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Are All Students Getting Equal Access to High-Quality Mathematics Education? Data From the 2018 NSSME+

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Kristen A. Malzahn
Peggy J. Trygstad
Eric R. Banilower
Meredith L. Hayes
Michelle E. Blessing

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 NSSME+[1] 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.[2]

Prior research has shown that students' educational opportunities and experiences are shaped by a number of factors. Social inequalities originating outside of schools have consequences for students' classroom-based learning opportunities and their achievement.[3] Schools, once thought to "level the playing field" by providing equal learning opportunities for students of all backgrounds, are themselves unequally resourced in terms of material resources available for instruction, the qualifications of the teachers, school programs and practices to support effective instruction, and, consequently, the nature of instruction students receive. Historically, the unequal distribution of these resources has resulted in inequitable learning opportunities and outcomes for different groups of students.[4]

Although not designed primarily as an equity study, the 2018 NSSME+ provides data on some indicators of the extent to which students across the nation have equitable educational opportunities. To this end, data from the study were analyzed by four factors historically

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[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.

[2] Complete details of the study—sample design, sampling error considerations, instrument development, data collection, file preparation and analysis, and composite definitions—as well as copies of the instruments, are included in the technical report, which is available free of charge at: http://horizon-research.com/NSSME/2018-nssme/research-products/reports/technical-report.

[3] Denton, K., & West, J. (2002). *Children's reading and mathematics achievement in kindergarten and first grade*. Retrieved August 23, 2018 from https://nces.ed.gov/pubs2002/2002125.pdf.

Duncan, G. J. & Murnane, R. J. (Eds.) (2011). *Whither opportunity? Rising inequality, schools, and children's life chances*. New York: Russell Sage Foundation.

Rothstein, R. (2004). *Class and schools: Using social, economic, and educational reform to close the black-white achievement gap*. Washington, DC: Economic Policy Institute.

Jordan, N. C., Kaplan, D., Olah, L. N., & Locuniak, M. N. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. *Child Development, 77*, 153–175.

National Center for Education Statistics. (2000). *America's kindergartners*. Retrieved August 23, 2018 from https://nces.ed.gov/pubs2000/2000070.pdf.

[4] Campbell, J. R., Hombo, C. M., & Mazzeo, J. (2000). *NAEP 1999 trends in academic progress: Three decades of student performance.* Washington DC: Department of Education, National Center for Education Statistics.

Kozol, J. (1991). *Savage inequalities: Children in America's schools.* New York: Crown.

Oakes, J., Ormseth, T., Bell, R., & Camp, P. (1990). *Multiplying inequalities: The effects of race, social class, and tracking on opportunities to learn mathematics and science.* Santa Monica, CA: Rand Corp.

Smith, P. S., Trygstad, P. J., & Banilower, E. R. (2016). Widening the gap: Unequal distribution of resources for K–12 science instruction. *Education Policy Analysis Archives, 24*(8), 1–42.

associated with differences in educational opportunities. These "equity factors" fall into two categories, those associated with school characteristics and associated with the composition of classes.[5]

- **Percentage of students in the school eligible for free/reduced-price lunch (FRL)**
Each school was classified into 1 of 4 categories based on the percentage of students eligible for free/reduced-price lunch (FRL). Defining common categories across grades K–12 would have been misleading, as students tend to select out of the FRL program as they advance in grade due to perceived social stigma. Therefore, the categories were defined as quartiles within groups of schools serving the same grades (e.g., schools with grades K–5, schools with grades 6–8). Cut points for these quartiles are included in Appendix A.

- **Community type**
Schools were coded into 1 of 3 types of communities:
    - Urban: central city;
    - Suburban: area surrounding a central city, but still located within the counties constituting a Metropolitan Statistical Area (MSA); or
    - Rural: area outside any MSA.

- **Percentage of students in the class from race/ethnicity groups historically underrepresented in STEM (HUS)**
Each randomly selected class was classified into 1 of 4 quartiles based on the percentage of students in the class from race/ethnicity groups historically underrepresented in STEM (i.e., American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, multi-racial); gender is not a part of this factor. Cut points for these quartiles are included in Appendix A.

- **Prior achievement level of the class**
Based on teacher-provided information,[6] classes were coded into 1 of 3 categories, composed of:
    - Mostly low-prior-achieving students;
    - Mostly average-prior-achieving students/a mixture of levels; or
    - Mostly high-prior-achieving students.

Organization of This Report

This report is organized by equity factor, with each chapter highlighting the distribution of four educational resources among K–12 schools and classrooms in the United States:

[5] It is important to note that, to varying degrees, these factors are correlated. For example, classes containing higher percentages of students from race/ethnicity groups historically underrepresented in STEM are more likely to be located in schools with higher percentages of students eligible for free/reduced-price lunch (in addition to being more likely to be classified as low-prior-achieving students). Urban schools tend to have higher percentages of free/reduced-price lunch and historically underrepresented students than suburban and rural schools.

[6] Because it was not feasible for the NSSME+ to collect student data, the only way to gather nationally representative data about students' prior achievement was by relying on teacher report. However, it is important to recognize that multiple factors can influence teachers' perceptions of students and what they have or have not achieved in the past.

- Nature of instruction;
- Material resources;
- Well-prepared teachers; and
- Supportive context for learning.

Data from the 2018 NSSME+, both individual items and composite variables,[7] are shown in tables, with the standard errors for the estimates included in parentheses. Within each equity factor, comparisons were made between groups. For FRL and HUS, comparisons were made between the highest and lowest quartiles. For prior achievement, comparisons were made between classes of mostly low-prior-achieving students and classes of mostly high-prior-achieving students. For community type, comparisons were made among all three community types (urban vs. suburban, urban vs. rural, and rural vs. suburban), using the False Discovery Rate method[8] to maintain an overall Type I error rate of five percent. Statistically significant differences ($p < 0.05$) are denoted by asterisks in the tables.

In addition, when possible, data from the 2018 and 2012[9] studies were compared to examine whether the magnitude of differences between groups changed across the two time points.[10] Statistically significant changes over time are illustrated in figures. However, it is important to note that even though the data might be the same in 2012 and 2018, there may still have been significant differences within years.

