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2018 NSSME+: Status of High School Mathematics

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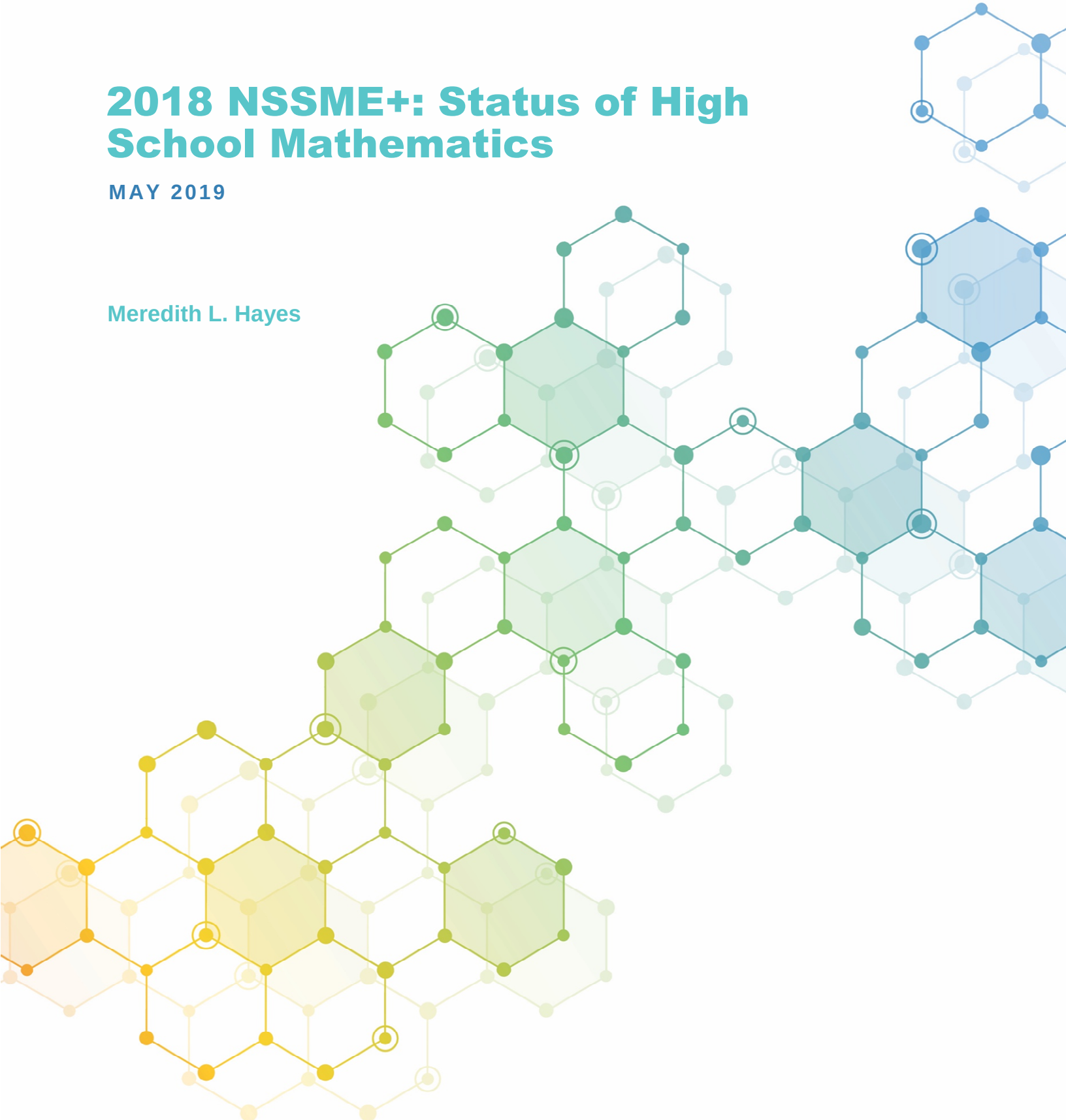

Disclaimer

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Additional Information

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

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

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

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

The 2018 NSSME+ is based on a national probability sample of schools and computer science, mathematics, and science teachers in grades K–12 in the 50 states and the District of Columbia. The sample was designed to yield national estimates of course offerings and enrollment, teacher background preparation, textbook usage, instructional techniques, and availability and use of facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being sampled. A total of 7,600 computer science, mathematics, and science teachers in 1,273 schools across the United States participated in this study, a response rate of 78 percent.

Selecting a random sample of mathematics teachers might result in a smaller than desired number of teachers of advanced mathematics courses. In order to ensure that the sample would include a sufficient number of advanced mathematics teachers for separate analysis, information on teaching assignments was used to create separate domains, and sampling rates were adjusted

by domain. This report describes the status of high school (grades 9–12) mathematics instruction based on the responses of 1,832 high school mathematics teachers.[1] For comparison purposes, many of the tables organize these data into three groups based upon the type of a randomly selected class: informal review, formal required, or formal advanced mathematics. Details on which courses are included each category are shown in Table 1.

Table 1
Definitions of Grade 9–12 Mathematics Course Types

COURSE LEVEL	COURSE TYPE	EXAMPLE COURSES
Informal Review	Non-college prep mathematics courses	Developmental Math; High School Arithmetic; Remedial Math; General Math; Vocational Math; Consumer Math; Basic Math; Business Math; Career Math; Practical Math; Essential Math; Pre-Algebra; Introductory Algebra; Algebra 1 Part 1; Algebra 1A; Math A; Basic Geometry; Informal Geometry; Practical Geometry
Formal Required	Formal/College prep mathematics level 1 courses	Algebra 1; Math 1; Integrated/Unified Math I; Algebra 1 Part 2; Algebra 1B; Math B
	Formal/College prep mathematics level 2 courses	Geometry; Plane Geometry; Solid Geometry; Math 2; Integrated/Unified Math II; Math C
Formal Advanced	Formal/College prep mathematics level 3 courses	Algebra 2; Intermediate Algebra; Algebra and Trigonometry; Advanced Algebra; Math 3; Integrated/Unified Math III
	Formal/College prep mathematics level 4 courses	Algebra 3; Trigonometry; Pre-Calculus; Analytic/Advanced Geometry; Elementary Functions; Integrated Math 4; Unified Math IV; Calculus (not including college level/AP); any other college prep senior math with Algebra 2/Math 3 as a prerequisite
	Mathematics courses that might qualify for college credit	Advanced Placement Calculus (AB, BC); Advanced Placement Statistics; IB Mathematics Standard Level; IB Mathematics Higher Level; concurrent college and high school credit/dual enrollment

Details on the survey sample design, data collection and analysis procedures, and creation of composite variables[2] are included in the *Report of the 2018 NSSME+*.[3] The standard errors for the estimates presented in this report are included in parentheses in the tables. The narrative sections of the report point out only those differences that are substantial as well as statistically significant at the 0.05 level.[4]

[1] A high school mathematics teacher is defined as someone whose randomly selected class was a grades 9–12 mathematics course.

[2] Factor analysis was used to create several composite variables related to key constructs measured on the questionnaires. Composite variables, which are more reliable than individual survey items, were computed to have a minimum possible value of 0 and a maximum possible value of 100.

[3] 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.

[4] The False Discovery Rate was used to control the Type I error rate when comparing multiple groups on the same outcome. Benjamini, Y. & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B, 57*(1), 289–300.

This status report of high school mathematics teaching is organized into major topical areas:

- Characteristics of the high school mathematics teaching force;
- Professional development of high school mathematics teachers;
- High school mathematics courses offered;
- High school mathematics instruction, in terms of both objectives and class activities;
- Resources available for high school mathematics instruction; and
- Factors affecting high school mathematics instruction.

High School Mathematics Teachers' Backgrounds and Beliefs

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

Teacher Characteristics

Overall, high school mathematics classes are more likely to be taught by female than male teachers and the overwhelming majority by white teachers (see Table 2). Although about half of all mathematics classes are taught by teachers with more than 10 years of teaching experience, informal review and formal required classes are more likely than formal advanced classes to be taught by teachers new to teaching mathematics (14 vs. 7 percent with two or fewer years of experience). This finding is of interest because of the association between inexperienced teachers and lower student performance.[5]

Recognizing that teaching is not always an individual's first career, the survey also included an item asking whether mathematics teachers had a full-time job in a mathematics-related field (e.g., accounting, engineering, computer programming) after completing their undergraduate degree and prior to teaching. About 1 in 5 high school mathematics classes are taught by teachers with full-time job experience in a mathematics-related field prior to teaching.

[5] Coenen, J., Cornelisz, I., Groot, W., Maassen van den Brink, H., & Van Klaveren, C. (2018). Teacher characteristics and their effects on student test scores: A systematic review. *Journal of Economic Surveys*, *32*(3), 848-877.

Nye, B., Konstantopoulus, S., & Hedges, L.V. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis*, *26*(3), 237–257.

