly Offered High School Mathematics Courses†

	PERCENT OF CLASSES	
	2012	2018
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	13 (1.0)	13 (1.2)
Formal/College prep level 1 (e.g., Algebra 1, Integrated/Unified Math I)	20 (1.3)	20 (1.1)
Formal/College prep level 2 (e.g., Geometry, Integrated/Unified Math II)	23 (1.2)	21 (1.4)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	21 (1.1)	23 (1.3)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	15 (1.1)	14 (1.0)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	8 (0.7)	10 (0.8)

† There is not a statistically significant difference in the distributions of responses between classes in 2012 and those in 2018 (Chi-square test of independence, $p \geq 0.05$).

Other Characteristics of Mathematics Classes

The 2018 NSSME+ found that the average size of mathematics classes is generally around 21 students, with a slight decrease in high school class size between 2012 and 2018 (see Table 4.13). Table 4.14 shows average class size in different high school courses. For all courses, the average class size has remained stable since 2012. As can be seen in Figure 4.1, however, these averages can obscure a wide variation in class sizes. For example, in 2018, 15 percent of high school mathematics classes had 30 or more students, compared to 42 percent that had fewer than 20 students.

Table 4.13
Average Mathematics Class Size, by Grade Range

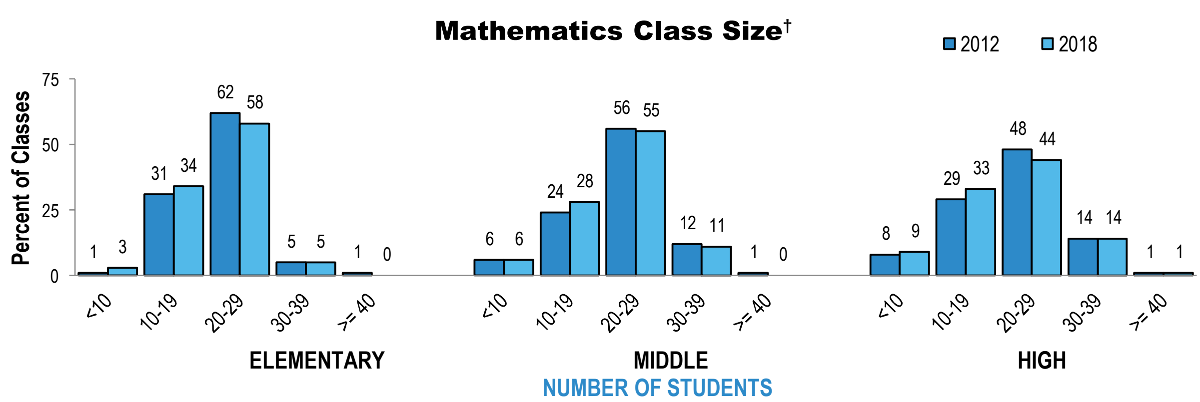
	AVERAGE NUMBER OF STUDENTS	
	2012	2018
Elementary	21.4 (0.2)	21.0 (0.2)
Middle	22.1 (0.4)	21.7 (0.4)
High*	21.4 (0.3)	20.5 (0.3)

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

Table 4.14
Average High School Mathematics Class Size†

	AVERAGE NUMBER OF STUDENTS	
	2012	2018
Non-college prep	19.0 (0.7)	18.0 (0.6)
Formal/College prep level 1	22.4 (0.5)	21.1 (0.6)
Formal/College prep level 2	22.5 (0.5)	22.0 (0.5)
Formal/College prep level 3	21.4 (0.7)	21.9 (0.6)
Formal/College prep level 4	21.1 (0.5)	19.8 (0.7)
Courses that might qualify for college credit	18.2 (0.9)	18.1 (0.9)

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



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

Figure 4.1

Table 4.15 shows the percentages of female students and students from race/ethnicity groups historically underrepresented in STEM in mathematics classes in the different grade bands. With regard to gender, female students were just as likely as male students to be enrolled in mathematics classes in 2018, regardless of grade level. In high school, where students are generally not required to take each subject every year, the data show that only about 40 percent of students from historically underrepresented race/ethnicity groups took mathematics. Relative to 2012, the percentage of these students increased at each grade range; however, that increase likely reflects an increase in their make up of the student body more broadly.

Table 4.15
Average Percentages of Female and Historically Underrepresented Students in Mathematics Classes

	PERCENT OF STUDENTS	
	2012	2018
Female		
Elementary	47 (0.5)	48 (0.7)
Middle	48 (0.6)	47 (0.7)
High	48 (0.7)	48 (0.9)
Historically Underrepresented		
Elementary*	40 (1.5)	44 (1.7)
Middle*	37 (1.8)	44 (2.0)
High*	31 (1.1)	38 (1.6)

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

In terms of gender, specific high school mathematics courses tended to have classes that were evenly split between male and female students on average (see Table 4.16). One exception was non-college prep mathematics classes, which tended to have smaller percentages of female students. These data were unchanged between 2012 and 2018.

A pattern of decreasing enrollment of students from race/ethnicity groups historically underrepresented in STEM is seen in the class composition data across the progression of high school mathematics courses. For example, in 2018, students from these groups made up 38 percent of students in formal/college prep level 1 classes, compared to only 22 percent in classes that might qualify for college credit. However, compared to 2012, students from race/ethnicity groups historically underrepresented in STEM were more likely to take the second, third, or fourth level formal college prep courses in 2018. Then again, this difference could be due to the overall increase in proportion of students in these groups

Table 4.16
Average Percentages of Female and Historically Underrepresented Students in High School Mathematics Courses

	PERCENT OF STUDENTS	
	2012	**2018**
Female		
Non-college prep	42 (1.4)	43 (1.8)
Formal/College prep level 1	48 (1.1)	47 (1.9)
Formal/College prep level 2	50 (1.5)	50 (1.2)
Formal/College prep level 3	51 (1.4)	50 (1.2)
Formal/College prep level 4	48 (2.1)	51 (1.7)
Courses that might qualify for college credit	48 (1.7)	50 (3.0)
Historically Underrepresented		
Non-college prep	45 (3.3)	53 (4.4)
Formal/College prep level 1	39 (2.2)	38 (2.5)
Formal/College prep level 2*	31 (2.0)	39 (3.2)
Formal/College prep level 3*	27 (2.3)	37 (2.4)
Formal/College prep level 4*	22 (2.0)	33 (2.5)
Courses that might qualify for college credit	17 (2.0)	22 (2.4)

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

Summary

The frequency and amount of time self-contained elementary classes devoted to mathematics instruction between 2012 and 2018 remained largely unchanged. Virtually all grades K–3 and grades 4–6 classes received mathematics instruction all or most days for an average of one hour per day.

In terms of the course offerings at the secondary level, the data have also been stable. At the middle school, Algebra 1 was likely offered, but relatively few students completed it prior to 9th grade. At the high school level, almost all schools offered formal/college prep levels 1–3. Nearly as many high schools offered a fourth year in the formal mathematics sequence; three-fourths of high schools offered courses that might quality for college credit. Between 2012 and 2018 there was an increase in the percentage of schools offering AP Calculus BC (23 to 30 percent) and AP Statistics (27 to 34 percent). The percentage of students with access to AP Calculus BC also increased, but the percentage with access to AP Statistics did not.

In 2018, female students were generally just as likely as male students to be enrolled in mathematics classes, regardless of grade range. The one exception was in non-college prep classes, where female students accounted for only 43 percent of students. Enrollment of students from race/ethnicity groups historically underrepresented in STEM in high school college prep mathematics courses was disproportionately low. Also, students from these groups accounted for 53 percent of enrollment in non-college prep courses, but only 22 percent in courses that might qualify for college credit.