[7] 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 Appendix C.

[8] The false discovery rate method adjusts the alpha level required for statistical significance. Benjamini, Y. & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society,* B, 57, 289–300.

[9] Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 National Survey of Science and Mathematics Education.* Chapel Hill, NC: Horizon Research, Inc.

[10] The wording of some survey items changed slightly between 2012 and 2018. Items included in both studies, and those similar enough to be considered trend, are denoted by a "(t)" in tables. Additionally, 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. Details about item wording and composite definition changes between 2012 and 2018 can be found in Appendices B and C, respectively.

Free/Reduced-Price Lunch

This chapter of the report examines differences in data from the study by the socioeconomic status of students served by schools (measured by percentage of students eligible for FRL), specifically comparing schools with the largest percentages to schools with the smallest percentages of FRL-eligible students.[11] As described in the introduction, schools were classified into quartiles created within groups of schools by grades served (e.g., schools with some or all grades K–5, schools with some or all grades 6–8). As can be seen in Table 2.1, schools in the highest quartile have an average of 95 percent of students eligible for FRL and schools in the lowest quartile have an average of 11 percent of students eligible for FRL.

Table 2.1
Average Percentage of Students in School Eligible for FRL in Each Quartile

	PERCENT FRL
Lowest Quartile Schools	11 (0.8)
Second Quartile Schools	37 (0.9)
Third Quartile Schools	61 (0.8)
Highest Quartile Schools	95 (0.5)

Nature of Mathematics Instruction

Student opportunity to learn important mathematics is a function of both access to mathematics instruction (courses at the secondary level) and the nature of instruction they receive. The 2018 NSSME+ collected a variety of data about mathematics instruction, including time spent on mathematics in the elementary grades and course offerings in secondary grades. Mathematics teachers were also asked about: (1) their perceptions of autonomy in making curricular and instructional decisions, (2) instructional objectives and class activities they use in accomplishing these objectives, and (3) how student performance is assessed. This section presents these data, highlighting the similarities and differences between high-FRL schools and low-FRL schools.

Time Spent In Elementary Grades

The amount of instruction devoted to a subject is an important component of student opportunity to learn. Table 2.2 shows the average number of minutes per day typically spent on mathematics, science, social studies, and reading/language arts in elementary grades self-contained classes that cover all four subjects. Classes in the highest quartile of schools and lowest quartile of schools spent approximately the same amount of time on mathematics instruction per day. When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

[11] Throughout this chapter, schools with the largest percentage and the smallest percentage of students eligible for FRL are referred to as high- and low-FRL schools, highest and lowest quartile schools, and high- and low-poverty schools.

Table 2.2
Average Number of Minutes per Day Spent Teaching Each Subject in Elementary Grades Self-Contained Classes,[a] by FRL Quartile†

	NUMBER OF MINUTES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Reading/Language Arts	83 (2.8)	92 (4.0)	93 (3.6)	87 (5.0)
(t) Mathematics	52 (1.7)	62 (2.8)	62 (2.1)	56 (3.3)
(t) Science	18 (1.3)	19 (1.6)	17 (1.1)	20 (1.3)
(t) Social Studies	17 (1.0)	16 (1.1)	15 (0.9)	17 (1.1)

(t) Trend item

† There are no statistically significant differences between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p \geq 0.05$).

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

Course-Taking Opportunities in Secondary Grades

The study also collected data about course-taking opportunities provided to students in secondary schools. Middle school program representatives were asked how many 8th grade students would complete Algebra 1 and Geometry prior to 9th grade. As can be seen in Table 2.3, students in high-poverty schools were less likely than students in low-poverty schools to complete Algebra 1 before entering 9th grade. This disparity between high-poverty and low-poverty schools also existed in 2012, highlighting a persistent challenge that requires further attention to help close this gap and ensure that more students in high-poverty middle schools have opportunities and are prepared to complete advanced courses.

Table 2.3
Average Percentage of 8th Graders Completing Algebra 1 and Geometry Prior to 9th Grade, by FRL Quartile

	PERCENT OF STUDENTS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Algebra 1*	48 (5.1)	25 (4.1)	20 (4.2)	29 (6.1)
(t) Geometry	17 (5.5)	2 (0.8)	2 (0.9)	7 (5.9)

(t) Trend item

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

At the high school level, teachers were asked to provide information about a randomly selected class, including the course type, which allows for an estimate of the percentage of mathematics courses of each type in schools (see Table 2.4). Here again, a disturbing pattern in non-equitable student course-taking opportunities is apparent. In 2018, high-FRL schools were more likely than low-FRL schools to offer non-college prep courses (17 vs. 6 percent) and less likely to offer courses that might qualify for college credit, such as Advanced Placement (AP) courses (5 vs. 13 percent). These data are not significantly different from the 2012 data.

Table 2.4
Prevalence of High School Mathematics Courses, by FRL Quartile(t)

	PERCENT OF CLASSES*			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	6 (1.5)	10 (1.5)	18 (2.3)	17 (3.2)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	18 (2.5)	23 (2.9)	18 (2.2)	19 (2.3)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	21 (3.1)	19 (2.1)	23 (2.7)	23 (2.8)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	24 (2.5)	23 (2.7)	22 (2.5)	23 (2.6)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	18 (2.1)	14 (1.6)	9 (1.1)	13 (2.3)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	13 (1.8)	12 (1.7)	10 (1.3)	5 (1.1)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (Chi-square test of independence, $p < 0.05$)

Teachers' Perceptions of Their Decision-Making Autonomy

Many in education believe that classroom teachers are in the best position to know their students' needs and interests and, therefore, should be the ones making decisions about tailoring instruction to a particular group of students. Teachers were asked the extent to which they had control over a number of curriculum and instruction decisions for their classes.

As can be seen in Table 2.5, classes, regardless of school poverty level, were equally likely to be taught by teachers who perceived themselves as having strong control over some pedagogical decisions, but not others. For example, teachers in about two-thirds of classes in both high-poverty and low-poverty schools reported having strong control over determining the amount of homework to be assigned. However, teachers of classes in high-poverty schools were less likely than their low-poverty school counterparts to perceive strong control over selecting teaching techniques (53 vs. 65 percent) and determining the amount of instructional time to spend on each topic (26 vs. 38 percent).