Table 2
Characteristics of the High School Mathematics Teaching Force

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Sex				
Female	62 (1.5)	57 (5.0)	64 (2.5)	61 (2.0)
Male	38 (1.5)	43 (5.0)	36 (2.5)	39 (2.0)
Other	0 (0.1)	0 ---†	0 ---†	0 (0.2)
Hispanic or Latino				
Yes	8 (1.1)	13 (3.6)	7 (1.4)	7 (1.0)
No	92 (1.1)	87 (3.6)	93 (1.4)	93 (1.0)
Race				
White	92 (1.0)	90 (2.4)	92 (1.2)	92 (1.4)
Black or African American	4 (0.8)	5 (1.7)	4 (0.9)	5 (1.1)
Asian	5 (0.6)	5 (1.9)	5 (1.0)	4 (0.9)
American Indian or Alaska Native	2 (0.3)	2 (0.8)	2 (0.5)	2 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.3)	1 (0.8)	0 (0.2)	1 (0.5)
Age				
≤ 30	21 (1.6)	22 (5.4)	26 (2.5)	15 (2.0)
31–40	27 (1.2)	36 (5.0)	27 (2.3)	24 (1.6)
41–50	27 (1.4)	20 (3.8)	24 (2.1)	31 (2.0)
51–60	20 (1.2)	15 (3.5)	18 (1.8)	22 (2.0)
61 +	6 (0.8)	7 (2.0)	5 (1.5)	7 (1.1)
Experience Teaching Mathematics at the K–12 Level				
0–2 years	11 (1.1)	14 (3.0)	14 (1.9)	7 (1.3)
3–5 years	17 (1.3)	24 (5.9)	20 (2.4)	12 (1.6)
6–10 years	17 (1.3)	21 (3.8)	15 (2.0)	18 (1.9)
11–20 years	35 (1.6)	28 (4.4)	33 (2.7)	39 (2.0)
≥ 21 years	20 (1.2)	14 (2.8)	18 (2.0)	24 (1.9)
Full-Time Job in Mathematics Prior to Teaching				
Yes	19 (1.4)	24 (5.4)	20 (2.4)	18 (1.6)
No	81 (1.4)	76 (5.4)	80 (2.4)	82 (1.6)

† No teachers of informal review or formal required mathematics courses in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

The vast majority of high school mathematics classes are taught by teachers who have had formal preparation leading to a teaching credential, most as part of their undergraduate program (see Table 3). Twenty percent of classes are taught by teachers who received certification through a master's program, and 16 percent are taught by teachers who earned a teaching credential through a non-master's post-baccalaureate program. The data are similar across the three types of secondary mathematics courses.

Table 3
Paths to Teacher Certification Taken by Teachers of High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
An undergraduate program leading to a bachelor's degree and a teaching credential	57 (2.1)	60 (6.4)	57 (3.5)	57 (2.9)
A master's program that also led to a teaching credential	20 (1.7)	17 (3.6)	20 (2.9)	22 (2.5)
A post-baccalaureate credentialing program (no master's degree awarded)	16 (1.3)	17 (4.3)	19 (2.2)	14 (1.8)
Has not earned a teaching credential	6 (1.2)	7 (3.4)	4 (1.7)	7 (1.5)

Content Preparedness

As can be seen in Table 4, 80 percent of high school mathematics classes are taught by teachers with a college degree in mathematics or mathematics education. Teachers of formal advanced classes are more likely to have a mathematics-related degree than those teaching informal review or formal required classes.

Table 4
College Degrees Earned by Teachers of High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Mathematics	55 (1.6)	35 (4.6)	56 (2.5)	60 (2.2)
Mathematics Education	54 (1.9)	46 (6.3)	50 (3.0)	60 (2.7)
Mathematics or Mathematics Education	80 (1.4)	68 (6.0)	77 (2.3)	86 (1.6)

Ninety-four percent of high school mathematics classes are taught by teachers who have taken a calculus course and 89 percent by teachers with at least one course in statistics (see Table 5). However, formal required and formal advanced classes are more likely to be taught by teachers who have completed college coursework in advanced calculus, linear algebra, and abstract algebra.

Table 5
Various College Courses Completed by Teachers of High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Mathematics				
Calculus	94 (1.0)	83 (5.8)	93 (1.4)	98 (0.6)
Statistics	89 (1.1)	83 (4.9)	88 (1.9)	91 (1.0)
Advanced calculus	87 (1.1)	72 (5.8)	86 (1.7)	91 (1.2)
Linear algebra (e.g., vectors, matrices, eigenvalues)	85 (1.4)	71 (6.1)	84 (2.0)	90 (1.4)
Abstract algebra (e.g., groups, rings, ideals, fields)	74 (1.5)	63 (5.7)	72 (2.5)	78 (1.8)
Probability	74 (1.3)	69 (5.3)	72 (2.2)	78 (2.1)
Mathematics content for high school teachers	70 (1.7)	60 (5.9)	68 (2.8)	75 (1.7)
Differential equations	68 (1.5)	61 (5.6)	67 (2.5)	71 (2.0)
Analytic/Coordinate Geometry (e.g., transformations or isometries, conic sections)	66 (1.7)	58 (5.1)	65 (2.6)	70 (1.8)
Discrete mathematics (e.g., combinatorics, graph theory, game theory)	62 (1.5)	52 (5.1)	60 (2.4)	67 (2.3)
Axiomatic Geometry (Euclidean or non-Euclidean)	61 (1.9)	53 (5.9)	57 (2.5)	66 (2.5)
Number theory (e.g., divisibility theorems, properties of prime numbers)	60 (1.7)	51 (6.2)	59 (2.3)	63 (2.5)
Real analysis	50 (1.6)	40 (5.0)	47 (2.5)	56 (2.1)
Integrated mathematics	46 (1.7)	48 (5.6)	49 (2.8)	42 (2.2)
Other upper division mathematics	59 (1.9)	49 (5.7)	54 (3.0)	66 (2.3)
Other				
Computer Science	63 (1.7)	64 (5.8)	59 (2.7)	67 (2.3)
Engineering	17 (1.2)	21 (3.6)	13 (1.8)	20 (2.0)

The National Council of Teachers of Mathematics (NCTM) has recommended that high school mathematics teachers take college coursework in seven different areas, including algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics.[6] Approximately three-quarters of all high school mathematics classes are taught by teachers who meet or come close to meeting this recommendation, completing courses in at least five areas (see Table 6).

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

Table 6
Extent to Which Teachers of High School Mathematics Classes Have Completed Coursework Related to NCTM Preparation Standards

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Courses in algebra, calculus, discrete mathematics, geometry, number theory, probability, and statistics	36 (1.6)	31 (4.5)	34 (2.6)	39 (2.5)
Courses in 5–6 of the 7 areas	42 (1.6)	34 (4.3)	43 (3.0)	44 (2.8)
Courses in 3–4 of the 7 areas	15 (1.4)	21 (5.2)	15 (2.0)	14 (1.4)
Courses in 1–2 of the 7 areas	6 (0.7)	8 (2.0)	8 (1.3)	4 (0.7)
Courses in 0 of the 7 areas	1 (0.6)	6 (4.8)	1 (0.3)	0 (0.0)

The survey also asked mathematics teachers to rate how well prepared they feel to teach each of a number of fundamental topics in mathematics. In a large majority of high school mathematics classes, teachers feel very well prepared to teach about the number system and operations, algebraic thinking, and functions (see Table 7). Teachers in 60 percent of high school mathematics classes report being very well prepared to teach modeling, but relatively few classes are taught by teachers who feel very well prepared to teach statistics and probability or discrete mathematics (31 percent and 21 percent, respectively). Formal advanced courses are more likely than the other two course categories to be taught by teachers who feel very well prepared to teach functions and discrete mathematics. Despite the push to integrate coding/computer science into mathematics instruction, very few classes are taught by teachers who feel very well prepared to teach computer science.

Table 7
High School Mathematics Classes in Which Teachers Consider Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
The number system and operations	90 (0.9)	90 (2.6)	86 (1.8)	93 (1.0)
Algebraic thinking	90 (0.9)	87 (3.1)	87 (1.5)	93 (1.1)
Functions	85 (1.2)	76 (5.1)	81 (2.3)	92 (1.1)
Measurement	74 (1.5)	68 (4.1)	72 (2.1)	77 (2.4)
Geometry	65 (1.4)	64 (4.4)	67 (2.1)	65 (2.5)
Modeling	60 (1.7)	56 (5.4)	56 (2.7)	64 (2.3)
Statistics and probability	31 (1.3)	35 (6.2)	25 (2.9)	34 (2.0)
Discrete mathematics	21 (1.2)	14 (2.8)	17 (1.9)	26 (1.7)
Computer science/programming	5 (0.6)	5 (2.1)	4 (1.1)	5 (0.8)

Data from these items were combined into a composite variable called Perceptions of Preparedness to Teach Mathematics Content. As can be seen in Table 8, teachers of formal advanced courses feel more prepared to teach mathematics content than teachers of informal review and formal required, though the differences are relatively small.

Table 8
High School Mathematics Class Mean Scores for Teacher Perceptions of Content Preparedness Composite

	MEAN SCORE
All	82 (0.4)
Informal Review	81 (1.4)
Formal Required	80 (0.8)
Formal Advanced	84 (0.6)

Pedagogical Preparedness

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

As can be seen in Table 9, high school mathematics teachers in the majority of classes feel very well prepared to develop students' abilities to do mathematics, develop students' conceptual understanding of mathematical ideas, and use formative assessment to monitor student learning. For a somewhat smaller percentage of classes, mathematics teachers feel very well prepared to encourage participation of all students in mathematics and encourage students' interest in mathematics. Teachers in only about one-third of high school mathematics classes feel very well prepared to differentiate instruction, with teachers of informal review courses more likely to feel very well prepared to do so than teachers of formal courses. In addition, teachers of informal review courses are more likely than teachers of formal courses to feel very well prepared to incorporate students' cultural backgrounds into mathematics instruction, perhaps because these courses have a larger proportion of students from race/ethnicity groups historically underrepresented in mathematics.[7]

[7] Data about student characteristics in classes are provided in the "High School Mathematics Courses Offered" section of this report.