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

Instructional Decision Making, Objectives, and Activities

Overview

The 2018 NSSME+ collected data about teachers' perceptions of their autonomy in making curricular and instructional decisions. Questions also focused on teachers' instructional objectives, class activities they use in accomplishing these objectives, and how student performance is assessed in a particular, randomly selected class. These data are discussed in the following sections, noting changes since 2012.

Teachers' Perceptions of Their Decision-Making Autonomy

Teachers were asked the extent to which they had control over a number of curricular and instructional decisions for their classes. As can be seen in Table 5.1, in mathematics classes across all grade levels, teachers tended to perceive themselves as having strong control over pedagogical decisions such as determining the amount of homework to be assigned (ranging from 61–75 percent). In contrast, especially in the elementary grades, teachers were less likely to feel strong control in determining course goals and objectives (16–30 percent); selecting curriculum materials (11–27 percent); and selecting content, topics, and skills to be taught (11–26 percent).

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

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

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Determining the amount of homework to be assigned	56 (2.6)	61 (2.2)
Selecting teaching techniques*	44 (2.5)	52 (2.2)
Choosing criteria for grading student performance	29 (2.4)	34 (2.0)
Determining course goals and objectives*	12 (1.5)	16 (1.7)
Selecting content, topics, and skills to be taught	8 (1.1)	11 (1.3)
Selecting curriculum materials (e.g., textbooks)*[,a]	3 (0.8)	11 (1.5)
Middle		
Determining the amount of homework to be assigned	77 (2.4)	71 (2.4)
Selecting teaching techniques	70 (2.6)	68 (2.5)
Choosing criteria for grading student performance	56 (2.7)	52 (2.9)
Determining course goals and objectives	24 (2.1)	28 (2.4)
Selecting content, topics, and skills to be taught	23 (2.2)	21 (2.1)
Selecting curriculum materials (e.g., textbooks)	13 (2.3)	18 (2.1)
High		
Determining the amount of homework to be assigned	75 (2.0)	75 (1.6)
Selecting teaching techniques	72 (1.8)	71 (1.5)
Choosing criteria for grading student performance	55 (2.1)	53 (2.0)
Determining course goals and objectives	28 (2.1)	30 (1.6)
Selecting content, topics, and skills to be taught	24 (1.9)	26 (1.6)
Selecting curriculum materials (e.g., textbooks)*	20 (2.1)	27 (1.8)

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

[a] In 2012, this item read “Selecting textbooks/programs.”

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

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Determining the amount of homework to be assigned	3 (0.8)	3 (1.0)
Selecting teaching techniques	3 (1.1)	2 (0.6)
Choosing criteria for grading student performance	9 (1.3)	6 (1.2)
Determining course goals and objectives*	44 (2.3)	34 (2.3)
Selecting content, topics, and skills to be taught	47 (2.3)	40 (2.6)
Selecting curriculum materials (e.g., textbooks)*,[a]	46 (2.4)	33 (2.3)
Middle		
Determining the amount of homework to be assigned	2 (1.6)	1 (0.4)
Selecting teaching techniques	1 (0.3)	0 (0.0)
Choosing criteria for grading student performance	5 (1.8)	2 (0.7)
Determining course goals and objectives	26 (2.2)	26 (2.2)
Selecting content, topics, and skills to be taught*	25 (1.9)	31 (2.0)
Selecting curriculum materials (e.g., textbooks)*	34 (2.7)	27 (2.2)
High		
Determining the amount of homework to be assigned	1 (0.4)	2 (0.6)
Selecting teaching techniques	0 (0.3)	0 (0.2)
Choosing criteria for grading student performance	2 (0.5)	3 (0.6)
Determining course goals and objectives*	18 (1.4)	14 (1.4)
Selecting content, topics, and skills to be taught	16 (1.6)	17 (1.8)
Selecting curriculum materials (e.g., textbooks)*	32 (1.8)	20 (1.8)

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

[a] In 2012, this item read "Selecting textbooks/programs."

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

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

For Pedagogy Control, the items are:

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

Table 5.3 displays the mean scores on these composites, which indicate that teachers in 2018 perceived more control over decisions related to pedagogy than curriculum. They also show that perceived control over curriculum-related decisions increased from 2012 to 2018 at the elementary and high school level, with control over pedagogical decisions increasing at the elementary level only.

Table 5.3
Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites, by Grade Range

	MEAN SCORE	
	2012	2018
Curriculum[a]		
Elementary*	29 (1.2)	37 (1.4)
Middle	45 (1.5)	47 (1.6)
High*	52 (1.4)	57 (1.3)
Pedagogy		
Elementary*	74 (1.1)	78 (0.9)
Middle	87 (1.4)	86 (0.9)
High	88 (0.7)	87 (0.7)

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

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

Instructional Objectives

The survey provided a list of possible objectives of instruction and asked teachers how much emphasis each would receive in an entire course of a particular, randomly selected class. Table 5.4 shows the percentage of mathematics classes by grade range placing heavy emphasis on each. In 2018, having students understand mathematical ideas was the most frequently emphasized objective across the grade ranges (67–71 percent), followed by learning how to do mathematics (61–63 percent) and learning mathematical procedures and/or algorithms (52–55 percent). All other objectives were considerably less likely to receive heavy emphasis.

Several changes occurred between 2012 and 2018. For example, classes across the grade ranges were more likely to emphasize learning how to do mathematics and less likely to emphasize learning test taking skills/strategies in 2018. Further, elementary mathematics classes were considerably less likely in 2018 than in 2012 to emphasize learning about real-life applications (34 vs. 45 percent), as well as increasing students' interest in mathematics (41 vs. 50 percent).

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

	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)*,[a]	51 (1.5)	62 (1.9)
Learning mathematical procedures and/or algorithms*	44 (1.9)	52 (1.7)
Increasing students' interest in mathematics*	50 (1.7)	41 (1.9)
Learning about real-life applications of mathematics*	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*	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)*	54 (2.3)	61 (2.1)
Learning mathematical procedures and/or algorithms	49 (2.2)	53 (2.6)
Increasing students' interest in mathematics	37 (1.9)	34 (2.0)
Learning about real-life applications of mathematics	42 (1.9)	37 (1.9)
Learning to perform computations with speed and accuracy	24 (1.8)	20 (1.6)
Learning test-taking skills/strategies*	36 (2.5)	23 (1.5)
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)*	55 (1.3)	63 (1.6)
Learning mathematical procedures and/or algorithms*	48 (1.5)	55 (1.8)
Increasing students' interest in mathematics	27 (1.4)	26 (1.3)
Learning about real-life applications of mathematics	29 (1.3)	32 (1.4)
Learning to perform computations with speed and accuracy*	18 (1.2)	21 (1.3)
Learning test-taking skills/strategies*	28 (1.3)	25 (1.3)

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

[a] In 2012, this item read "Learning mathematical practices (e.g., considering how to approach a problem, justifying solutions)."

A sub-set of these items were combined into a composite variable titled, "Reform-Oriented Instructional Objectives." The items are:

- Understanding mathematical ideas;
- Learning how to do mathematics;
- Learning about real-life applications of mathematics; and
- Increasing students' interest in mathematics.

The mean scores for this composite are shown in Table 5.5. In 2018, mathematics classes were, on average, likely to emphasize reform-oriented instructional objectives at all grade levels. These data have not changed since 2012.

Table 5.5
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite,[a] by Grade Range[†]

	MEAN SCORE	
	2012	**2018**
Elementary	82 (0.5)	81 (0.6)
Middle	81 (0.6)	81 (0.6)
High	78 (0.4)	78 (0.5)

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

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

Class Activities

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

Depending on grade range, 59–73 percent of classes in 2018 included the teacher explaining mathematical ideas in all or almost all lessons (see Table 5.6). The majority of elementary mathematics classes engaged in whole class discussions in nearly every lesson, though this activity became less frequent with increasing grade level. Approximately half of elementary mathematics classes and a third of secondary classes had students work in small groups in all or almost all mathematics lessons.