Teachers' perceptions of control over some curricular decisions show a somewhat similar pattern. About one-fourth of classes in the highest quartile and lowest quartile of schools were taught by teachers who considered themselves as having strong control over determining course goals and objectives. Also, teachers of about one-fifth of classes in each quartile perceived strong control over selecting curriculum materials. In contrast, only one-fifth of classes in the highest quartile of schools compared to one-third of classes in the lowest quartile were taught by teachers who perceived this same level of control in selecting the sequence in which topics are covered. In addition, teachers of classes in the highest quartile were less likely than their lowest-quartile counterparts to report having strong control in selecting content, topics, and skills to be taught (14 vs. 21 percent).

Table 2.5
Mathematics Classes in Which Teachers Reported Having Strong Control Over Various Curricular and Instructional Decisions, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Determining the amount of homework to be assigned	70 (2.1)	68 (2.7)	67 (2.5)	64 (3.0)
(t) Selecting teaching techniques*	65 (2.4)	66 (2.7)	60 (2.6)	53 (3.5)
(t) Choosing criteria for grading student performance	40 (2.6)	47 (2.9)	42 (2.6)	44 (3.1)
Determining the amount of instructional time to spend on each topic*	38 (2.6)	34 (2.5)	32 (2.6)	26 (2.9)
(t) Determining course goals and objectives	25 (2.3)	25 (2.1)	21 (2.0)	20 (2.3)
Selecting the sequence in which topics are covered*	36 (2.5)	31 (2.5)	30 (2.4)	19 (2.6)
(t) Selecting curriculum materials (e.g., textbooks)	19 (1.9)	19 (2.0)	16 (1.9)	15 (2.4)
(t) Selecting content, topics, and skills to be taught*	21 (2.2)	19 (2.0)	16 (1.8)	14 (2.0)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Interestingly, comparing 2018 and 2012 data shows that perceptions of control over the amount of homework to be assigned by FRL quartile have reversed (see Figure 2.1). Specifically, 69 percent of classes in high-FRL schools and 62 percent in low-FRL schools were taught by teachers feeling strong control in this area in 2012, compared to 64 and 70 percent of classes in 2018, respectively.

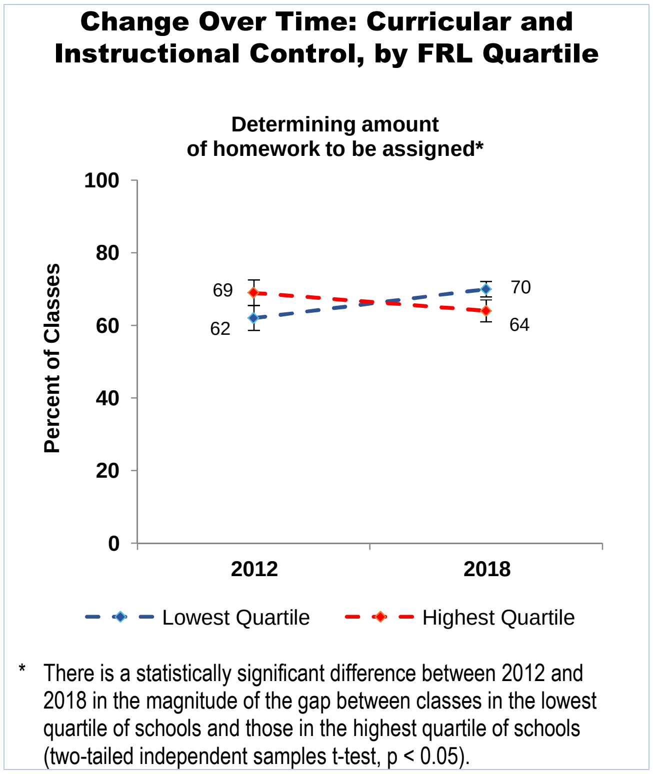


Figure 2.1

A subset of the items in Table 2.5 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 2.6 shows the mean scores on these composites by school poverty level. These scores indicate that teachers of classes in high-poverty schools tended to report less control over decisions related to curriculum than their counterparts in low-poverty schools. Perceived control for pedagogical decisions was equally as strong for teachers of classes in high-poverty and low-poverty schools. These data are not significantly different from the data in 2012.

Table 2.6
Mathematics Class Mean Scores for
Curriculum Control and Pedagogy Control Composites, by FRL Quartile

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Curriculum Control*,[a]	51 (1.9)	49 (1.9)	47 (1.6)	43 (2.0)
(t) Pedagogy Control	82 (0.8)	84 (1.1)	82 (1.2)	80 (1.3)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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 for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Instructional Objectives

What teachers emphasize in their mathematics instruction heavily influences student opportunity to learn and is another important factor to consider when examining potential inequities in mathematics education. The survey provided a list of possible objectives of instruction and asked teachers how much emphasis each would receive in the randomly selected class. Regardless of school poverty level, classes had relatively equal emphasis on many of the instructional objectives in 2018 (see Table 2.7). For example, roughly 60–70 percent of classes in high-poverty and low-poverty schools heavily emphasized learning how to do mathematics and understanding mathematical ideas, two key elements of high-quality mathematics teaching outlined in the *Common Core State Standards for Mathematics* and NCTM's *Principles to Actions*.[12] Also, learning mathematical procedures and/or algorithms was emphasized in approximately half of classes in high-poverty and low-poverty schools. Although not as common as other objectives, classes in the highest quartile of schools were more likely than those in the lowest quartile to emphasize traditional instructional objectives, such as learning mathematics vocabulary (37 vs. 30 percent), learning test-taking skills (32 vs. 21 percent), and learning to perform computations with speed and accuracy (30 vs. 24 percent).

[12] National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: Author.