Table 9
High School Mathematics Classes in Which Teachers Consider Themselves Very Well Prepared for Each of a Number of Tasks

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	66 (1.7)	62 (5.4)	64 (2.6)	70 (2.1)
Develop students' conceptual understanding of the mathematical ideas you teach	62 (1.6)	58 (5.0)	60 (2.6)	64 (2.0)
Use formative assessment to monitor student learning	58 (1.5)	57 (5.1)	58 (2.3)	59 (2.3)
Encourage participation of all students in mathematics	45 (1.7)	48 (5.1)	43 (2.6)	46 (2.2)
Encourage students' interest in mathematics	37 (1.3)	41 (4.7)	31 (2.2)	40 (2.0)
Differentiate mathematics instruction to meet the needs of diverse learners	32 (1.7)	43 (5.5)	30 (2.7)	31 (2.2)
Provide mathematics instruction that is based on students' ideas	26 (1.5)	32 (5.2)	25 (2.5)	26 (2.0)
Incorporate students' cultural backgrounds into mathematics instruction	15 (1.2)	32 (5.6)	10 (1.4)	15 (1.7)
Develop students' awareness of STEM careers	15 (1.2)	24 (5.2)	14 (1.8)	14 (1.4)

In roughly two-thirds of high school mathematics classes, teachers feel very well prepared to assess student understanding at the end of a unit (see Table 10). For a somewhat smaller percentage of classes, teachers feel very well prepared to (1) anticipate difficulties that students may have with particular mathematical ideas and procedures in the unit (59 percent) and (2) find out what students thought or already knew about the key mathematical ideas (48 percent).

Table 10
High School Mathematics Classes in Which Teachers Feel Very Well Prepared for Each of a Number of Tasks in the Most Recent Unit in a Designated Class

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Assess student understanding at the conclusion of this unit	68 (1.4)	63 (5.2)	67 (2.5)	71 (1.9)
Implement the instructional materials to be used during this unit	61 (1.6)	60 (4.8)	57 (2.8)	65 (2.1)
Monitor student understanding during this unit	61 (1.6)	59 (5.3)	58 (2.7)	63 (2.0)
Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit	59 (1.5)	55 (5.5)	56 (2.4)	63 (2.0)
Find out what students thought or already knew about the key mathematical ideas	48 (1.4)	49 (5.7)	43 (2.6)	51 (2.2)

These two sets of items were combined into composite variables. As can be seen in Table 11, high school mathematics teachers feel more prepared to monitor and address student thinking in a particular unit than they do to use student-centered pedagogies more broadly.

Table 11
High School Mathematics Class Mean Scores for Teachers' Perceptions of General and Unit-Specific Pedagogical Preparedness Composites

	MEAN SCORE	
	PEDAGOGICAL PREPAREDNESS	PREPAREDNESS TO IMPLEMENT INSTRUCTION IN PARTICULAR UNIT
All	71 (0.6)	84 (0.5)
Informal Review	74 (1.9)	82 (2.1)
Formal Required	69 (0.9)	82 (0.9)
Formal Advanced	72 (0.7)	86 (0.6)

Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning in mathematics; results are reported in Table 12. Teachers of high school mathematics classes hold a number of views that align with what is known about effective mathematics instruction. For example, in nearly all mathematics classes, teachers agree that: (1) teachers should ask students to justify their mathematical thinking, (2) students should learn mathematics by doing mathematics, and (3) most class periods should provide opportunities for students to share their thinking and reasoning.

At the same time, many high school mathematics teachers also hold views that are consistent with traditional mathematics instruction. In over three-fourths of high school mathematics classes, teachers believe that students should be provided with definitions for new vocabulary at the beginning of instruction on a mathematical idea, a belief that is even more prevalent among teachers of informal review courses. Similarly, more than half of informal review courses are taught by teachers who agree that hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned. This belief is less commonly held among teachers of formal advanced courses.

Table 12
High School Mathematics Classes in Which Teachers Agree† With Various Statements About Teaching and Learning

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Reform-Oriented Beliefs				
Teachers should ask students to justify their mathematical thinking.	98 (0.5)	98 (1.3)	98 (0.6)	98 (0.9)
Students should learn mathematics by doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models).	96 (0.9)	95 (2.1)	96 (1.4)	96 (1.2)
Most class periods should provide opportunities for students to share their thinking and reasoning.	93 (0.9)	94 (1.9)	92 (1.7)	95 (1.1)
Students learn best when instruction is connected to their everyday lives.	85 (1.6)	93 (2.5)	85 (2.9)	82 (2.4)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	83 (1.5)	84 (3.9)	82 (2.2)	84 (1.9)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts.	80 (1.4)	85 (3.2)	82 (3.0)	77 (2.4)
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.	78 (1.9)	87 (2.9)	77 (3.2)	76 (2.4)
Students learn mathematics best in classes with students of similar abilities.	70 (1.7)	68 (4.6)	65 (3.6)	74 (2.0)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	43 (1.9)	56 (5.3)	45 (2.9)	38 (2.7)
Teachers should explain an idea to students before having them investigate the idea.	30 (2.1)	35 (6.4)	29 (3.1)	29 (2.3)

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

Data from these items were combined into two composite variables called Reform-Oriented Teaching Beliefs and Traditional Teaching Beliefs. As can be seen in Table 13, teachers of all course types have similar scores on the reform-oriented beliefs composite. However, informal review classes are slightly more likely than formal mathematics classes to be taught by teachers with traditional beliefs about teaching mathematics.

Table 13
Class Mean Scores for High School Mathematics Teachers' Beliefs About Teaching and Learning Composite

	MEAN SCORE	
	REFORM-ORIENTED BELIEFS	TRADITIONAL BELIEFS
All	80 (0.4)	60 (0.9)
Informal Review	81 (1.4)	66 (1.7)
Formal Required	80 (0.8)	59 (1.3)
Formal Advanced	78 (0.7)	60 (0.9)

Leadership Roles and Responsibilities

In addition to asking teachers about their education background, beliefs, and preparedness, the survey asked teachers whether they have served in various leadership roles in the profession in the last three years. As can be seen in Table 14, teachers in about half of high school mathematics classes have served on a school or district/diocese-wide mathematics committee or observed another teacher's mathematics lesson for the purpose of giving feedback. Teachers in only about 1 in 5 high school mathematics classes supervised a student teacher, and teachers of informal review classes are less likely than teachers of formal courses to have supervised a student teacher. In addition, teachers of informal review classes, compared to those teaching formal courses, are less likely to have served as a lead teacher or department chair in mathematics in the last three years. These discrepancies are not surprising, as teachers of informal review courses tend to be less experienced mathematics teachers.

Table 14
High School Mathematics Classes in Which Teachers Have Had Various Leadership Responsibilities Within the Last Three Years

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Served on a school or district/diocese-wide mathematics committee	51 (1.9)	48 (6.6)	47 (3.3)	56 (2.4)
Observed another teacher's mathematics lesson for the purpose of giving them feedback	51 (2.2)	52 (7.2)	47 (3.0)	53 (2.7)
Taught a mathematics lesson for other teachers in your school to observe	40 (2.3)	44 (8.2)	40 (3.0)	39 (2.8)
Served as a lead teacher or department chair in mathematics	30 (1.9)	18 (4.1)	27 (2.8)	35 (2.7)
Served as a formal mentor or coach for a mathematics teacher	27 (1.7)	24 (7.0)	25 (2.6)	30 (2.6)
Led or co-led a workshop or professional learning community for other teachers focused on mathematics or mathematics teaching	26 (1.7)	19 (3.8)	27 (2.8)	26 (2.2)
Supervised a student teacher in your classroom	20 (1.6)	13 (3.5)	21 (2.4)	21 (2.0)

Professional Development of High School Mathematics Teachers

Like all professionals, high school mathematics teachers 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 professional development, as well as characteristics of the professional development.

One important measure of teachers' continuing education is how long it has been since they participated in professional development. Teachers in 71 percent of high school mathematics classes have participated in professional development focused on mathematics content or the teaching of mathematics within the last 12 months, increasing to about 90 percent when extended to within the last three years (see Table 15).

Table 15
Most Recent Mathematics-Focused Professional Development Completed by Teachers of High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
In the last 12 months	71 (1.5)	70 (5.0)	74 (2.3)	68 (2.3)
1–3 years ago	20 (1.6)	21 (4.5)	16 (2.1)	23 (2.3)
4–6 years ago	4 (0.6)	4 (1.7)	4 (0.9)	4 (0.7)
7–10 years ago	1 (0.2)	1 (0.4)	1 (0.3)	1 (0.4)
More than 10 years ago	2 (0.6)	2 (1.1)	2 (1.0)	2 (0.7)
Never	3 (0.5)	3 (1.1)	3 (1.0)	2 (0.7)

However, teachers of high school mathematics classes report varying extents of participation in professional development specific to mathematics teaching. Only about 40 percent of all high school mathematics classes are taught by teachers who have completed more than 35 hours of mathematics-related professional development in the last three years (see Table 16). A similar proportion of classes are taught by teachers who have completed 15 or fewer hours in the last three years.