Comparing 2012 to 2018, secondary mathematics classes were considerably less likely in 2018 to include the teacher explaining mathematical ideas to the whole class in all or almost all lessons. In contrast, classes regardless of grade range, were more likely in 2018 than in 2012 to have students work in small groups, perhaps suggesting a shift to emphasizing more peer learning.

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

	PERCENT OF CLASSES	
	2012	**2018**
Elementary		
Explain mathematical ideas to the whole class	77 (1.7)	73 (2.0)
Engage the whole class in discussions	76 (1.6)	71 (1.5)
Have students work in small groups*	34 (1.8)	51 (2.4)
Provide manipulatives for students to use in problem-solving/investigations	34 (1.9)	35 (2.0)
Focus on literacy skills (e.g., informational reading or writing strategies)	15 (1.4)	16 (1.5)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*	9 (1.2)	13 (1.2)
Have students read from a textbook or other material in class, either aloud or to themselves*	18 (1.5)	12 (1.1)
Have students practice for standardized tests	9 (1.1)	8 (0.8)
Middle		
Explain mathematical ideas to the whole class*	71 (1.8)	59 (2.2)
Engage the whole class in discussions	59 (1.9)	54 (2.0)
Have students work in small groups*	24 (1.6)	35 (2.1)
Provide manipulatives for students to use in problem-solving/investigations	4 (0.9)	6 (0.9)
Focus on literacy skills (e.g., informational reading or writing strategies)	5 (0.8)	4 (0.7)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	6 (0.9)	8 (1.1)
Have students read from a textbook or other material in class, either aloud or to themselves*	10 (1.3)	7 (1.2)
Have students practice for standardized tests	10 (1.5)	7 (1.0)
High		
Explain mathematical ideas to the whole class*	72 (1.4)	65 (1.7)
Engage the whole class in discussions	48 (1.3)	50 (1.7)
Have students work in small groups*	20 (1.3)	30 (1.7)
Provide manipulatives for students to use in problem-solving/investigations	3 (0.5)	4 (0.8)
Focus on literacy skills (e.g., informational reading or writing strategies)	4 (0.4)	4 (0.8)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	3 (0.4)	5 (0.9)
Have students read from a textbook or other material in class, either aloud or to themselves	8 (0.8)	6 (1.0)
Have students practice for standardized tests	9 (0.9)	8 (0.8)

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

In 2018, three instructional activities occurred at least once a week in a large majority of mathematics classes across grade ranges (see Table 5.7): (1) explaining mathematical ideas to the whole class, (2) engaging the whole class in discussions, and (3) having students work in small groups. Elementary classes were much more likely than secondary classes to: (1) provide manipulatives for students to use, (2) have students write their reflections, and (3) focus on literacy skills at least once a week.

Between 2012 and 2018 there were a number of shifts in class activities. For example, in 2018 there was an increase in the percentage of K–12 classes that had students write their reflections at least once a week and a decrease in the percentage of classes having students read from a textbook or other material. Further, elementary and middle grades classes were less likely to have students practice standardized tests at least once a week.

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

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

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

In addition to asking about class activities in the course as a whole, teachers were asked about activities that took place during their most recent mathematics lesson in the randomly selected class. As can be seen in Table 5.8, the teacher explaining mathematical ideas to the whole class was the most common activity across grade bands, occurring in about 9 in 10 classes in 2018.

Whole class discussions were also relatively common, though more so in elementary classes than in middle or high school classes (87, 78, and 70 percent of classes, respectively).

Comparing 2018 to 2012, these data also indicate that the teacher explaining mathematical ideas became slightly less common across K–12 classes. Also, there was a decrease in the percentages of elementary and middle grade classes having students do hands-on/manipulative activities, and secondary classes engaging students in whole class discussions and completing textbook/worksheet problems in the most recent lesson.

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

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

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

The survey also asked teachers to estimate the time spent on each of a number of types of activities in this most recent mathematics lesson. Across the grades, about 40 percent of class time was spent on whole class activities, 30 percent on small group work, and 20 percent on students working individually (see Table 5.9). Non-instructional activities, including attendance taking and interruptions, accounted for about 10 percent of mathematics class time. The distribution of percentage of time spent on each type of activity, at each grade range, changed between 2012 and 2018. This difference appears to be due to a shift from whole class activities to small group work, which is consistent with other findings about an increase in engaging students in small group settings.

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

	AVERAGE PERCENT OF CLASS TIME	
	2012	2018
Elementary*		
Whole class activities (e.g., lectures, explanations, discussions)	40 (0.6)	35 (0.7)
Small group work	29 (0.8)	33 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	26 (0.6)	24 (0.6)
Non-instructional activities (e.g., attendance taking, interruptions)	6 (0.3)	8 (0.3)
Middle*		
Whole class activities (e.g., lectures, explanations, discussions)	42 (0.8)	39 (0.8)
Small group work	24 (0.9)	28 (1.0)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	24 (0.7)	22 (0.7)
Non-instructional activities (e.g., attendance taking, interruptions)	10 (0.2)	11 (0.3)
High*		
Whole class activities (e.g., lectures, explanations, discussions)	48 (0.7)	42 (0.7)
Small group work	22 (0.8)	26 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	22 (0.6)	22 (0.7)
Non-instructional activities (e.g., attendance taking, interruptions)	9 (0.2)	10 (0.2)

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

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. In 2018, the amount of time students were asked to spend on mathematics homework increased with increasing grade range (see Table 5.10). For example, over half of high school mathematics classes were assigned one or more hours of homework per week, compared to under one-fifth of elementary classes. Relative to 2012, the distribution of time assigned to homework changed across the grade ranges, with a shift toward assigning less homework in 2018.

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

	PERCENT OF CLASSES	
	2012	2018
Elementary*		
Fewer than 15 minutes per week	16 (1.9)	26 (2.0)
16–30 minutes per week	19 (2.0)	25 (1.9)
31–60 minutes per week	35 (2.6)	31 (2.3)
61–90 minutes per week	17 (1.8)	11 (1.5)
91–120 minutes per week	9 (1.3)	6 (1.0)
More than 2 hours per week	4 (0.9)	1 (0.4)
Middle*		
Fewer than 15 minutes per week	5 (0.8)	12 (1.9)
16–30 minutes per week	13 (2.6)	16 (2.1)
31–60 minutes per week	28 (2.9)	34 (2.4)
61–90 minutes per week	29 (2.9)	21 (2.2)
91–120 minutes per week	14 (1.5)	13 (2.0)
More than 2 hours per week	10 (1.6)	4 (1.3)
High*		
Fewer than 15 minutes per week	7 (1.0)	8 (0.9)
16–30 minutes per week	8 (1.2)	12 (1.6)
31–60 minutes per week	22 (1.7)	29 (1.7)
61–90 minutes per week	27 (1.8)	26 (1.6)
91–120 minutes per week	13 (1.1)	14 (1.3)
More than 2 hours per week	23 (1.8)	12 (1.5)

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

The survey also asked how often students in the randomly selected class were required to take assessments the teachers did not develop, such as state or district benchmark assessments. Given states' high stakes accountability systems, is not surprising that the frequency of external testing in mathematics classes was high in both 2012 and 2018 (see Table 5.11). Roughly three quarters of elementary and middle school classes and a third of high school classes required testing three or more times a year. Between 2012 and 2018, the distribution of frequency of testing shifted at the elementary and high school levels, with more elementary classes being tested three or four times a year and more high school classes being tested twice a year.