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

Table 2.7
Mathematics Classes With Heavy Emphasis on Various Instructional Objectives, by FRL Quartile

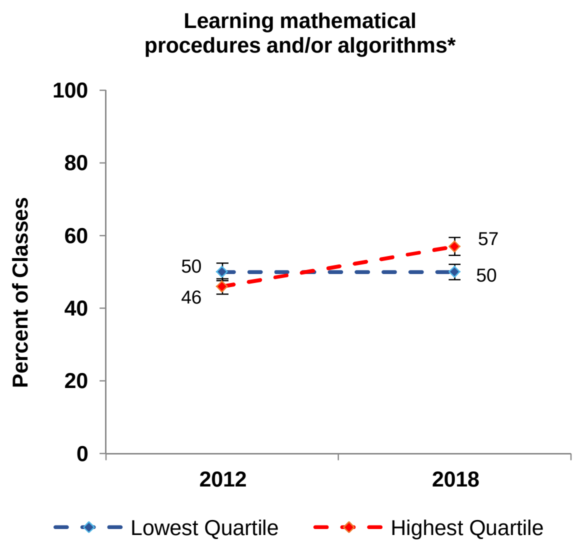
	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Understanding mathematical ideas	73 (1.8)	72 (2.0)	63 (2.2)	66 (2.7)
(t) Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	65 (2.4)	63 (1.8)	59 (2.4)	62 (2.6)
(t) Learning mathematical procedures and/or algorithms	50 (2.1)	53 (2.3)	53 (2.2)	57 (2.5)
Developing students' confidence that they can successfully pursue careers in mathematics	41 (2.3)	32 (2.0)	35 (2.1)	42 (2.3)
(t) Increasing students' interest in mathematics	39 (2.2)	29 (2.1)	31 (2.2)	42 (2.3)
(t) Learning about real-life applications of mathematics	37 (1.9)	30 (1.9)	29 (1.8)	40 (2.7)
Learning mathematics vocabulary*	30 (2.3)	31 (2.0)	31 (2.3)	37 (2.5)
(t) Learning test-taking skills/strategies*	21 (1.8)	24 (1.9)	30 (2.3)	32 (2.4)
(t) Learning to perform computations with speed and accuracy*	24 (1.7)	26 (2.2)	26 (2.5)	30 (2.2)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Looking at trends over time, the gap between the percentage of classes in high-FRL schools and those in low-FRL schools that heavily emphasized learning mathematical procedures and/or algorithms has changed significantly since 2012 (see Figure 2.2). In 2012, 46 percent of classes in the highest quartile of schools, compared to 50 percent of classes in the lowest quartile, had a heavy emphasis on this objective. In 2018, 57 percent of classes in the highest quartile had a heavy emphasis on this objective, indicating an increased emphasis on more traditional instructional objectives in these schools since 2012.

Change Over Time:
Instructional Objectives, by FRL Quartile



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Figure 2.2

The objectives related to reform-oriented instruction (understanding mathematical ideas, learning how to do mathematics, learning about real-life applications of mathematics, increasing students' interest in mathematics, and developing students' confidence that they can successfully pursue careers in mathematics) were combined into a composite variable. Interestingly, the mean scores indicate that mathematics classes were, on average, likely to emphasize reform-oriented instructional objectives regardless of school poverty level (see Table 2.8). The 2018 data are not significantly different from the 2012 data.

Table 2.8
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite,[a] by FRL Quartile[(t),†]

	MEAN SCORE
Lowest Quartile Schools	80 (0.6)
Second Quartile Schools	78 (0.6)
Third Quartile Schools	77 (0.7)
Highest Quartile Schools	80 (0.9)

(t) Trend item

† There is not a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Class Activities

Similar to instructional objectives, the nature of class activities says a great deal about the type of mathematics instruction students receive and their opportunities to learn. The 2018 NSSME+ included several sets of items that provide information about how mathematics was taught. One set of items asked how often different pedagogies (e.g., explaining ideas to students, small group work) were used. Nearly all mathematics classes in both high-FRL and low-FRL schools included the teacher explaining mathematical ideas and leading whole class discussions at least once a week (see Table 2.9). Having students work in small groups was also common regardless of school poverty level.

Classes in high-FRL schools were more likely than their low-FRL school counterparts to have students use manipulatives at least once a week (59 vs. 49 percent) and write reflections (43 vs. 27 percent), two activities that can support conceptual learning. However, they were also more likely to have students practice for standardized tests (38 vs. 18 percent), focus on literacy skills (41 vs. 28 percent), and read from a textbook or other materials in class (34 vs. 19 percent). The differences in class activities between the lowest and highest quartiles of schools have not significantly changed since 2012.

Table 2.9
Mathematics Classes in Which Teachers Reported Using Various Activities at Least Once a Week, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Explain mathematical ideas to the whole class	95 (0.9)	95 (0.8)	93 (1.1)	95 (1.2)
(t) Engage the whole class in discussions	92 (1.0)	91 (1.1)	90 (1.1)	90 (1.4)
(t) Have students work in small groups	83 (1.8)	79 (1.8)	80 (1.8)	81 (2.2)
(t) Provide manipulatives for students to use in problem-solving/investigations*	49 (2.8)	47 (2.3)	50 (2.8)	59 (3.0)
(t) Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*	27 (2.2)	29 (2.2)	31 (2.4)	43 (2.7)
(t) Focus on literacy skills (e.g., informational reading or writing strategies)*	28 (2.1)	22 (2.0)	26 (1.9)	41 (2.7)
(t) Have students practice for standardized tests*	18 (1.8)	26 (2.0)	31 (2.0)	38 (2.6)
(t) Have students read from a textbook or other material in class, either aloud or to themselves*	19 (2.1)	20 (1.8)	23 (1.9)	34 (2.1)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)*	9 (1.5)	10 (1.4)	12 (2.0)	15 (2.1)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