Table 16
Time Spent on Mathematics-Focused Professional Development in the Last Three Years by Teachers of High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
None	9 (1.0)	10 (2.3)	10 (1.7)	9 (1.4)
Less than 6 hours	7 (0.9)	7 (1.8)	8 (1.6)	5 (1.0)
6–15 hours	20 (1.6)	21 (5.6)	19 (2.0)	20 (1.9)
16–35 hours	22 (1.3)	26 (3.7)	22 (2.1)	21 (1.6)
36–80 hours	25 (1.5)	23 (4.6)	25 (2.4)	26 (2.5)
More than 80 hours	17 (1.3)	14 (3.0)	16 (2.1)	19 (1.6)

As to how this time is spent, teachers in about 90 percent of high school mathematics classes have attended at least one program or workshop in the previous three years (see Table 17). Teachers in almost two-thirds of high school mathematics classes have participated in a professional learning community or other type of teacher study group within the past three years. Teachers of formal classes are more likely than those teaching informal review classes to have attended a national, state, or regional mathematics teacher association meeting. Only about 1 in 5 high school mathematics classes are taught by teachers who have taken a formal course for college credit in the last three years.

Table 17
High School Mathematics Classes in Which Teachers Participated in Various Mathematics-Focused Professional Development Activities in the Last Three Years

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Attended a professional development program/workshop	91 (1.4)	95 (1.6)	92 (2.1)	89 (2.1)
Participated in a professional learning community/lesson study/teacher study group	63 (2.2)	67 (6.2)	67 (3.1)	58 (3.4)
Received assistance or feedback from a formally designated coach/mentor	42 (2.2)	45 (6.6)	45 (3.3)	38 (3.1)
Attended a national, state, or regional mathematics teacher association meeting	36 (2.5)	25 (4.6)	38 (3.6)	38 (3.3)
Completed an online course/webinar	32 (2.0)	30 (5.9)	33 (3.2)	32 (3.1)
Took a formal course for college credit	19 (1.9)	25 (5.1)	17 (1.9)	20 (2.8)

† Only classes taught by high school mathematics teachers indicating that they participated in mathematics-focused professional development in the last three years are included in these analyses.

It is widely agreed upon that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include providing opportunities for teachers to engage in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; examine student work and other classroom artifacts for evidence of what students do and do not understand; and apply what they have learned in their classrooms and subsequently discuss how it went.[8] Accordingly, teachers who had participated in professional development in the last three years were asked a series of additional questions about the nature of those experiences.

As can be seen in Table 18, in a majority of high school mathematics classrooms in which the teacher has participated in professional development, teachers have had substantial opportunity to work closely with other teachers from their school and with teachers at other schools teaching the same grade and subject. Relatively few mathematics classes are taught by teachers who have had opportunities to rehearse instructional practices as part of their professional development. Teachers of informal review courses, compared to teachers of formal required or formal advanced courses, are more likely to have had substantial opportunities during professional development in the last three years to:

- work closely with other teachers from their school;
- apply what they learned and then come back and talk about it as part of the professional development; and
- examine classroom artifacts.

[8] 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., & 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 18
High School Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent†

	PERCENT OF CLASSES‡			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Worked closely with other teachers from my school	66 (2.1)	78 (4.9)	70 (3.4)	58 (3.1)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from my school	56 (2.0)	64 (6.3)	61 (3.0)	50 (2.8)
Had opportunities to apply what I learned to my classroom and then come back and talk about it as part of the professional development	44 (2.0)	61 (5.8)	46 (3.4)	38 (2.8)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	43 (2.0)	54 (5.6)	47 (3.6)	37 (2.9)
Had opportunities to engage in mathematics investigations	43 (1.9)	45 (6.6)	42 (3.2)	42 (2.6)
Had opportunities to experience lessons, as my students would, from the textbook/units I use in my classroom	41 (2.3)	51 (6.3)	40 (3.6)	40 (2.9)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	30 (1.8)	40 (6.0)	32 (3.3)	25 (2.7)

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

‡ Only classes taught by high school mathematics teachers indicating that they participated in mathematics-focused professional development in the last three years are included in these analyses.

Another series of items asked about the focus of the professional development. Teachers of about half of high school mathematics classes have had professional development opportunities that gave heavy emphasis to: (1) monitoring student understanding during mathematics instruction, (2) differentiating instruction to meet the needs of diverse learners, and (3) deepening their own understanding of how mathematics is done (see Table 19). Teachers in relatively few high school mathematics classes have had professional development with a heavy emphasis on learning how to provide mathematics instruction that integrates engineering, science, and/or computer science. Teachers of informal review courses, compared to teachers of formal courses, are more likely to have participated in professional development in the last three years that gave heavy emphasis to:

- differentiating mathematics instruction to meet the needs of diverse learners;
- incorporating students' cultural backgrounds into mathematics instruction; and
- learning about difficulties that students may have with particular mathematical ideas and procedures.

These differences may be due to teachers of these courses recognizing that their students tend to be more diverse and likely to have had less success in previous mathematics courses. In addition, teachers of informal review courses are the most likely to have participated in professional development with a heavy emphasis on:

- deepening their own mathematics content knowledge;
- deepening their own understanding of how mathematics is done;
- implementing the mathematics textbook to be used; and
- monitoring student understanding during mathematics instruction.

Table 19
High School Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas

	PERCENT OF CLASSES‡			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Monitoring student understanding during mathematics instruction	52 (1.7)	65 (5.1)	53 (3.1)	47 (2.7)
Differentiating mathematics instruction to meet the needs of diverse learners	51 (2.0)	71 (4.9)	49 (3.0)	48 (2.9)
Deepening your understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	50 (2.2)	62 (6.2)	48 (3.5)	48 (2.8)
Learning about difficulties that students may have with particular mathematical ideas and procedures	46 (1.8)	61 (6.1)	47 (3.3)	41 (3.1)
Deepening your own mathematics content knowledge	39 (2.1)	53 (6.3)	37 (3.4)	38 (2.6)
Learning how to use hands-on activities/manipulatives for mathematics instruction	39 (2.0)	45 (5.7)	42 (3.5)	35 (2.7)
Finding out what students think or already know prior to instruction on a topic	36 (2.0)	48 (6.5)	39 (3.1)	31 (2.5)
Implementing the mathematics textbook to be used in your classroom	24 (1.7)	35 (5.8)	25 (2.9)	21 (2.1)
Incorporating students' cultural backgrounds into mathematics instruction	23 (1.9)	47 (6.6)	21 (2.6)	19 (2.5)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	21 (1.8)	19 (4.7)	25 (3.4)	18 (2.2)

† Includes high school mathematics teachers responding 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

‡ Only classes taught by high school mathematics teachers indicating that they participated in mathematics-focused professional development in the last three years are included in these analyses.

These items were combined into two composite variables called Extent Professional Development Aligns with Elements of Effective Professional Development and Extent Teachers' Professional Development Supports Student-Centered Instruction. The relatively low composite scores displayed in Table 20 indicate that overall teachers' experiences in the last three years are only somewhat aligned with elements of effective professional development and have not heavily emphasized student-centered instruction. However, teachers of formal advanced classes are less likely to experience professional development aligned with these elements than teachers of informal review and formal required classes. Similarly, teachers of formal courses, compared to those teaching informal review courses, are less likely to have attended professional development that supports student-centered instruction in the last three years.

Table 20
High School Mathematics Class Mean Scores for Professional Development Composites

	MEAN SCORE	
	EXTENT PROFESSIONAL DEVELOPMENT ALIGNS WITH ELEMENTS OF EFFECTIVE PROFESSIONAL DEVELOPMENT	EXTENT PROFESSIONAL DEVELOPMENT SUPPORTS STUDENT-CENTERED INSTRUCTION
All	57 (0.9)	54 (0.9)
Informal Review	62 (2.2)	62 (2.2)
Formal Required	58 (1.5)	54 (1.3)
Formal Advanced	54 (1.3)	52 (1.3)

High School Mathematics Courses Offered

The 2018 NSSME+ collected data on mathematics course offerings in the nation's high schools, including availability of different mathematics courses and the composition of classes (e.g., gender, race/ethnicity, and prior achievement levels of students). Of the high schools (schools including grades 9, 10, 11, or 12) in the United States, nearly all offer at least one formal/ college-prep mathematics course such as Algebra 1 (see Table 21). An overwhelming majority offer higher level formal/college courses (Levels 2, 3, and 4) as well. About 80 percent of high schools offer a non-college prep course, such as Remedial Math, and 72 percent offer courses that might quality for college credit.

Table 21
High Schools Offering Various Mathematics Courses

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

Almost all high schools (98 percent) offer single-discipline mathematics courses, with 80 percent offering only these types of courses (see Table 22). Almost 1 in 5 high schools also offer coordinated or integrated mathematics course; only 2 percent of high schools offer coordinated or integrated mathematics courses exclusively.

Table 22
Type of High School Mathematics Courses Offered

	PERCENT OF SCHOOLS
Single-subject mathematics courses only	80 (2.2)
Integrated mathematics courses only	2 (0.7)
Both	18 (2.1)

As can be seen in Table 23, just over half of high schools offer AP Calculus, typically AP Calculus AB. AP Calculus BC and AP Statistics are each offered by about one-third of high schools. The percentage of grades 9–12 students with access to each course is substantially greater than the percentage of schools offering it, indicating that AP mathematics course are more likely to be offered in larger schools. Very few high schools offer International Baccalaureate (IB) mathematics courses.