Table 5.11
Frequency of Required External Testing in Mathematics Classes, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary*		
Never	9 (0.9)	9 (1.3)
Once a year	14 (1.3)	9 (1.3)
Twice a year	7 (0.9)	9 (1.4)
Three or four times a year	38 (1.7)	48 (2.8)
Five or more times a year	31 (1.7)	25 (2.2)
Middle		
Never	2 (0.4)	1 (0.4)
Once a year	19 (2.2)	12 (2.1)
Twice a year	10 (1.4)	11 (1.6)
Three or four times a year	38 (2.4)	43 (2.7)
Five or more times a year	31 (1.7)	33 (2.7)
High*		
Never	21 (1.3)	20 (1.6)
Once a year	28 (1.3)	25 (1.9)
Twice a year	15 (1.0)	22 (1.8)
Three or four times a year	22 (1.2)	24 (1.7)
Five or more times a year	14 (1.1)	10 (1.3)

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

Summary

In both 2012 and 2018, mathematics teachers tended to feel more control over decisions related to pedagogy than those related to curriculum. However, between these years, the percentage of elementary and middle school teachers who felt control over curriculum-related decisions grew substantially. For example, in 2018, elementary grades teachers were more likely to feel some control over selecting curriculum materials. Teachers' perceived control over pedagogy-related decisions, which was already quite high in 2012, did not change, with the exception of a very small increase among elementary grades teachers.

In terms of instructional objectives, in 2018, increasing students' understanding of mathematical ideas was the most frequently emphasized across the grade ranges. Compared to 2012, K–12 classes were more likely to emphasize learning how to do mathematics and less likely to emphasize learning test taking skills/strategies.

There were several shifts in the prevalence of class activities between 2012 and 2018, although engaging the whole class in discussion and explaining ideas to the whole class remained at or near the top of those most commonly used. At the secondary level, there was a shift away from explaining ideas to the whole class and toward having students work in small groups. Across grade levels there was a decrease in having students read from a mathematics textbook or other material and an increase in students writing reflections on their learning. Further, elementary and middle grades classes were less likely to have students practice standardized tests. Finally, relative to 2012, there appeared to be a shift toward assigning less homework across K–12 mathematics classes and a change in the distribution of frequency of external testing in elementary and high school classes.

Instructional Resources

Overview

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

Use of Textbooks and Other Instructional Resources

Teachers were asked whether the most recent unit in their randomly selected class was based primarily on a commercially published textbook or materials developed by the state or district. As shown in Table 6.1, a majority of mathematics classes, regardless of grade range, were based on such materials in 2018, and among elementary and middle school classes, there was a substantial increase between 2012 and 2018.

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

	PERCENT OF CLASSES	
	2012	2018
Elementary*	73 (2.0)	81 (1.5)
Middle*	64 (1.9)	70 (2.3)
High	73 (1.3)	73 (1.8)

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

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

When teachers responded that their most recent unit was based on one of these materials, they were asked how they used the material (see Table 6.2). Two important findings emerge from these data. First, when classes used commercially published and state/district-developed materials, the materials heavily influenced mathematics instruction at all grade ranges. Teachers in more than 80 percent of these classes across grade-level categories used the textbook substantially to guide the overall structure and content emphasis of their units, which was an increase from 2012. Second, it is clear that teachers modified their materials substantially when designing instruction. In roughly half or more of classes in 2018, teachers incorporated activities from other sources substantially and “picked and skipped” parts of the material. Among elementary and high school classes, incorporating activities from other sources was more common in 2018 than in 2012.

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

	PERCENT OF CLASSES[b]	
	2012	2018
Elementary		
I used these materials to guide the structure and content emphasis of the unit.*	81 (1.6)	87 (1.6)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.*	62 (2.1)	69 (1.9)
I picked what is important from these materials and skipped the rest.	43 (2.0)	49 (2.5)
Middle		
I used these materials to guide the structure and content emphasis of the unit.*	71 (2.2)	82 (1.9)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	68 (2.6)	65 (3.1)
I picked what is important from these materials and skipped the rest.	51 (2.5)	52 (2.8)
High		
I used these materials to guide the structure and content emphasis of the unit.*	74 (1.5)	81 (1.5)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.*	56 (1.9)	64 (2.0)
I picked what is important from these materials and skipped the rest.	52 (1.6)	52 (1.9)

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

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

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

Teachers in roughly half of mathematics classes using this type of material skipped activities substantially. As can be seen in Table 6.3, across all grade ranges, some of the most frequently selected reasons for skipping parts of the materials were: (1) having another activity that works better than the one skipped, (2) the mathematical ideas addressed not being included in pacing guides or standards. There are no differences between the 2012 and 2018 data.

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

	PERCENT OF CLASSES[a]	
	2012	2018
Elementary		
I have different activities for those mathematical ideas that work better than the ones I skipped.	78 (2.5)	80 (2.2)
My students already knew the mathematical ideas or were able to learn them without the activities I skipped.	71 (2.9)	67 (2.9)
The mathematical ideas addressed in the activities I skipped are not included in my pacing guide/standards.	68 (2.9)	65 (2.8)
The activities I skipped were too difficult for my students.	31 (3.2)	38 (2.8)
I did not have the materials needed to implement the activities I skipped.	29 (2.9)	26 (2.3)
Middle		
I have different activities for those mathematical ideas that work better than the ones I skipped.	79 (2.9)	80 (2.5)
My students already knew the mathematical ideas or were able to learn them without the activities I skipped.	57 (3.9)	59 (3.5)
The mathematical ideas addressed in the activities I skipped are not included in my pacing guide/standards.	78 (3.2)	72 (3.1)
The activities I skipped were too difficult for my students.	41 (3.3)	44 (3.6)
I did not have the materials needed to implement the activities I skipped.	30 (4.4)	27 (3.0)
High		
I have different activities for those mathematical ideas that work better than the ones I skipped.	79 (2.0)	74 (2.2)
My students already knew the mathematical ideas or were able to learn them without the activities I skipped.	54 (2.8)	54 (2.5)
The mathematical ideas addressed in the activities I skipped are not included in my pacing guide/standards.	66 (2.9)	73 (2.1)
The activities I skipped were too difficult for my students.	55 (2.5)	55 (2.5)
I did not have the materials needed to implement the activities I skipped.	30 (2.7)	24 (2.2)

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

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

Given that teachers often skipped activities in their materials because they knew of better ones, it is perhaps not surprising that teachers in well more than half of K–12 mathematics classes using a textbook or state/district-developed material supplemented it. Of the reasons listed on the questionnaire, two stand out above the rest: (1) providing students with additional practice, and (2) differentiating instruction for students at different achievement levels (see Table 6.4). The influence of standardized testing was also prominent, with 56–72 percent of classes supplementing for test-preparation purposes. Finally, in roughly 40 percent of mathematics classes, teachers supplemented their materials because their pacing guide indicated that they should. Relatively to 2012, these data have remained stable.