In 2018, teachers were also asked how often they engage students in the practices of mathematics described in the CCSSM, such as making sense of problems, constructing arguments, critiquing the reasoning of others, and modeling with mathematics. Interestingly, students in high-FRL and low-FRL schools had similar opportunities to engage in most of the mathematical practices at least once a week (see Table 2.10). For example, a large majority of classes, regardless of school poverty level, had students: (1) determine whether their answer makes sense, (2) provide mathematical reasoning, (3) develop representations of aspects of problems, and (4) continue to work through a mathematics problem when they reach points of difficulty. Two differences between high-FRL schools and their low-FRL counterparts were having students: (1) compare and contrast different solution strategies in terms of their strengths and limitations (63 vs. 56 percent) and (2) discussing how terms or phrases have specific meanings in mathematics that are different from their meaning in everyday language (68 vs. 61 percent). Both practices were somewhat more likely to occur in classes of high-FRL schools. This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 2.10
Mathematics Classes in Which Teachers Reported Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Determine whether their answer makes sense	88 (1.3)	84 (1.9)	82 (2.3)	85 (2.1)
Provide mathematical reasoning to explain, justify, or prove their thinking	85 (1.7)	82 (1.8)	81 (2.1)	82 (1.8)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	83 (1.5)	84 (1.6)	79 (2.3)	81 (2.1)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	81 (1.6)	83 (1.8)	78 (2.6)	79 (2.3)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	75 (1.9)	77 (1.6)	77 (1.9)	78 (1.9)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	74 (1.9)	75 (2.3)	69 (1.8)	78 (1.8)
Figure out what a challenging problem is asking	71 (1.9)	73 (2.1)	71 (2.0)	76 (2.2)
Identify relevant information and relationships that could be used to solve a mathematics problem	73 (2.1)	74 (2.2)	73 (2.7)	74 (2.4)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements	71 (2.1)	71 (1.9)	70 (2.5)	73 (2.1)
Develop a mathematical model to solve a mathematics problem	68 (2.1)	72 (1.8)	70 (2.4)	73 (2.6)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	70 (2.2)	62 (2.2)	65 (2.2)	72 (1.9)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed	69 (2.1)	66 (2.1)	68 (2.4)	72 (2.2)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language*	61 (2.3)	61 (2.1)	62 (2.4)	68 (2.1)
Determine what tools are appropriate for solving a mathematics problem	64 (2.4)	65 (2.1)	69 (2.3)	66 (2.4)
Analyze the mathematical reasoning of others	61 (2.2)	56 (2.2)	59 (2.4)	66 (2.1)
Work on generating a rule or formula	61 (2.0)	60 (2.2)	63 (2.4)	64 (2.2)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations*	56 (2.3)	54 (2.2)	56 (2.5)	63 (2.2)

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Table 2.11 shows the mean scores for the Engaging Students in the Practices of Mathematics composite formed from these items. Overall, scores were similar for classes in highest and lowest quartiles of schools.

Table 2.11
Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite, by FRL Quartile†

	MEAN SCORE
Lowest Quartile Schools	73 (0.7)
Second Quartile Schools	73 (0.7)
Third Quartile Schools	72 (0.8)
Highest Quartile Schools	74 (0.8)

† There is not a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p \geq 0.05$).

The survey also asked how often students in the randomly selected class were required to take assessments the teacher did not develop, such as state or district benchmark assessments. As can be seen in Table 2.12, students in high-poverty schools were more likely be tested two or more times per year than those in low-poverty schools. This same disparity among high-poverty and low-poverty schools was present in 2012, highlighting a persistent issue in over testing students who are historically disadvantaged.

Table 2.12
Mathematics Classes Required to Take External Assessments Two or More Times per Year, by FRL Quartile(t)

	PERCENT OF CLASSES*
Lowest Quartile Schools	68 (2.7)
Second Quartile Schools	77 (2.2)
Third Quartile Schools	83 (2.2)
Highest Quartile Schools	77 (2.8)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Summary

There are a number of aspects of mathematics instruction that were relatively similar between FRL quartiles in 2018, but there are also some notable differences. At the elementary level, classes in high-FRL schools spent significantly more time on mathematics instruction than their low-FRL counterparts. Of course, whether that finding is positive or negative depends on how that additional time was being spent. In terms of course-taking opportunities at the secondary level, students in high-FRL schools were less likely than those in low-FRL schools to complete Algebra 1 before entering 9th grade. They also were less likely than students in low-FRL schools to have opportunities to take courses in high school that might qualify for college credit (e.g., Advanced Placement courses).

Data about teachers' perceptions of control and emphasis on instructional objectives are also mixed. For example, teachers of classes in high-FRL schools reported somewhat less control over decisions related to curriculum than their low-FRL school counterparts, though their perceptions of control over pedagogical decisions were equally as strong. Mathematics classes, regardless of school poverty level, had relatively equal emphasis on reform-oriented instructional objectives (e.g., understanding mathematical ideas, learning how to do mathematics). However, traditional instructional objectives, such as learning test-taking skills, were more likely to be emphasized in classes of high-FRL schools.

Types of instructional activities used in classrooms were relatively similar regardless of school poverty level. The teacher explaining ideas, whole group discussion, and small group work were prominent activities at least once a week in classes of high-poverty schools and low-poverty schools. Also, students in classes in both high-poverty and low-poverty schools had similar opportunities to engage in a number of mathematical practices at least once a week. In contrast, classes in high-poverty schools were more likely to provide manipulatives for problem solving/ investigations and have students write reflections, but were also more likely to have them practice for standardized tests and focus on literacy skills. External testing also occurred more frequently in classes of high-poverty schools.

Since 2012, the nature of mathematics instruction provided in high-FRL and low-FRL schools has remained largely consistent. The one notable difference is the emphasis placed on learning mathematical procedures and/or algorithms. Since 2012, the gap between classes in high-FRL schools and their low-FRL school counterparts in emphasizing this objective has become more pronounced, disadvantaging students in high-FRL schools.

Material Resources

The quality and availability of instructional resources are major factors affecting mathematics teaching and student opportunity to learn. The 2018 NSSME+ included a series of items on instructional materials—which ones teachers use and how teachers use them—as well as the adequacy of other resources for mathematics instruction. This section provides data about the distribution of material resources and teachers' perceptions of the adequacy of those materials, by FRL level.