Table 23
Access to AP and IB Mathematics Courses, by Schools and Students

	PERCENT OF HIGH SCHOOLS OFFERING	PERCENT OF HIGH SCHOOL STUDENTS WITH ACCESS
AP Calculus	**53 (3.2)**	**82 (1.6)**
AP Calculus AB	53 (3.2)	81 (1.7)
AP Calculus BC	30 (2.4)	56 (2.5)
AP Statistics	**34 (2.8)**	**63 (2.4)**
IB Mathematics	**4 (0.8)**	**9 (1.7)**
IB Mathematical Studies Standard Level	3 (0.7)	8 (1.5)
IB Mathematics Standard Level	3 (0.6)	8 (1.5)
IB Mathematics Higher Level	3 (0.6)	7 (1.5)
IB Further Mathematics Standard Level	1 (0.2)	2 (0.7)

The typical high school mathematics class has approximately 21 students; two-thirds of the classes have between 13 and 28 students. On average, class sizes across course types differ by only a few students; informal review, formal required, and formal advanced classes have mean class sizes of 18, 22, and 20 students, respectively. Across all classes, 49 percent of mathematics students are female; a greater proportion of students in formal mathematics classes than informal review classes are female (see Table 24). Only about a third of students from race/ethnicity groups historically underrepresented[9] in mathematics take formal advanced mathematics courses.

Table 24
Demographics of Students in High School Mathematics Courses

	PERCENT OF STUDENTS	
	FEMALE	HISTORICALLY UNDERREPRESENTED
All	49 (0.9)	38 (1.5)
Informal Review	43 (1.8)	54 (4.3)
Formal Required	49 (1.3)	39 (2.2)
Formal Advanced	50 (1.1)	32 (1.5)

Ability grouping is a common practice in mathematics education (see Table 25). Not surprisingly, formal advanced classes are far more likely to be composed of students with high prior achievement, and informal review classes are more likely to be composed of mostly low prior achievers. Heterogeneous grouping of students is more common in formal required courses than informal review.

[9] Includes students identified as American Indian or Alaskan Native, Black or African American, Hispanic or Latino, or Native Hawaiian or Other Pacific Islander.

Table 25
Prior Achievement Grouping in High School Mathematics Courses

	PERCENT OF CLASSES			
	MOSTLY LOW ACHIEVERS	MOSTLY AVERAGE ACHIEVERS	MOSTLY HIGH ACHIEVERS	A MIXTURE OF LEVELS
All	22 (1.4)	27 (1.6)	27 (1.3)	24 (1.6)
Informal Review	57 (5.3)	19 (3.7)	7 (2.7)	17 (4.4)
Formal Required	26 (2.6)	31 (2.2)	17 (1.6)	27 (2.5)
Formal Advanced	9 (1.1)	27 (1.9)	41 (2.3)	23 (1.9)

High School Mathematics Instruction

This section of the report describes data about what transpires in mathematics classrooms. It includes data on teachers' perceptions of autonomy for making decisions about the content and pedagogy of their classes, instructional objectives, and class activities.

Teachers' Perceptions of Their Decision-Making Autonomy

Teachers were asked the extent to which they had control over a number of curriculum and instruction decisions for their classes. In high school mathematics classes, teachers are more likely to perceive themselves as having strong control over pedagogical decisions such as determining the amount of homework to be assigned, selecting teaching techniques, and choosing criteria for grading student performance (see Table 26). In fewer classes, teachers perceive themselves as having strong control in determining course goals and objectives, selecting curriculum materials, and selecting what content/skills to teach.

Table 26
High School Mathematics Classes in Which Teacher Report Having Strong Control Over Various Curricular and Instructional Decisions

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Determining the amount of homework to be assigned	75 (1.6)	76 (6.1)	73 (2.7)	77 (2.8)
Selecting teaching techniques	71 (1.5)	73 (5.9)	68 (2.7)	73 (2.8)
Choosing criteria for grading student performance	53 (2.0)	63 (6.4)	49 (3.1)	55 (3.0)
Determining the amount of instructional time to spend on each topic	49 (2.1)	57 (6.0)	42 (3.3)	53 (3.0)
Selecting the sequence in which topics are covered	45 (1.8)	54 (6.3)	37 (3.1)	51 (2.9)
Determining course goals and objectives	30 (1.6)	46 (6.0)	26 (2.5)	29 (2.5)
Selecting curriculum materials (e.g., textbooks)	27 (1.7)	41 (4.9)	22 (2.2)	29 (2.7)
Selecting content, topics, and skills to be taught	26 (1.5)	44 (6.0)	22 (2.9)	25 (2.4)

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

- Determining course goals and objectives;
- Selecting curriculum materials;
- Selecting content, topics, and skills to be taught; and
- Selecting the sequence in which topics are covered.

For Pedagogy Control, the items are:

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

Table 27 displays the mean scores on these composites. Overall, high school mathematics teachers perceive greater control over pedagogical decisions than curricular decisions. Comparing different types of classes, teachers of formal required classes perceive a lower level of curriculum control than teachers of both informal review and formal advanced classes. One possible explanation is that formal required courses, which are tied most closely to high-stakes accountability testing, typically call for teachers to follow a more prescribed curriculum than other course types.

Table 27
High School Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM CONTROL	PEDAGOGY CONTROL
All	60 (1.2)	87 (0.7)
Informal Review	69 (4.7)	87 (2.8)
Formal Required	55 (2.0)	86 (1.2)
Formal Advanced	62 (1.5)	87 (1.2)

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate each in terms of the emphasis they receive in the randomly selected class. As can be seen in Table 28, a majority of high school mathematics classes have a heavy emphasis on understanding mathematical ideas, learning how to do mathematics, and learning mathematical procedures and/or algorithms. Formal advanced courses have a greater emphasis than formal required or informal review courses on understanding mathematical ideas. Informal review classes have a greater emphasis than formal courses on learning about real-life applications of mathematics and increasing students' interest in mathematics. Interestingly, informal review courses are also the most likely to have a heavy emphasis on learning test-taking skills/strategies. Only about 1 in 5 high school mathematics classes give heavy emphasis to learning to perform computations with speed and accuracy.

Table 28
High School Mathematics Classes With Heavy Emphasis on Various Instructional Objectives

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Understanding mathematical ideas	69 (1.7)	59 (5.4)	67 (2.3)	74 (1.9)
Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	63 (1.7)	62 (4.9)	63 (2.7)	64 (2.3)
Learning mathematical procedures and/or algorithms	55 (1.9)	60 (4.8)	51 (2.8)	57 (2.4)
Developing students' confidence that they can successfully pursue careers in mathematics	36 (1.5)	38 (5.0)	33 (2.6)	39 (2.3)
Learning about real-life applications of mathematics	32 (1.4)	53 (5.2)	27 (2.6)	31 (1.8)
Learning mathematics vocabulary	29 (1.5)	37 (5.3)	32 (2.4)	24 (1.8)
Increasing students' interest in mathematics	26 (1.3)	39 (4.8)	20 (2.2)	27 (2.2)
Learning test-taking skills/strategies	24 (1.3)	37 (5.0)	21 (2.1)	24 (2.0)
Learning to perform computations with speed and accuracy	21 (1.3)	23 (4.2)	15 (1.8)	26 (2.0)

The following items were combined into a composite variable named Reform-Oriented Instructional Objectives:

- Understanding mathematical ideas;
- Learning how to do mathematics;
- Developing students' confidence that they can successfully pursue careers in mathematics;
- Learning about real-life applications of mathematics; and
- Increasing students' interest in mathematics.

As can be seen in Table 29, informal review classes are slightly more likely to emphasize reform-oriented objectives than formal required courses, though the difference is small.

Table 29
High School Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
All	77 (0.4)
Informal Review	79 (1.3)
Formal Required	75 (0.8)
Formal Advanced	78 (0.6)

Class Activities

The 2018 NSSME+ included several items that provide information about how mathematics is taught at the high school level. One series of items listed various instructional strategies and asked teachers to indicate the frequency with which they use each in a randomly selected class. As can be seen in Table 30, the vast majority of high school mathematics classes include the teacher explaining mathematical ideas and engaging students in whole class discussions at least once a week. About 7 in 10 classes have students working in small groups. Providing manipulatives for students to use and focusing on literacy skills are more common in informal

review classes than in formal classes. Very few classes of any course type use flipped instruction.

Table 30
High School Mathematics Classes in Which Teachers Report Using Various Activities at Least Once a Week

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Explain mathematical ideas to the whole class	95 (0.7)	90 (2.4)	96 (0.8)	95 (1.1)
Engage the whole class in discussions	84 (1.2)	85 (2.9)	85 (1.8)	83 (1.9)
Have students work in small groups	71 (1.7)	65 (5.3)	74 (2.4)	70 (2.3)
Have students practice for standardized tests	29 (1.6)	29 (4.2)	34 (2.5)	24 (1.8)
Provide manipulatives for students to use in problem-solving/investigations	20 (1.4)	31 (5.4)	22 (2.2)	15 (1.6)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	19 (1.4)	20 (4.0)	22 (2.5)	15 (1.7)
Focus on literacy skills (e.g., informational reading or writing strategies)	17 (1.2)	32 (5.6)	18 (2.0)	13 (1.5)
Have students read from a textbook or other material in class, either aloud or to themselves	16 (1.5)	19 (3.6)	16 (2.3)	15 (1.8)
Use flipped instruction (have students watch lectures/ demonstrations outside of class to prepare for in-class activities)	11 (1.2)	8 (2.4)	11 (2.0)	11 (1.4)

High school mathematics teachers were also asked how often they engage students in the practices described in the *Common Core State Standards for Mathematics* (CCSSM)[10] such as making sense of problems, constructing arguments, critiquing the reasoning of others, and modeling with mathematics. As can be seen in Table 31, a majority of high school mathematics classes engage students in each of the practices at least weekly. For example, in over 70 percent of classes across course types, students are asked to:

- determine whether their answer makes sense;
- continue working through a mathematics problem when they reach points of difficulty, challenge, or error;
- represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it; and
- identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem.