Table 6.4
Reasons Why Mathematics Materials Were Supplemented, by Grade Range†

	PERCENT OF CLASSES[a]	
	2012	2018
Elementary		
Supplemental activities were needed to provide students with additional practice.	95 (1.5)	95 (1.0)
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	96 (1.0)	94 (1.3)
Supplemental activities were needed to prepare students for standardized tests.	65 (2.7)	60 (2.9)
My pacing guide indicated that I should use supplemental activities.	49 (3.1)	45 (3.0)
Middle		
Supplemental activities were needed to provide students with additional practice.	96 (1.1)	94 (1.3)
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	97 (1.0)	97 (1.0)
Supplemental activities were needed to prepare students for standardized tests.	72 (4.4)	72 (3.4)
My pacing guide indicated that I should use supplemental activities.	40 (4.2)	37 (3.7)
High		
Supplemental activities were needed to provide students with additional practice.	94 (1.3)	91 (1.6)
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	91 (1.7)	89 (1.9)
Supplemental activities were needed to prepare students for standardized tests.	55 (2.6)	56 (2.6)
My pacing guide indicated that I should use supplemental activities.	36 (2.1)	41 (2.6)

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

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

Facilities and Equipment

The 2018 NSSME+ asked mathematics program representatives how much money their schools spent during the most recently completed school year on three kinds of resources: equipment (excluding computers), consumable supplies (e.g., graph paper), and software specific to mathematics instruction. By dividing these amounts by school enrollment, per-pupil estimates were generated. Table 6.5 shows the median per-pupil spending in 2012, adjusted for inflation, and 2018. In 2018, the median per-pupil spending for was substantially higher in elementary schools than in middle and high schools. Compared to 2012, there were no changes in the inflation-adjusted numbers.

Table 6.5
Median Amount Schools Spent Per Pupil on
Mathematics Equipment, Consumable Supplies, and Software, by Grade Range†

	MEDIAN AMOUNT		
	2012	2012 (ADJ.)[a]	2018
Elementary			
Consumable supplies	$1.08 (0.2)	$1.18 (0.2)	$1.46 (0.2)
Non-consumable items	$0.95 (0.2)	$1.04 (0.2)	$0.92 (0.2)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.05 (0.4)[b]
Total	**$4.27 (0.7)**	**$4.68 (0.7)**	**$6.45 (1.1)**
Middle			
Consumable supplies	$0.64 (0.1)	$0.70 (0.2)	$0.97 (0.2)
Non-consumable items	$0.73 (0.1)	$0.80 (0.2)	$0.80 (0.1)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.00 ---[c]
Total	**$2.76 (0.4)**	**$3.02 (0.5)**	**$3.43 (0.5)**
High			
Consumable supplies	$0.61 (0.1)	$0.67 (0.1)	$0.56 (0.1)
Non-consumable items	$1.05 (0.2)	$1.14 (0.2)	$0.93 (0.2)
Software	$0.00 ---[c]	$0.00 ---[c]	$0.09 (0.2)[b]
Total	**$2.46 (0.4)**	**$2.69 (0.5)**	**$2.74 (0.4)**

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

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

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

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

Table 6.6 shows mathematics teachers' ratings of the adequacy of resources they had on hand. In 2018, teachers of high school classes were more likely than their elementary counterparts to rate the availability of instructional technology as adequate, but the pattern was reversed for manipulatives. Since 2012, ratings of the adequacy for most of the resources improved, including instructional technology, measurement tools, and consumables. In the high school classrooms, ratings for the adequacy of manipulatives also improved.

Table 6.6
Adequacy[a] of Resources for Mathematics Instruction, by Grade Range

	PERCENT OF CLASSES	
	2012	2018
Elementary		
Manipulatives (e.g., pattern blocks, algebra tiles)	82 (1.7)	87 (1.8)
Measurement tools (e.g., protractors, rulers)*	67 (1.9)	79 (1.7)
Instructional technology (e.g., calculators, computers, probes/sensors)*	50 (1.9)	67 (2.0)
Consumable supplies (e.g., graphing paper, batteries)*	57 (1.6)	65 (2.5)
Middle		
Manipulatives (e.g., pattern blocks, algebra tiles)	59 (2.1)	63 (2.8)
Measurement tools (e.g., protractors, rulers)*	72 (1.7)	82 (2.1)
Instructional technology (e.g., calculators, computers, probes/sensors)*	62 (1.8)	79 (2.3)
Consumable supplies (e.g., graphing paper, batteries)*	64 (1.9)	75 (2.4)
High		
Manipulatives (e.g., pattern blocks, algebra tiles)*	43 (1.6)	51 (2.3)
Measurement tools (e.g., protractors, rulers)*	70 (1.4)	80 (1.6)
Instructional technology (e.g., calculators, computers, probes/sensors)*	71 (1.4)	85 (1.6)
Consumable supplies (e.g., graphing paper, batteries)*	66 (1.6)	77 (1.6)

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

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

These items were combined into a composite variable named Adequacy of Resources for Instruction. As shown in Table 6.7, perceptions of the adequacy of resources were relatively high in 2018, regardless of grade range. Not surprising given the improved ratings on the individual items, the mean scores across grade levels increased between 2012 and 2018.

Table 6.7
Class Mean Scores for the Adequacy of Resources for Mathematics Instruction Composite, by Grade Range

	MEAN SCORE	
	2012	2018
Elementary*	70 (0.9)	80 (1.0)
Middle*	71 (1.0)	80 (1.0)
High*	70 (0.8)	78 (0.9)

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

Summary

In 2018, a majority of K–12 mathematics classes based their most recent unit on a published material (published commercially or by the state or school district). The percentage of elementary and middle grades classes doing so increased between 2012 and 2018; however, there was no change at the high school level.

The data regarding how mathematics teachers use their instructional materials have remained relatively stable since 2012. Modifying materials by supplementing them or skipping substantial parts was still prominent among teachers in 2018, although incorporating activities from other sources was more common among elementary and high school classes in 2018 than in 2012. When teachers supplemented their materials, it was frequently for the purpose of providing students with additional practice and differentiating instruction. When teachers skipped parts of the materials, a common reason was having another activity that they thought worked better than the one skipped. Another factor in skipping was the guidance included in pacing guides and standards to do so.

Although per pupil spending for mathematics did not change from 2012 (adjusted for inflation) to 2018, K–12 mathematics teachers' ratings of the adequacy of their resources improved. Increases in the perceived adequacy of instructional technology, measurement tools, and consumables were particularly large across grade ranges.

Factors Affecting Instruction

Overview

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

School Programs and Practices

Elementary school program representatives were asked about several instructional arrangements for students in elementary self-contained classrooms, such as whether they were pulled out for remediation or enrichment in mathematics and whether they received mathematics instruction from specialists instead of, or in addition to, their regular teacher. Table 7.1 shows the percentage of elementary schools indicating that each program or practice is in place. In 2018, students were pulled out for mathematics remediation in more than 60 percent of schools, and in just over one-third of schools, students were pulled out for mathematics enrichment. There were no changes in these data between 2012 and 2018.

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

	PERCENT OF SCHOOLS	
	2012	**2018**
Students in self-contained classes are pulled out for remedial instruction in mathematics.	58 (3.0)	62 (3.0)
Students in self-contained classes are pulled out for enrichment in mathematics.	31 (2.8)	36 (2.8)
Students in self-contained classes are pulled out from mathematics instruction for additional instruction in other content areas.	19 (2.6)	25 (2.5)
Students in self-contained classes receive instruction from a district/diocese/school mathematics specialist *in addition* to their regular teacher.[a]	26 (2.6)	23 (2.4)
Students in self-contained classes receive instruction from a district/diocese/school mathematics specialist *instead of* their regular teacher.[a]	10 (1.9)	8 (1.7)

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

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

High school program representatives were asked how many years of mathematics students are required to take in order to graduate. As can be seen in Table 7.2, the vast majority of high schools required at least three years of mathematics. For most schools, graduation requirements were just as demanding as state university entrance requirements.[7] However, when there was a difference, graduation requirements tended to be more rigorous; 32 percent of high schools required more

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

mathematics for graduation than state universities did for entrance. These data remained stable from 2012 to 2018.