Instructional Materials

In 2018, a large majority of mathematics classes, regardless of school poverty level, had instructional materials designated for use by the district (see Table 2.13). Commercially published textbooks were by far the most frequently designated type of material, and the use of lessons or resources from websites that are free or have a subscription fee was less common in both the highest and lowest quartiles of schools. In contrast, classes in high-poverty schools were more likely than their low-poverty school counterparts to have designated state, county, district-developed units (46 vs. 31 percent) and online units that students work through at their own pace, such as i-Ready (40 vs. 18 percent). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 2.13
Types of Instructional Materials Designated for Mathematics Classes, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
District Designates Instructional Materials†				
No	18 (1.7)	18 (1.9)	20 (1.9)	19 (2.3)
Yes	82 (1.7)	82 (1.9)	80 (1.9)	81 (2.3)
Types of Designated Instructional Materials[a]				
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks	91 (1.6)	90 (1.8)	86 (2.4)	89 (2.0)
State, county, district, or diocese-developed units or lessons*	31 (2.7)	35 (2.8)	47 (3.0)	46 (3.2)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*	18 (2.7)	25 (2.5)	32 (3.0)	40 (3.5)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	23 (2.5)	26 (2.4)	29 (2.5)	31 (2.8)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	23 (2.2)	25 (2.2)	26 (2.6)	28 (2.7)

† There is not a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (Chi-square test of independence, $p \geq 0.05$).

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

[a] Only mathematics classes for which instructional materials are designated by the state, district, or diocese are included in these analyses.

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction was based on various types of materials. Commercially published textbooks were commonly used, serving as the basis of instruction at least once a week in 70 percent of classes in high-FRL and low-FRL schools (see Table 2.14). Units or lessons developed by teachers were also used at least once a week in 60 percent of classes, regardless of school poverty level. However, teachers in high-FRL schools were more likely than their low-FRL school counterparts to use lessons or resources from websites that are free (e.g., Khan Academy); state, county, or district-developed units or lessons; and online units or courses that students work through at their own pace. This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 2.14
Mathematics Classes Basing Instruction on Various Types of Instructional Materials at Least Once a Week, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks	71 (2.0)	73 (2.3)	65 (2.7)	68 (2.5)
Units or lessons you created (either by yourself or with others)	63 (2.4)	56 (2.8)	56 (2.5)	58 (2.9)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	35 (2.4)	35 (2.6)	45 (2.3)	42 (2.9)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)*	29 (2.1)	32 (2.0)	37 (2.5)	40 (2.6)
State, county, district, or diocese-developed units or lessons*	27 (1.9)	29 (2.4)	34 (2.2)	39 (2.5)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*	16 (2.1)	22 (2.0)	31 (2.7)	37 (2.8)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	30 (1.8)	30 (2.0)	32 (2.2)	34 (2.7)

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Teachers who indicated that they used commercially published textbooks were asked to record the title, author, publication year, and ISBN of the material used most often in the class. As can be seen in Table 2.15, about half of classes that used textbooks, regardless of FRL quartile, used ones published in 2012 or earlier. The 2018 data are not significantly different from the 2012 data in terms of the age of textbooks.

Table 2.15
Age of Mathematics Textbooks in 2018, by FRL Quartile(t),†

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
6 or more years old	51 (3.5)	50 (4.1)	44 (4.5)	44 (3.8)
5 or fewer years old	49 (3.5)	50 (4.1)	56 (4.5)	56 (3.8)

(t) Trend item

† There is not a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (Chi-square test of independence, $p \geq 0.05$).

Facilities and Resources

Access to appropriate and adequate resources is another important factor in student opportunity to learn. Given the increased emphasis on computing in instruction across STEM disciplines, the 2018 NSSME+ included questions about availability of computing resources. As shown in Table 2.16, the highest and lowest quartiles of schools had similar access to each type of resource. Virtually all schools had school-wide Wi-Fi and a large majority had laptop/tablet carts available for teachers to use in their classes. Only a third of high-FRL and low-FRL schools had a 1-to-1 initiative where every student was provided with a laptop or tablet. The 2018 data are not significantly different from the 2012 data.

Table 2.16
Schools With Various Computing Resources, by FRL Quartile†

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
School-wide Wi-Fi	99 (0.7)	97 (1.5)	100 (0.2)	98 (1.2)
(t) Laptop/tablet carts available for teachers to use with their classes	83 (2.9)	86 (3.0)	85 (2.8)	88 (2.2)
(t) One or more computer labs available for teachers to schedule for their classes	66 (4.4)	79 (3.0)	67 (4.1)	71 (4.1)
A 1-to-1 initiative (every student is provided with a laptop or tablet)	34 (3.3)	40 (4.3)	44 (4.0)	33 (4.1)

(t) Trend item

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

Table 2.17 shows the median amount schools spent per pupil on equipment, consumable supplies, and software for mathematics instruction. The apparent difference in expenditures for mathematics between high- and low-poverty schools is not statistically significant. Further, the 2018 data on spending are not significantly different from the 2012 data.

Table 2.17
Median School Spending per Pupil on Mathematics Equipment, Consumable Supplies, and Software, by FRL Quartile(t),†

	MEDIAN AMOUNT
Lowest Quartile Schools	$4.20 (1.1)
Second Quartile Schools	$4.59 (1.2)
Third Quartile Schools	$4.87 (1.1)
Highest Quartile Schools	$5.38 (1.3)

(t) Trend item

† There is not a statistically significant difference between schools in the lowest quartile and those in the highest quartile (two-tailed independent samples t-test, $p \geq 0.05$).

Teachers were asked to rate the adequacy of the instructional resources they have available. As can be seen in Table 2.18, ratings of the availability of instructional technology and manipulatives were similar between classes of high-FRL and low-FRL schools, ranging from 69–78 percent. In contrast, teachers of classes in high-FRL schools were less likely than their low-FRL counterparts to rate their measurement tools as adequate (73 vs. 82 percent) and consumable supplies as adequate (62 vs. 77 percent). The same inequities between schools were present in 2012.

Table 2.18
Adequacy[a] of Resources for Mathematics Instruction, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Measurement tools (e.g., protractors, rulers)*	82 (2.3)	86 (1.8)	79 (2.2)	73 (2.3)
(t) Instructional technology (e.g., calculators, computers, probes/sensors)	78 (2.6)	76 (2.4)	72 (2.8)	73 (2.6)
(t) Manipulatives (e.g., pattern blocks, algebra tiles)	69 (3.0)	75 (2.0)	72 (2.5)	70 (3.0)
(t) Consumable supplies (e.g., graphing paper, batteries)*	77 (2.5)	73 (2.1)	70 (2.7)	62 (3.1)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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 adequate" to 5 "adequate."