[10] National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common Core State Standards for mathematics*. Washington, DC: Author.

Table 31
High School Mathematics Classes in Which Teachers Report Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Determine whether their answer makes sense	84 (1.2)	84 (3.1)	85 (1.9)	84 (1.6)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	79 (1.3)	75 (4.9)	80 (2.1)	79 (2.0)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	76 (1.4)	73 (4.4)	76 (2.0)	76 (2.2)
Provide mathematical reasoning to explain, justify, or prove their thinking	76 (1.3)	68 (4.7)	79 (2.1)	76 (2.1)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	74 (1.3)	77 (3.2)	75 (1.9)	73 (2.2)
Identify relevant information and relationships that could be used to solve a mathematics problem	73 (1.7)	69 (5.0)	74 (2.1)	72 (2.7)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	71 (1.3)	60 (5.1)	73 (2.1)	73 (1.8)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements	67 (1.6)	63 (5.1)	68 (2.6)	68 (2.1)
Develop a mathematical model to solve a mathematics problem	64 (1.7)	61 (5.6)	67 (2.4)	62 (2.5)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	63 (1.5)	67 (5.1)	63 (2.5)	61 (2.3)
Figure out what a challenging problem is asking	63 (1.5)	62 (4.7)	62 (2.4)	64 (2.4)
Work on generating a rule or formula	61 (1.5)	62 (4.8)	63 (2.4)	58 (2.3)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed	61 (1.7)	61 (5.4)	59 (2.8)	63 (2.4)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	61 (1.8)	60 (4.9)	62 (2.4)	61 (2.5)
Determine what tools are appropriate for solving a mathematics problem	59 (1.7)	64 (5.2)	60 (2.7)	57 (2.4)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations	54 (1.7)	56 (5.0)	55 (2.5)	52 (2.3)
Analyze the mathematical reasoning of others	53 (1.3)	59 (5.3)	54 (2.7)	50 (1.8)

Table 32 shows the means for a composite variable created from these items. The scores are very similar across course types.

Table 32
High School Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite

	MEAN SCORE
All	71 (0.5)
Informal Review	70 (1.4)
Formal Required	71 (0.7)
Formal Advanced	71 (0.8)

The 2018 NSSME+ also asked teachers how frequently they incorporate coding into mathematics instruction. As can be seen in Table 33, the overwhelming majority of classes, regardless of course type, never include coding as part of their mathematics instruction.

Table 33
High School Mathematics Classes in Which Teachers Report Incorporating Coding Into Instruction

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Never	89 (1.0)	89 (3.0)	91 (1.7)	88 (1.6)
Rarely (e.g., a few times per year)	9 (1.0)	7 (2.6)	8 (1.5)	10 (1.5)
Sometimes (e.g., once or twice a month)	2 (0.4)	1 (0.9)	1 (0.4)	2 (0.6)
Often (e.g., once or twice a week)	1 (0.2)	1 (0.5)	1 (0.4)	0 (0.2)
All or almost all mathematics lessons	0 (0.1)	1 (1.0)	0 (0.0)	0 (0.1)

In addition to asking about class activities in the course as a whole, the 2018 NSSME+ asked teachers about activities that took place during their most recent mathematics lesson in the randomly selected class. The most recent lessons in over 90 percent of high school mathematics classes include the teacher explaining a mathematical idea to the whole class (see Table 34). Students completing textbook/worksheet problems, working in small groups, and whole class discussion are also very common, occurring in about three-quarters of lessons. Interestingly, both hands-on/manipulative activities and teacher demonstrations are more common in informal review classes than in formal required or formal advanced courses, though the use of manipulatives is relatively rare in high school mathematics overall.

Table 34
High School Mathematics Classes Participating in Various Activities in Most Recent Lesson

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Teacher explaining a mathematical idea to the whole class	91 (1.0)	89 (2.7)	92 (1.2)	90 (1.4)
Students completing textbook/worksheet problems	78 (1.4)	85 (3.1)	79 (2.2)	74 (1.7)
Students working in small groups	78 (1.2)	74 (4.6)	81 (1.8)	76 (1.8)
Whole class discussion	70 (1.4)	73 (4.4)	74 (2.2)	66 (1.9)
Teacher conducting a demonstration while students watched	64 (1.3)	76 (3.7)	68 (2.5)	59 (1.8)
Test or quiz	19 (1.2)	23 (4.7)	20 (1.9)	17 (2.0)
Students doing hands-on/manipulative activities	16 (1.6)	26 (5.9)	16 (2.0)	14 (1.5)
Practicing for standardized tests	15 (1.0)	20 (3.9)	16 (1.7)	13 (1.3)
Students reading about mathematics	14 (1.3)	15 (3.1)	15 (2.4)	14 (1.5)
Students writing about mathematics	14 (1.1)	15 (3.3)	14 (2.0)	13 (1.4)

The survey also asked teachers to estimate the time spent on each of a number of types of activities in the most recent mathematics lesson. Overall, 42 percent of class time is spent on whole class activities, 26 percent on small group work, and 22 percent on students working individually (see Table 35). Non-instructional activities, including attendance taking and interruptions, account for 10 percent of mathematics class time. On average, whole class activities are somewhat more prevalent in formal advanced mathematics classes, and students working individually is somewhat more prevalent in informal review mathematics classes.

Table 35
Average Percentage of Time Spent on Different Activities in the Most Recent High School Mathematics Lesson

	AVERAGE PERCENT OF CLASS TIME			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Whole class activities (e.g., lectures, explanations, discussions)	42 (0.7)	39 (1.7)	41 (0.9)	45 (1.2)
Small group work	26 (0.8)	23 (1.9)	27 (1.0)	25 (1.0)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	22 (0.7)	27 (1.7)	22 (0.9)	21 (1.2)
Non-instructional activities (e.g., attendance taking, interruptions)	10 (0.2)	10 (0.5)	10 (0.4)	9 (0.3)

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. About half of high school mathematics classes assign over 60 minutes of homework per week (see Table 36). Overall, there is a trend of more homework in formal advanced mathematics classes than other mathematics classes, with over 90 minutes of homework assigned in nearly one-third of formal advanced classes.

Table 36
Amount of Homework Assigned in High School Mathematics Classes Per Week

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
None	3 (0.6)	12 (3.8)	3 (1.1)	1 (0.6)
1–15 minutes per week	4 (0.7)	10 (2.7)	5 (1.3)	2 (0.5)
16–30 minutes per week	12 (1.6)	22 (6.6)	14 (2.5)	8 (1.5)
31–60 minutes per week	29 (1.6)	32 (6.4)	30 (2.6)	26 (2.5)
61–90 minutes per week	27 (1.6)	11 (3.2)	28 (2.7)	29 (2.5)
91–120 minutes per week	14 (1.3)	7 (2.4)	12 (2.0)	17 (2.1)
More than 2 hours per week	12 (1.5)	6 (3.5)	8 (1.9)	16 (2.0)

The survey asked how often students in the randomly selected class are required to take assessments the teacher did not develop, such as state or district benchmark assessments. Eighty percent of high school mathematics classes are required to take such an assessment at least once a year (see Table 37). Additionally, administration of three or more external assessments is more common in formal required classes than formal advanced classes, perhaps because formal required classes are more likely to be focused on in state accountability systems.

Table 37
Frequency of Required External Testing in High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Never	20 (1.6)	24 (7.6)	8 (1.6)	30 (2.4)
Once a year	24 (1.8)	21 (6.4)	26 (3.1)	24 (2.4)
Twice a year	22 (1.8)	19 (4.4)	22 (2.9)	22 (2.7)
Three or four times a year	24 (1.7)	24 (5.4)	28 (3.0)	20 (2.0)
Five or more times a year	10 (1.3)	12 (3.9)	16 (2.4)	5 (0.9)

Resources Available for High School Mathematics

The quality and availability of instructional resources are major factors affecting mathematics teaching. The 2018 NSSME+ included a series of items on instructional materials—which ones teachers use and how teachers use them.

Instructional Materials

The 2018 NSSME+ collected data on the use of various instructional resources, including commercially published textbooks or programs, both print and electronic. Of particular interest is how much latitude teachers have in selecting instructional resources. Table 38 shows that the district designates at least a portion of instructional materials in about two-thirds of high school mathematics classes.

Table 38
High School Mathematics Classes for Which the District Designates Instructional Materials to Be Used

	PERCENT OF CLASSES
All	66 (1.7)
Informal Review	63 (5.2)
Formal Required	69 (2.7)
Formal Advanced	65 (2.1)

When teachers responded that their randomly selected class had a designated instructional material, the survey presented them with a list of possible types of materials. As can be seen in Table 39, the most commonly designated material by far is commercially published textbooks. State-, county-, or district-developed instructional materials are more likely to be designated in informal review or formal required classes than formal advanced courses.