Table 7.2
High School Mathematics Graduation vs. State University Entrance Requirements†

	PERCENT OF SCHOOLS	
	2012	2018
Graduation Requirement		
1 Year	0 ---[a]	0 (0.5)
2 Years	5 (1.0)	4 (1.2)
3 Years	50 (3.0)	44 (3.1)
4 Years	45 (3.0)	52 (3.2)
State University Entrance Requirement		
1 Year	0 ---[a]	0 ---[a]
2 Years	0 ---[a]	1 (0.5)
3 Years	72 (2.3)	76 (3.1)
4 Years	28 (2.3)	23 (3.1)
Difference		
2 Years Fewer Required for Graduation	1 (0.7)	0 (0.5)
1 Year Fewer Required for Graduation	15 (2.2)	8 (2.3)
No Difference	53 (2.5)	60 (3.1)
1 Year More Required for Graduation	30 (2.4)	32 (2.7)
2 Years More Required for Graduation	0 ---[a]	0 ---[a]
3 Years More Required for Graduation	0 ---[a]	0 ---[a]

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

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

Program representatives were asked to indicate which of several practices their school employs to enhance student interest and/or achievement in mathematics. Depending on grade range, 67–85 percent of schools offered after-school help in mathematics (e.g., tutoring) in 2018, and roughly half of schools across the grade ranges encouraged students to participate in mathematics summer programs or camps (see Table 7.3). The data have remained largely unchanged between 2012 and 2018 with two exceptions. Elementary and middle schools were more likely to offer after-school programs for enrichment in mathematics in 2018 than in 2012. Also, although it was not a prominent program or practice, there was an increase from 2012 to 2018 in the percentage of middle schools that coordinated meetings with adult mentors who work in mathematics fields (9 vs. 15 percent).

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

	PERCENT OF SCHOOLS	
	2012	2018
Elementary		
Offers after-school help in mathematics (e.g., tutoring)	67 (2.4)	67 (2.7)
Encourages students to participate in mathematics summer programs or camps (e.g., offered by community colleges, universities, museums or mathematics centers)	44 (2.7)	47 (2.9)
Holds family math nights	31 (2.6)	38 (2.8)
Has one or more teams participating in mathematics competitions (e.g., Math Counts)	24 (2.4)	27 (2.5)
Offers formal after-school programs for enrichment in mathematics*	18 (2.0)	27 (2.8)
Offers one or more mathematics clubs	15 (2.0)	20 (2.3)
Coordinates visits to business, industry, and/or research sites related to mathematics[a]	15 (2.3)	17 (2.2)
Participates in a local or regional mathematics fair	13 (2.2)	16 (2.4)
Coordinates meetings with adult mentors who work in mathematics fields[a]	10 (1.7)	14 (2.0)
Middle		
Offers after-school help in mathematics (e.g., tutoring)	80 (2.8)	79 (2.9)
Encourages students to participate in mathematics summer programs or camps (e.g., offered by community colleges, universities, museums or mathematics centers)	51 (2.8)	49 (2.9)
Holds family math nights	19 (2.3)	21 (2.6)
Has one or more teams participating in mathematics competitions (e.g., Math Counts)	35 (2.7)	37 (3.1)
Offers formal after-school programs for enrichment in mathematics*	24 (2.5)	35 (3.1)
Offers one or more mathematics clubs	23 (2.0)	29 (2.9)
Coordinates visits to business, industry, and/or research sites related to mathematics[a]	15 (2.2)	14 (2.4)
Participates in a local or regional mathematics fair	17 (2.6)	19 (2.6)
Coordinates meetings with adult mentors who work in mathematics fields*,[a]	9 (1.6)	15 (2.2)
High		
Offers after-school help in mathematics (e.g., tutoring)	92 (2.7)	85 (2.9)
Encourages students to participate in mathematics summer programs or camps (e.g., offered by community colleges, universities, museums or mathematics centers)	55 (3.6)	51 (3.1)
Holds family math nights	10 (2.8)	6 (1.2)
Has one or more teams participating in mathematics competitions (e.g., Math Counts)	43 (3.6)	43 (3.0)
Offers formal after-school programs for enrichment in mathematics	21 (2.9)	18 (1.8)
Offers one or more mathematics clubs	32 (2.7)	36 (2.6)
Coordinates visits to business, industry, and/or research sites related to mathematics[a]	17 (2.8)	19 (2.4)
Participates in a local or regional mathematics fair	21 (3.4)	19 (1.9)
Coordinates meetings with adult mentors who work in mathematics fields[a]	10 (1.5)	13 (2.0)

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

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

Extent of Influence of State Standards

School mathematics program representatives were given a series of statements about the influence of state standards in their school and district, and asked about the extent to which they agreed with each. As can be seen in Table 7.4, it is clear that state standards had a major influence at the school level. For example, in both 2012 and 2018, about 90 percent of program representatives agreed that teachers in the school teach to the state mathematics standards. Similarly, a large majority of representatives agreed that there was a school-wide effort to align instruction to mathematics standards and that standards had been thoroughly discussed by teachers in the school. The only change in these data from 2012 to 2018 is a decrease in the percentage of high schools that organized mathematics professional development based on the standards (66 vs. 53 percent).

Table 7.4
Influence[a] of State Mathematics Standards in Schools, by Grade Range

	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)
State mathematics standards have been thoroughly discussed by mathematics teachers in this school.	85 (2.4)	87 (2.4)
The school/district/diocese organizes mathematics professional development based on state standards.[b]	70 (3.1)	73 (2.6)
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)
State mathematics standards have been thoroughly discussed by mathematics teachers in this school.	86 (2.7)	87 (2.7)
The school/district/diocese organizes mathematics professional development based on state standards.	66 (3.4)	67 (3.2)
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)
State mathematics standards have been thoroughly discussed by mathematics teachers in this school.	83 (2.7)	83 (2.9)
The school/district/diocese organizes mathematics professional development based on state standards.*	66 (2.9)	53 (3.2)

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

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

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

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

Table 7.5
School Mean Scores for the Focus on State Mathematics Standards Composite, by Grade Range[†]

	MEAN SCORE	
	2012	2018
Elementary	80 (1.3)	81 (1.2)
Middle	79 (1.6)	81 (1.5)
High	77 (1.7)	75 (1.6)

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

Factors That Promote and Inhibit Effective Instruction

Program representatives were also given a list of factors and asked to indicate their influence on mathematics instruction. Because there is little variation by grade range, the results are presented for schools overall (see Table 7.6). In 2018, about three-quarters of schools indicated that the importance it places on mathematics promotes effective mathematics instruction, whereas only about half of schools viewed the amount of time provided for professional development as promoting effective mathematics instruction. These data remained consistent between 2012 and 2018.

Table 7.6
Extent to Which Various Factors Promote[a] Effective Mathematics Instruction†

	PERCENT OF SCHOOLS	
	2012	2018
The importance that the school places on mathematics	82 (1.8)	78 (1.7)
The school/district/diocese mathematics professional development policies and practices[b]	65 (2.1)	66 (2.3)
The amount of time provided by the school/district/diocese for teacher professional development in mathematics[c]	56 (2.0)	52 (2.4)

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

a Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

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

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

These items were combined into a composite variable in order to look at the effects of the factors on mathematics instruction more holistically. As can be seen in Table 7.7, although there were no significant changes on the individual items, there was a decrease at each grade ranges from 2012 to 2018, suggesting the context became less supportive.

Table 7.7
School Mean Scores for the Supportive Context for Mathematics Instruction Composite,[a] by Grade Range

	MEAN SCORE	
	2012	2018
Elementary*	77 (1.5)	72 (1.4)
Middle*	77 (1.4)	71 (1.4)
High*	76 (1.6)	66 (1.4)

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

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

Program representatives were also asked to rate whether each of several factors was a problem for instruction in their school (see Table 7.8–7.10). Depending on grade range, low student interest in mathematics was perceived as a problem by 56–82 percent of the schools, lack of parent/guardian support and involvement by 60–67 percent, and inadequate materials for differentiating mathematics instruction by 50–54 percent. Changes in the data between 2012 and 2018 were minimal. At each grade range, inadequate funds for purchasing equipment and supplies and lack of mathematics textbooks were less likely in 2018 than in 2012 to be seen as a problem. Large class sizes at the elementary level was also viewed as being less problematic for instruction.