These items were combined into a composite variable named Adequacy of Resources for Mathematics Instruction. As shown in Table 2.19, teachers of classes with the highest percentage of students eligible for FRL had somewhat less positive views about their resources compared to those with the lowest percentage (mean scores of 76 vs. 81). The 2018 data are not significantly different from the 2012 data.

Table 2.19
Mathematics Class Mean Scores for the Adequacy of Resources for Instruction Composite, by FRL Quartile[(t)]

	MEAN SCORE*
Lowest Quartile Schools	81 (1.1)
Second Quartile Schools	81 (0.9)
Third Quartile Schools	79 (1.2)
Highest Quartile Schools	76 (1.2)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Summary

Overall, differences among high-poverty and low-poverty schools were minimal with regard to the distribution of material resources for mathematics instruction. Commercially published textbooks were the most commonly designated and the most frequently used type of mathematics instructional material (whether designated or not) regardless of school poverty level. Units or lessons developed by teachers were also commonly used. However, high-poverty schools were more likely to use lessons or resources from websites that are free (e.g., Khan Academy); state, county, district-developed units; and online units or courses that students work through on their own pace (e.g. i-Ready, Edgenuity).

Computer and Internet resources, including school-wide Wi-Fi and computers or tablets for students were also equally available to students in both high-FRL schools and low-FRL schools. In addition, the amount of money spent on instructional resources was similar across these schools.

In contrast, there were disparities related to teachers' perceptions of the adequacy of these resources. In particular, teachers of classes in high-FRL schools had less positive views about the resources available to them than those in classes of low-FRL schools. For example, these teachers were less likely to rate their measurement tools and consumable supplies as adequate.

Because items about material resources were either added, removed, or substantially modified for the 2018 study, trend analysis was limited. When trend analyses were conducted, there were no significant changes since 2012.

Well-Prepared Teachers

Of all the factors that affect students' mathematics education experience and their opportunity to learn, teachers are among the most important. The 2018 NSSME+ collected data on a number of indicators of teacher preparedness, including their years of teaching experience, content preparation, beliefs about teaching and learning, perceptions of preparedness to teach mathematics content and use classroom pedagogies, and professional development experiences. The extent to which well-prepared teachers were equally distributed among schools in different FRL quartiles is described in the following sections.

Teacher Characteristics and Preparation

Table 2.20 provides information about the characteristics of teachers of mathematics classes in 2018. Overall, mathematics classes, regardless of the school's poverty level, were taught by teachers with relatively similar backgrounds and experience. For example, 60–70 percent of secondary classes in the highest and lowest quartiles of schools were taught by teachers with a degree in mathematics or mathematics education. About 60 percent completed a substantial amount of coursework related to the NCTM preparation standards for their grade band.[13] In addition, about a third of classes in both quartiles were taught by teachers with five or fewer years of experience teaching mathematics. One difference by FRL quartile is in the race/ ethnicity of the teacher. Classes in the highest quartile of schools were more likely than those in the lowest quartile to be taught by teachers from race/ethnicity groups historically underrepresented in STEM.

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

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

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

Table 2.20
Teacher Characteristics, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) 0–5 years of experience teaching mathematics	29 (2.2)	29 (2.3)	31 (2.8)	34 (2.7)
(t) Historically underrepresented race/ethnicity group*	7 (1.8)	9 (1.5)	12 (1.4)	38 (3.1)
(t) Degree in mathematics or mathematics education[a]	71 (2.9)	70 (2.6)	67 (3.1)	62 (3.6)
(t) Substantial coursework related to NCTM preparation standards[b]	62 (2.3)	59 (2.7)	58 (2.3)	57 (2.6)

(t) Trend item

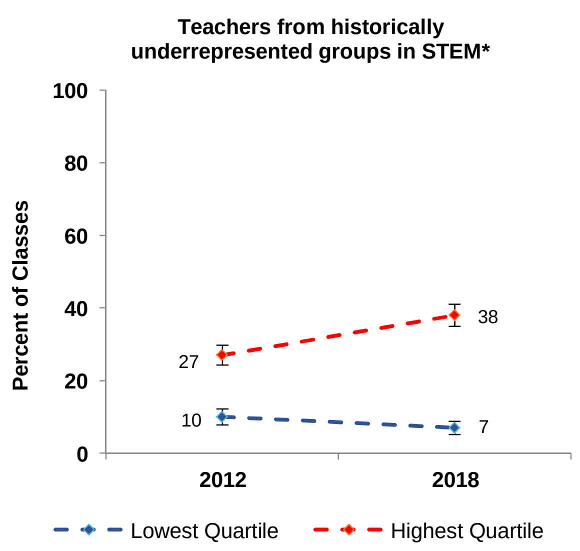
* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

[a] Only secondary teachers are included in this analysis.

[b] Includes elementary mathematics teachers who have courses in 3 or more of the 5 areas recommended for them, middle school mathematics teachers who have courses in 4 or more of the 6 recommended areas, and high school mathematics teachers who have courses in 5 or more of the 7 recommended areas.

Since 2012, the difference between the percent of classes in high-FRL schools and low-FRL schools taught by teachers from race/ethnicity groups historically underrepresented in STEM has changed significantly (see Figure 2.3). This difference appears to be largely due to an increase in the percentage of classes in high-FRL schools being taught by teachers from these groups. Specifically, in 2012, 27 percent of classes in high-FRL schools and 10 percent of classes in low-FRL schools were taught by teachers in these groups, compared to 38 and 7 percent of classes, respectively, in 2018.

Change Over Time: Teacher Characteristics, by FRL Quartile



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Figure 2.3

Teacher Pedagogical Beliefs

Because beliefs are important mediators of behaviors, teachers were asked about their beliefs regarding effective teaching and learning (see Table 2.21). In 2018, teachers tended to hold a number of reform-oriented beliefs, regardless of school poverty level. For example, nearly all classes in high-FRL and low-FRL schools were taught by teachers who agreed that: (1) they 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. Classes in high-FRL schools were more likely than their low-FRL school counterparts to be taught by teachers who believed that students learn best when instruction is connected to their everyday lives (95 vs. 91 percent) and that most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts (94 vs. 85 percent).