Table 39
High School Mathematics Classes for Which Various Types of Instructional Resources Are Designated

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Commercially published textbooks (printed or electronic), including the supplementary materials that accompany the textbooks	92 (1.2)	93 (2.7)	90 (2.3)	93 (1.7)
State, county, or district/diocese-developed instructional materials	32 (1.9)	39 (5.6)	39 (3.2)	23 (1.9)
Lessons or resources from websites that are free	24 (1.6)	31 (5.6)	25 (2.9)	20 (2.1)
Lessons or resources from websites that have a subscription fee or per lesson cost	15 (1.5)	16 (4.3)	17 (2.8)	12 (1.6)
Online units or courses that students work through at their own pace	13 (1.7)	18 (5.1)	13 (2.1)	11 (1.8)

† Only high school mathematics classes for which instructional materials are designated by the state, district, or diocese are included in these analyses.

The 2018 NSSME+ also collected data on how often teachers base instruction on various types of materials, regardless of whether instructional materials had been designated for their class. As can be seen in Table 40, teacher-created materials are very likely to be used at least once a week in high school mathematics classes, though somewhat less often in formal required classes compared to informal review or formal advanced courses (73 vs. 81 percent). A majority of classes across all course types use commercially published textbooks at least once a week. The remaining instructional materials are relatively uncommon in high school mathematics, with only about a third or fewer classes using them on a weekly basis. No-cost lessons or resources from websites are more likely to be used at least once a week in informal review classes compared to others.

Table 40
Mathematics Classes Basing Instruction on Various Instructional Resources at Least Once a Week

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Units or lessons you created	78 (1.5)	81 (3.3)	73 (2.3)	81 (1.8)
Commercially published textbooks (printed or electronic), including the supplementary materials that accompany the textbooks	61 (1.7)	59 (4.4)	58 (2.7)	64 (2.3)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	35 (1.6)	43 (5.3)	34 (2.8)	34 (2.1)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	26 (1.5)	39 (5.4)	26 (2.5)	23 (1.8)
State, county, district, or diocese-developed units or lessons	23 (1.3)	30 (5.0)	26 (2.1)	17 (1.6)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	19 (1.3)	26 (5.0)	21 (2.3)	15 (1.5)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	12 (1.2)	18 (4.1)	13 (1.9)	9 (1.3)

Teachers who indicated that the randomly selected class used commercially published materials were asked to record the title, author, year, and ISBN of the material used most often in the class. Using this information, the publisher of the materials was identified. Table 41 shows the most commonly used high school mathematics materials.

Table 41
Most Commonly Used High School Mathematics Textbooks, by Course Type†

COURSE	PUBLISHER	TITLE
Non-College Prep Mathematics	McGraw-Hill Education	*Algebra 1*
Formal/College Prep Mathematics Level 1	Pearson	*Algebra 1*
	Houghton Mifflin Harcourt	*Algebra 1*
	McGraw-Hill Education	*Algebra 1*
	Houghton Mifflin Harcourt	*Big Ideas Math*
Formal/College Prep Mathematics Level 2	Houghton Mifflin Harcourt	*Geometry*
	Pearson	*Geometry*
	McGraw-Hill Education	*Geometry*
Formal/College Prep Mathematics Level 3	Houghton Mifflin Harcourt	*Algebra 2*
	McGraw-Hill Education	*Algebra 2*
	Pearson	*Algebra 2*
Formal/College Prep Mathematics Level 4	McGraw-Hill Education	*Precalculus*
Courses that might qualify for college credit	Macmillan	*The Practice of Statistics*
	Pearson	*Calculus: Graphical, Numerical, Algebraic*
	Cengage	*Calculus of a Single Variable*

† Only high school mathematics classes using commercially published textbooks/programs are included in these analyses.

Table 42 shows the publication year of commercially published instructional materials. Nearly a third of high school mathematics classes use materials published prior to 2010. Only 10 percent of classes use materials published since 2016.

Table 42
Publication Year of Textbooks/Programs Used in High School Mathematics Classes

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
2009 or earlier	29 (2.0)	31 (5.6)	20 (2.5)	36 (2.5)
2010–12	32 (2.1)	32 (7.0)	32 (3.7)	31 (2.6)
2013–15	29 (2.1)	24 (7.9)	38 (3.7)	23 (2.2)
2016–18	10 (1.3)	13 (4.1)	10 (2.0)	10 (1.8)

† Only high school mathematics classes using commercially published textbooks/programs are included in these analyses.

Teachers were also asked whether the most recent unit in their randomly selected class was based primarily on either a commercially published textbook or materials developed by the state or district. As can be seen in Table 43, about three-quarters of high school mathematics classes are based on such materials; the most recent unit in formal advanced courses are more likely than informal review courses to have been based on these types of materials.

Table 43
High School Mathematics Classes in Which the Most Recent Unit Was Based on a Commercially Published Textbook or a Material Developed by the State or District

	PERCENT OF CLASSES†
All	73 (1.9)
Informal Review	64 (5.7)
Formal Required	73 (2.6)
Formal Advanced	77 (1.9)

† Only high school mathematics classes using commercially published or state/district-developed materials at least once a month are included in these analyses.

When teachers responded that their most recent unit was based on one of these materials, they were asked how they use the material (see Table 44). Teachers in 81 percent of high school mathematics classes indicate that they use these materials to substantially guide the structure and content emphasis of the unit, suggesting that when classes use commercially published or state/district-developed materials, the materials heavily influence instruction. However, data also suggest that teachers may not strictly adhere to all parts of the materials; in the majority of high school mathematics classes, teachers deviate from the materials by incorporating activities, modifying activities, and picking what was important and skipping the rest.

Table 44
Ways High School Mathematics Teachers Substantially† Used Their Instructional Materials in Most Recent Unit

	PERCENT OF CLASSES‡			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
I used these materials to guide the structure and content emphasis of the unit.	81 (1.5)	83 (4.1)	82 (2.9)	80 (2.0)
I incorporated activities from other sources to supplement what these materials were lacking.	64 (2.0)	69 (5.5)	66 (3.4)	62 (3.1)
I modified activities from these materials.	60 (1.9)	70 (5.1)	61 (3.8)	57 (2.4)
I picked what is important from these materials and skipped the rest.	52 (1.9)	45 (6.5)	48 (3.5)	57 (2.6)

† Includes high school mathematics teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."
‡ Only high school mathematics classes in which the most recent unit was based on commercially published or state/district-developed materials are included in these analyses.

Teachers in about half of high school mathematics classes, regardless of course type, skip activities in the materials substantially. When asked why they skip parts of their instructional materials, some of the most frequent reasons are: (1) having different activities for those mathematical ideas that work better, (2) the mathematical ideas addressed not being including in pacing guides or standards, and (3) not having enough instructional time (See Table 45). Skipping activities because the students already knew the content or the activities being too difficult are also fairly common.

Table 45
Reasons Why Parts of High School Mathematics Materials Are Skipped

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
I have different activities for those mathematical ideas that work better than the ones I skipped.	74 (2.2)	84 (4.7)	74 (4.3)	71 (3.0)
The mathematical ideas addressed in the activities I skipped are not included in my pacing guide/standards.	73 (2.1)	75 (7.1)	73 (4.2)	73 (2.4)
I did not have enough instructional time for the activities I skipped.	69 (2.4)	71 (6.6)	68 (4.6)	71 (3.3)
The activities I skipped were too difficult for my students.	55 (2.5)	48 (8.7)	58 (4.6)	55 (3.5)
My students already knew the mathematical ideas or were able to learn them without the activities I skipped.	54 (2.5)	50 (8.4)	52 (5.1)	56 (3.3)
I did not have the materials needed to implement the activities I skipped.	24 (2.2)	23 (7.0)	25 (3.6)	24 (3.2)
I did not have the knowledge needed to implement the activities I skipped.	9 (1.6)	6 (3.4)	7 (2.1)	12 (2.3)

† Only high school mathematics classes in which (1) the most recent unit was based on commercially published or state/district-developed materials and (2) teachers reported skipping some activities are included in these analyses.

Teachers in roughly two-thirds of high school mathematics classes incorporate activities from other sources to supplement what they perceive materials to be lacking. The reasons for supplementing are consistent across all course types. In nearly all instances, teachers do so to provide students with additional practice and to help students at different levels of achievement learn targeted ideas (see Table 46). In 80 percent of classes, teachers supplement with additional activities that they like. Preparing students for standardized tests (56 percent) and following instructions in pacing guides (41 percent) are also common reasons for supplementing.

Table 46
Reasons Why High School Mathematics Materials Are Supplemented

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Supplemental activities were needed to provide students with additional practice.	92 (1.6)	88 (5.6)	93 (2.9)	92 (1.8)
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	89 (1.8)	90 (4.9)	89 (3.5)	89 (1.8)
I had additional activities that I liked.	80 (1.9)	69 (8.0)	82 (3.0)	82 (2.5)
Supplemental activities were needed to prepare students for standardized tests.	56 (2.6)	58 (8.1)	58 (4.1)	54 (3.4)
My pacing guide indicated that I should use supplemental activities.	41 (2.6)	51 (6.9)	40 (5.1)	41 (3.8)

† Only high school mathematics classes in which (1) the most recent unit was based on commercially published or state/district-developed materials and (2) teachers reported supplementing some activities are included in these analyses.