Table 7.8

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

	PERCENT OF SCHOOLS	
	2012	2018
Lack of parent/guardian support and involvement[b]	53 (2.8)	60 (3.0)
Low student interest in mathematics	57 (2.5)	56 (3.5)
Inadequate materials for differentiating mathematics instruction[c]	49 (3.1)	54 (3.0)
Inadequate mathematics-related professional development opportunities	61 (3.3)	52 (3.0)
Inappropriate student behavior	42 (2.6)	46 (2.8)
High student absenteeism	38 (2.8)	44 (2.9)
Inadequate teacher preparation to teach mathematics	32 (2.6)	39 (3.2)
Insufficient instructional time to teach mathematics[d]	44 (3.1)	36 (3.0)
Inadequate funds for purchasing mathematics equipment and supplies*	55 (2.9)	35 (2.4)
Large class sizes*	45 (2.8)	35 (3.3)
Lack of teacher interest in mathematics	21 (2.4)	25 (2.8)
Lack of mathematics textbooks*[,e]	34 (3.4)	17 (2.3)

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

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

b In 2012, the item read "Lack of parental support for mathematics education."

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

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

e In 2012, the item read "Inadequate supply of mathematics textbooks/programs."

Table 7.9

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

	PERCENT OF SCHOOLS	
	2012	2018
Low student interest in mathematics	68 (2.9)	67 (3.9)
Lack of parent/guardian support and involvement[b]	60 (3.1)	63 (3.7)
Inadequate materials for differentiating mathematics instruction[c]	55 (3.3)	53 (3.0)
Inadequate mathematics-related professional development opportunities*	62 (3.9)	51 (3.5)
High student absenteeism	48 (3.3)	51 (3.4)
Inappropriate student behavior	48 (2.9)	51 (3.1)
Inadequate funds for purchasing mathematics equipment and supplies*	60 (3.4)	43 (3.5)
Large class sizes	43 (2.9)	38 (2.9)
Insufficient instructional time to teach mathematics*,[d]	45 (3.6)	36 (3.0)
Inadequate teacher preparation to teach mathematics	26 (2.9)	29 (3.2)
Lack of mathematics textbooks*,[e]	43 (3.6)	19 (2.7)
Lack of teacher interest in mathematics	18 (2.6)	19 (2.7)

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

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

[b] In 2012, the item read "Lack of parental support for mathematics education."

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

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

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

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

	PERCENT OF SCHOOLS	
	2012	2018
Low student interest in mathematics	78 (3.6)	82 (2.2)
Lack of parent/guardian support and involvement[b]	64 (3.4)	67 (2.8)
High student absenteeism	56 (3.0)	59 (3.0)
Inadequate mathematics-related professional development opportunities	57 (3.9)	53 (3.1)
Inadequate materials for differentiating mathematics instruction[c]	51 (3.5)	50 (2.8)
Inappropriate student behavior	45 (3.2)	46 (2.9)
Inadequate funds for purchasing mathematics equipment and supplies*	58 (3.5)	45 (3.2)
Insufficient instructional time to teach mathematics[d]	46 (3.7)	44 (3.3)
Large class sizes	40 (3.7)	41 (3.2)
Lack of mathematics textbooks*,[e]	42 (4.2)	29 (3.0)
Inadequate teacher preparation to teach mathematics	19 (2.0)	19 (2.6)
Lack of teacher interest in mathematics	10 (1.5)	15 (2.4)

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

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

b In 2012, the item read "Lack of parental support for mathematics education."

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

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

Composite variables created from these items allow for a summary of the factors affecting mathematics instruction. Compared to 2012, resource-related issues were less problematic at each school level (see Table 7.11). There were no changes between 2012 and 2018 in student-related issues.

Table 7.11
School Mean Scores for Factors Affecting Mathematics Instruction Composites, by Grade Range

	MEAN SCORE	
	2012	2018
Extent to Which a Lack of Resources is Problematic[a]		
Elementary*	29 (1.8)	21 (1.1)
Middle*	34 (2.0)	23 (1.4)
High*	32 (2.3)	25 (1.5)
Extent to Which Student Issues Are Problematic[a]		
Elementary	30 (1.5)	32 (1.7)
Middle	37 (1.6)	38 (1.9)
High	39 (1.8)	42 (1.7)

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

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

Teachers were asked about factors that affect instruction in their randomly selected class. Table 7.12 displays the results for elementary mathematics. In 2018, students' motivation, interest, and effort in mathematics, amount of planning time, principal support, and current state standards were seen as factors promoting mathematics instruction in 70 percent or more elementary classes. Compared to 2012, teachers of elementary classes were less likely to view students' motivation, interest, and effort in mathematics, teacher evaluation policies, district testing/accountability policies, and textbook/module section policies as promoting mathematics instruction.

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

	PERCENT OF CLASSES	
	2012	**2018**
Current state standards	76 (2.5)	79 (1.9)
Principal support	82 (1.8)	78 (2.0)
Students' motivation, interest, and effort in mathematics*	78 (2.2)	71 (2.2)
Amount of time for you to plan, individually and with colleagues	66 (2.3)	71 (2.3)
Pacing guides	69 (2.3)	65 (2.0)
Amount of time available for your professional development	63 (2.3)	59 (2.3)
Parent/guardian expectations and involvement	59 (2.8)	53 (2.1)
Teacher evaluation policies*	59 (2.5)	49 (2.6)
State/district/diocese testing/accountability policies*[,b]	52 (2.6)	44 (2.2)
Textbook selection policies*[,c]	58 (2.6)	42 (2.3)

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

a Includes elementary mathematics teachers indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

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

c In 2012, the item read "textbook/program selection policies."

e In 2012, the item read "Inadequate supply of mathematics textbooks/programs."

A similar pattern is seen at the middle school, where principal support, amount of time for planning, and current state standards were all viewed as the top factors for promoting instruction in middle school mathematics classes (see Table 7.13). Also, relative to 2012, teachers of middle grades classes were less likely in 2018 to view teacher evaluation policies and textbook selection policies as promoting effective instruction.

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

	PERCENT OF CLASSES	
	2012	2018
Principal support	80 (2.3)	74 (2.2)
Amount of time for you to plan, individually and with colleagues	67 (3.0)	73 (2.2)
Current state standards	71 (3.0)	69 (2.9)
Pacing guides	58 (3.1)	60 (2.9)
Students' motivation, interest, and effort in mathematics	60 (3.2)	55 (2.6)
Amount of time available for your professional development	57 (2.7)	54 (2.9)
Parent/guardian expectations and involvement	46 (2.9)	45 (2.2)
Teacher evaluation policies*	56 (2.6)	43 (2.6)
State/district/diocese testing/accountability policies[b]	44 (3.0)	40 (3.0)
Textbook selection policies*[,c]	44 (3.1)	33 (2.7)

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

[a] Includes middle school mathematics teachers indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

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

[c] In 2012, the item read "textbook/program selection policies."

Table 7.14 displays the data for high school mathematics classes. Again, principal support, the amount of time for teachers to plan individually and with colleagues, as well as current state standards were seen as promoting mathematics in 62–70 percent of high school mathematics classes. Between 2012 and 2018, several factors became less likely to be seen as promoting instruction, including college entrance requirements (66 vs. 60 percent), teacher evaluation policies (55 vs. 47 percent), textbook selection policies (53 vs. 43 percent), and parent/guardian expectations and involvement (46 vs. 40 percent).