Finally, when high school mathematics teachers reported modifying their instructional materials (which 60 percent did), they rated each of several factors that may have contributed to their decision (see Table 47). Two factors stand out: teachers do not have enough time to implement the activities as designed (58 percent) and the activities are too difficult for students (55 percent).

Table 47
Reasons Why High School Mathematics Materials Are Modified

	PERCENT OF CLASSES†			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
I did not have enough instructional time to implement the activities as designed.	58 (2.6)	49 (7.0)	58 (4.5)	60 (3.2)
The original activities were too difficult conceptually for my students.	55 (2.9)	54 (7.3)	57 (4.7)	53 (3.9)
The original activities were too easy conceptually for my students.	38 (2.1)	36 (6.1)	38 (3.7)	39 (2.8)
The original activities were not structured enough for my students.	35 (2.0)	49 (8.4)	33 (3.8)	34 (3.3)
The original activities were too structured for my students.	32 (2.2)	32 (7.0)	28 (3.2)	34 (2.8)
I did not have the necessary materials/supplies for the original activities.	28 (2.0)	24 (5.3)	31 (3.6)	28 (3.2)

† Only high school mathematics classes in which (1) the most recent unit was based on commercially published or state/district-developed materials and (2) teachers reported modifying some activities are included in these analyses.

Other High School Mathematics Instructional Resources

Teachers in the majority of high school mathematics classes believe their access to measurement tools, instructional technology, consumable supplies, and manipulatives are adequate (see Table 48). However, high school mathematics teachers across all course types are far less likely to consider their access to manipulatives adequate in comparison to other resources. On a composite variable created from these items titled "Adequacy of Resources for Instruction," mean scores are similar across course types (see Table 49).

Table 48
Adequacy† of Resources for High School Mathematics Instruction

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Instructional technology (e.g., calculators, computers, probes/sensors)	85 (1.6)	84 (4.0)	83 (2.9)	87 (2.1)
Measurement tools (e.g., protractors, rulers)	80 (1.6)	79 (4.3)	78 (2.6)	82 (2.4)
Consumable supplies (e.g., graphing paper, batteries)	77 (1.6)	84 (3.5)	73 (2.7)	79 (2.5)
Manipulatives (e.g., pattern blocks, algebra tiles)	51 (2.3)	47 (7.5)	51 (3.4)	53 (2.7)

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

Table 49
High School Mathematics Class Mean Score for the Adequacy of Resources for Instruction Composite

	MEAN SCORE
All	78 (0.9)
Informal Review	77 (2.2)
Formal Required	76 (1.6)
Formal Advanced	80 (1.1)

Factors Affecting High School Mathematics Instruction

Although the primary focus of the 2018 NSSME+ was on teachers and teaching, the study also collected information on the context of classroom practice, particularly the extent various factors promote or inhibit effective mathematics instruction. As can be seen in Table 50, in over 60 percent of mathematics classes principal support, planning time, and current state standards are seen by teachers as promoting effective instruction. Student motivation, interest, effort, as well as prior knowledge and skills are considered promoting factors in about half of high school mathematics classes. Not surprisingly, college entrance requirements are far more likely to be seen as promoting effective instruction in formal courses than in informal review courses (66, 60, and 36 percent in formal advanced, formal required, and informal review classes, respectively). In contrast, state or district testing and accountability policies are more likely to be perceived as promoting effective instruction in informal review classes than formal courses.

Table 50

Factors Promoting† Effective Instruction in High School Mathematics Classes

	PERCENT OF CLASSES			
	ALL	INFORMAL REVIEW	FORMAL REQUIRED	FORMAL ADVANCED
Principal support	70 (2.0)	69 (4.9)	71 (3.3)	70 (2.6)
Amount of time for you to plan, individually and with colleagues	69 (1.5)	60 (7.1)	67 (3.0)	73 (2.3)
Current state standards	62 (1.6)	68 (4.9)	64 (3.3)	58 (2.5)
College entrance requirements	60 (2.4)	36 (7.5)	60 (3.5)	66 (2.6)
District/Diocese and/or school pacing guides	59 (2.0)	62 (6.8)	59 (3.2)	59 (2.6)
Students' prior knowledge and skills	57 (2.0)	59 (6.1)	54 (3.2)	58 (2.9)
Amount of time available for your professional development	55 (2.0)	50 (6.7)	55 (3.3)	56 (2.7)
Students' motivation, interest, and effort in mathematics	52 (1.9)	51 (7.5)	48 (3.2)	56 (3.1)
Teacher evaluation policies	47 (2.4)	58 (6.5)	44 (3.0)	47 (3.1)
Textbook selection policies	43 (2.2)	52 (7.3)	41 (3.7)	42 (3.2)
Parent/guardian expectations and involvement	40 (1.8)	30 (7.0)	41 (3.1)	42 (2.7)
State/district/diocese testing/accountability policies‡	39 (1.9)	54 (6.3)	36 (3.0)	38 (2.9)

† 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."

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

Three composites from these questionnaire items were created to summarize the extent to which various factors support effective instruction: (1) Extent to Which School Support Promotes Effective Instruction (i.e., amount of time for professional development and amount of planning time); (2) Extent to Which the Policy Environment Promotes Effective Instruction (i.e., testing/ accountability, textbook selection, pacing guides, teacher evaluation, and current state standards); and (3) Extent to Which Stakeholders Promote Effective Instruction (i.e., students' motivation and interest, students' prior knowledge, parent/guardian expectations and involvement). The mean scores for each composite are shown in Table 51. Overall, these data indicate that the climate is somewhat supportive for high school mathematics instruction.

Table 51
High School Mathematics Class
Mean Scores for Factors Affecting Instruction Composites

	MEAN SCORE		
	EXTENT TO WHICH SCHOOL SUPPORT PROMOTES EFFECTIVE INSTRUCTION	EXTENT TO WHICH THE POLICY ENVIRONMENT PROMOTES EFFECTIVE INSTRUCTION	EXTENT TO WHICH STAKEHOLDERS PROMOTE EFFECTIVE INSTRUCTION
All	69 (1.0)	64 (0.9)	60 (1.2)
Informal Review	67 (4.0)	70 (3.6)	56 (4.0)
Formal Required	69 (1.6)	62 (1.3)	58 (1.9)
Formal Advanced	70 (1.7)	64 (1.2)	62 (1.6)

Summary

Nearly all high school mathematics classes are taught by teachers who are white, and about half are taught by teachers with more than 10 years of teaching experience. A majority of high school mathematics classes are taught by teachers who received their teaching credential as part of an undergraduate program, and 80 percent are led by a teacher with a degree in mathematics or mathematics education. In addition, about 1 in 5 high school mathematics classes are taught by teachers with full-time job experience in a mathematics-related field prior to teaching. Approximately three-quarters of all high school mathematics classes are taught by teachers who meet or come close to meeting NCTM's preparation standards, having taken college courses in at least 5 of the 7 recommended areas. Teachers of high school mathematics classes tend to feel well prepared to teach the number system and operations, algebraic thinking, and functions, and they tend to feel less well prepared to teach discrete mathematics and statistics and probability. In addition, although mathematics teachers hold a number of beliefs about teaching and learning that are in alignment with what is known about effective mathematics instruction (e.g., students should be asked to justify their mathematical thinking, students should learn mathematics by doing mathematics), they also hold views that are more consistent with traditional instruction. For example, teachers in more than three-fourths of high school mathematics classes believe that students should be provided with definitions for new vocabulary at the beginning of instruction on an idea.

When asked about their professional development experiences, teachers in the vast majority of high school mathematics classes have participated in mathematics-focused professional development in the last three years. In addition, about 40 percent of high school mathematics classes are taught by a teacher with extensive mathematics-focused professional development (more than 35 hours) in that time period. However, a similar proportion of classes are taught by teachers who have completed 15 or fewer hours in the last three years.

Data on mathematics courses indicate that nearly all students in the nation have access to one or more formal/college-prep mathematics courses. A large majority of high schools offer higher level formal/college courses as well. Female students are just as likely as male students to take mathematics courses, with somewhat fewer females than males in informal review classes. Students from race/ethnic groups historically underrepresented in mathematics are less likely to take more advanced mathematics classes.

Data on teachers' perceptions of their decision-making autonomy indicate that overall, high school mathematics teachers perceive greater control over pedagogical decisions compared to curriculum decisions. A majority of high school mathematics classes have a heavy emphasis on understanding mathematical ideas, learning how to do mathematics, and learning mathematical procedures and/or algorithms. High school mathematics instruction relies heavily on lecture and discussion, and a majority of classes involve students working in small groups at least once a week. The data also indicate that students in the majority of high school mathematics classes engage in practices described in the CCSSM at least weekly. Eighty percent of high school mathematics classes are required to take an assessment that the teacher did not develop, such as state or district benchmark assessments, at least once a year.

About two-thirds of high school mathematics classes have at least a portion of instructional materials designated for use by their district or diocese. A large majority of classes use teacher-created materials and commercially published textbooks at least once a week. Skipping, modifying, and supplementing instructional materials are common practices among high school mathematics teachers.

Overall, data indicate that the climate, in terms of school support, policies, and stakeholders, is somewhat supportive of effective mathematics instruction. Factors seen as promoting effective instruction in many mathematics classes include principal support, planning time, and current state standards. Student motivation, interest, effort, as well as students' prior knowledge and skills, are considered promoting factors in about half of high school mathematics classes.