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

	PERCENT OF CLASSES	
	2012	2018
Principal support	75 (1.9)	70 (2.0)
Amount of time for you to plan, individually and with colleagues*	61 (2.2)	69 (1.6)
Current state standards	59 (1.8)	62 (1.6)
College entrance requirements*	66 (2.1)	60 (2.3)
Pacing guides	63 (2.2)	59 (2.0)
Amount of time available for your professional development	56 (1.9)	55 (2.0)
Students' motivation, interest, and effort in mathematics	55 (2.3)	52 (1.8)
Teacher evaluation policies*	55 (2.0)	47 (2.3)
Textbook selection policies*,[b]	53 (2.0)	43 (2.2)
Parent/guardian expectations and involvement*	46 (2.1)	40 (1.9)
State/district/diocese testing/accountability policies[c]	40 (1.9)	39 (1.9)

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

[a] Includes high school mathematics teachers indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

[b] In 2012, the item read "textbook/program selection policies."

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

Composites from these teacher questionnaire items were created to summarize the extent to which various factors support effective mathematics instruction. The means for each composite are shown in Table 7.15. A few patterns are apparent in the results. In 2018, the extent to which school support promoted effective instruction in mathematics varied little across grade levels, whereas the extent to which the policy environment promoted effective instruction was higher at the elementary level than secondary level. Among elementary classes, the mean scores for the policy environment composite were lower in 2018 than in 2012 (68 and 72 mean score, respectively). No other changes are evident.

Table 7.15
Class Mean Scores for Factors Affecting Mathematics Instruction Composites, by Grade Range

	MEAN SCORE	
	2012	2018
Extent to Which School Support Promotes Effective Instruction		
Elementary	71 (1.4)	72 (1.4)
Middle	69 (1.7)	71 (1.4)
High	67 (1.1)	69 (1.0)
Extent to Which the Policy Environment Promotes Effective Instruction[a]		
Elementary*	72 (1.2)	68 (1.0)
Middle	65 (1.4)	63 (1.2)
High	66 (0.8)	64 (0.9)

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

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

Summary

In 2018, mathematics instruction at the elementary grades typically included the use of special instructional arrangements. In fact, students being pulled out for remediation in mathematics was a prevalent practice in more than 60 percent of elementary schools, and pull-out instruction for mathematics enrichment occurred in a little more than a third of schools. These findings were consistent with 2012 data.

In terms of programs to enhance students' interest or achievement in mathematics, a majority of schools across the grade ranges offered after-school help in mathematics (e.g., tutoring) and roughly half of schools encouraged students to participate in mathematics summer programs or camps. These data have remained largely unchanged since 2012; however, elementary and middle school were more likely to offer after-school programs for enrichment in mathematics in 2018.

Although a majority of schools indicated that the importance it places on mathematics promotes effective mathematics instruction, the overall context for mathematics instruction appears to have become somewhat less supportive between 2012 and 2018. In terms of factors that affect effective mathematics instruction, program representative viewed resource-related issues as being less problematic at each school level in 2018 compared to 2012. In contrast, mathematics teachers were less likely to view the policy environment as promoting effective mathematics instruction. For example, relative to 2012, K–12 teachers were less likely to view teacher evaluation policies as promoting effective instruction in 2018.

Recomputed Composite Definitions

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

Definitions of Recomputed Teacher Composites

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

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

	2012 MTQ ITEM	2018 MTQ ITEM
I had opportunities to engage in mathematics investigations.	Q22a	Q21a
I had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction, e-portfolios).	Q22b	Q21c
I had opportunities to apply what I learned to my classroom and then come back and talk about it as part of the professional development.	Q22c	Q21e
I worked closely with other teachers from my school.	Q22d	Q21f
I worked closely with other teachers who taught the same grade and/or subject whether or not they were from my school.	Q22e	Q21g
Number of Items in Composite	**5**	**5**
Reliability – Cronbach's Coefficient Alpha	**0.77**	**0.67**
Confirmatory Factor Analysis Fit Index – SRMR	**0.06**	**0.06**

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

Table A-2
Traditional Teaching Beliefs

	2012 MTQ ITEM†	2018 MTQ ITEM
Students learn mathematics best in classes with students of similar abilities	Q29a	Q26a
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used	Q29e	Q26c
Teachers should explain an idea to students before having them investigate the idea	Q29f	Q26d
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	Q29i	Q26f
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.47**	**0.60**
Confirmatory Factor Analysis Fit Index – SRMR	**0.01**	**0.05**

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

Table A-3
Curriculum Control

	2012 MTQ ITEM	2018 MTQ ITEM
Determining course goals and objectives	Q32a	Q32a
Selecting curriculum materials (for example: textbooks/modules)	Q32b	Q32b
Selecting content, topics, and skills to be taught	Q32c	Q32c
Number of Items in Composite	**3**	**3**
Reliability – Cronbach's Coefficient Alpha	**0.84**	**0.82**
Confirmatory Factor Analysis Fit Index – SRMR	**0.04**	**0.04**

Table A-4
Reform-Oriented Instructional Objectives

	2012 MTQ ITEM	2018 MTQ ITEM
Understanding mathematical idea	Q36c	Q33d
Learning how to do mathematics	Q36d	Q33e
Learning about real-life applications of mathematics	Q36e	Q33f
Increasing students' interest in mathematics	Q36f	Q33g
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.70**	**0.69**
Confirmatory Factor Analysis Fit Index – SRMR	**0.05**	**0.05**

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

	2012 MTQ ITEM	2018 MTQ ITEM
Current state standards	Q51a	Q46a
School/District/Diocese pacing guides	Q51c	Q46b
State/District/Diocese testing/accountability policies†	Q51d & e	Q46c
Textbook/module selection policies	Q51f	Q46d
Teacher evaluation policies	Q51g	Q46e
Number of Items in Composite	**5**	**5**
Reliability – Cronbach's Coefficient Alpha	**0.83**	**0.79**
Confirmatory Factor Analysis Fit Index – SRMR	**0.05**	**0.06**

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

Definitions of Recomputed Program Composites

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

Table A-6
Supportive Context for Mathematics Instruction

	2012 MPQ ITEM	2018 MPQ ITEM
School/district/Diocese mathematics professional development policies and practices†	Q20a	Q19a
Amount of time provided for teacher professional development in mathematics	Q20b	Q19b
Importance that the school places on mathematics	Q20c	Q19c
Other school and/or district and/or diocese initiatives	Q20e	Q19d
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.72**	**0.82**
Confirmatory Factor Analysis Fit Index – SRMR	**0.07**	**0.07**

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

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

	2012 MPQ ITEM	2018 MPQ ITEM
Inadequate funds for purchasing mathematics equipment and supplies	Q21a	Q20b
Lack of mathematics textbooks	Q21b	Q20c
Inadequate materials for differentiating mathematics instruction	Q21c	Q20e
Number of Items in Composite	**3**	**3**
Reliability – Cronbach's Coefficient Alpha	**0.75**	**0.68**
Confirmatory Factor Analysis Fit Index – SRMR	**0.05**	**0.05**

Table A-8
Extent to Which Student Issues Are Problematic

	2012 MPQ ITEM	2018 MPQ ITEM
Low student interest in mathematics	Q21d	Q20f
High student absenteeism	Q21m	Q20n
Inappropriate student behavior	Q21n	Q20o
Lack of parent/guardian support and involvement	Q21o	Q20p
Number of Items in Composite	**4**	**4**
Reliability – Cronbach's Coefficient Alpha	**0.82**	**0.84**
Confirmatory Factor Analysis Fit Index – SRMR	**0.05**	**0.05**