However, classes in high-FRL schools were more likely than those in low-FRL schools to be taught by teachers who agreed with statements associated with traditional beliefs. For example, teachers of classes in high-poverty schools were more likely than those of classes in low-poverty schools to believe that: (1) students should be provided with definitions for new mathematics vocabulary at the beginning of a unit (86 vs. 76 percent) and (2) hands-on activities/ manipulatives should be used primarily to reinforce a mathematical idea (56 vs. 45 percent). A higher percentage classes in high-FRL schools also had teachers agreeing that they should explain an idea to students before having them investigate it (39 vs. 22 percent). The 2018 data are not significantly different from the 2012 data.

Table 2.21
Mathematics Classes in Which Teachers Agreed[a]
With Various Statements About Teaching and Learning, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Reform-Oriented Teaching Beliefs				
Teachers should ask students to justify their mathematical thinking.	97 (0.9)	98 (0.7)	98 (0.8)	99 (0.4)
Students should learn mathematics by doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models).	98 (0.9)	95 (1.1)	97 (0.9)	98 (0.8)
(t) Most class periods should provide opportunities for students to share their thinking and reasoning.	94 (1.5)	95 (1.1)	94 (1.0)	96 (0.9)
Students learn best when instruction is connected to their everyday lives.*	91 (1.3)	91 (1.5)	93 (1.3)	95 (1.2)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts.*	85 (1.8)	89 (1.4)	90 (1.6)	94 (1.1)
(t) It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	80 (2.2)	84 (1.9)	81 (2.1)	83 (2.3)
Traditional Teaching Beliefs				
(t) At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.*	76 (2.4)	78 (2.1)	83 (1.7)	86 (1.8)
(t) Students learn mathematics best in classes with students of similar abilities.	59 (2.5)	57 (2.9)	62 (2.9)	62 (2.6)
(t) Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.*	45 (2.6)	46 (2.9)	47 (3.2)	56 (3.3)
(t) Teachers should explain an idea to students before having them investigate the idea.*	22 (2.0)	33 (3.1)	37 (2.6)	39 (3.1)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

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

These items were combined into two composite variables: Traditional Teaching Beliefs and Reform-Oriented Teaching Beliefs. As can be seen in Table 2.22, both reform-oriented beliefs and traditional beliefs were significantly stronger among teachers of classes in the highest quartile of schools, but not by much. The 2018 data for Traditional Teaching Beliefs composite are not significantly different from the 2012 data.[14]

[14] Too few of the items in the 2018 Reform-Oriented Beliefs composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Table 2.22
Mathematics Class Mean Scores for Teachers' Beliefs About Teaching and Learning Composites, by FRL Quartile

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Reform-Oriented Teaching Beliefs*	82 (0.7)	82 (0.7)	84 (0.7)	85 (0.7)
(t) Traditional Teaching Beliefs*,[a]	57 (0.9)	59 (1.2)	61 (1.1)	63 (1.0)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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

The survey asked teachers how well prepared they felt to teach each of a number of mathematics topics at their assigned grade level. At the elementary level, teachers of classes in the highest and lowest quartiles of schools reported feeling equally well prepared to teach measurement and data representation and early algebra (see Table 2.23). However, significantly fewer classes in high-poverty schools than those in low-poverty schools were taught by teachers considering themselves well prepared to teach number and operations (66 vs. 79 percent) and geometry (40 vs. 57 percent).

Table 2.23
Elementary Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Various Mathematics Topics, by FRL Quartile

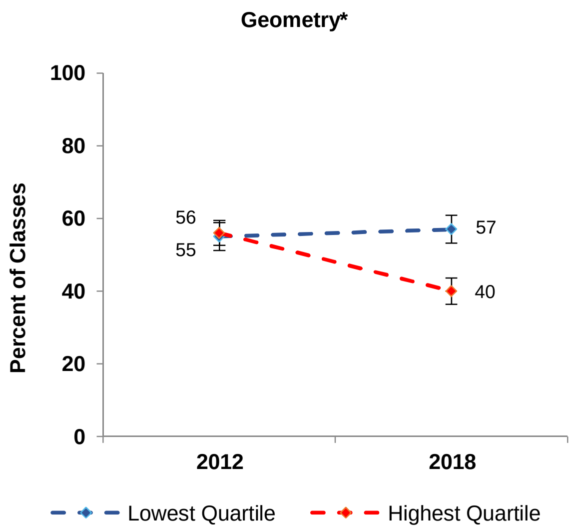
	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Number and operations*	79 (2.5)	75 (3.5)	77 (2.9)	66 (4.4)
(t) Measurement and data representation	59 (3.2)	50 (4.8)	51 (4.0)	50 (4.1)
(t) Geometry*	57 (3.8)	49 (5.0)	46 (3.9)	40 (3.6)
(t) Early algebra	48 (3.5)	43 (4.3)	35 (3.8)	40 (3.6)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Interestingly, since 2012, the difference in elementary teachers' perceptions of their preparedness to teach geometry has changed (see Figure 2.4). Unfortunately, this difference appears to be due to fewer classes in high-FRL schools being taught by teachers feeling well prepared to teach this topic (40 percent in 2018 compared to 56 percent in 2012).

Change Over Time: Preparedness to Teach Elementary Mathematics, by FRL Quartile



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Figure 2.4

Similar patterns of preparedness to teach mathematics are seen at the secondary level. Secondary mathematics classes in high- and low-FRL schools were just as likely to be taught by teachers who reported feeling very well prepared to teach measurement, geometry, modeling, statistics and probability, and discrete mathematics (see Table 2.24). However, classes in high-FRL schools were less likely than those in low-FRL schools to be taught by teachers who felt very well prepared to teach algebraic thinking (80 vs. 87 percent) and functions (62 vs. 74 percent). Surprisingly, the opposite pattern emerged with regard to teachers' preparedness to teach computer science/programming, though the vast majority of teachers in all schools did not feel very well prepared to teach this topic.

Table 2.24
Secondary Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Each of a Number of Topics, by FRL Quartile

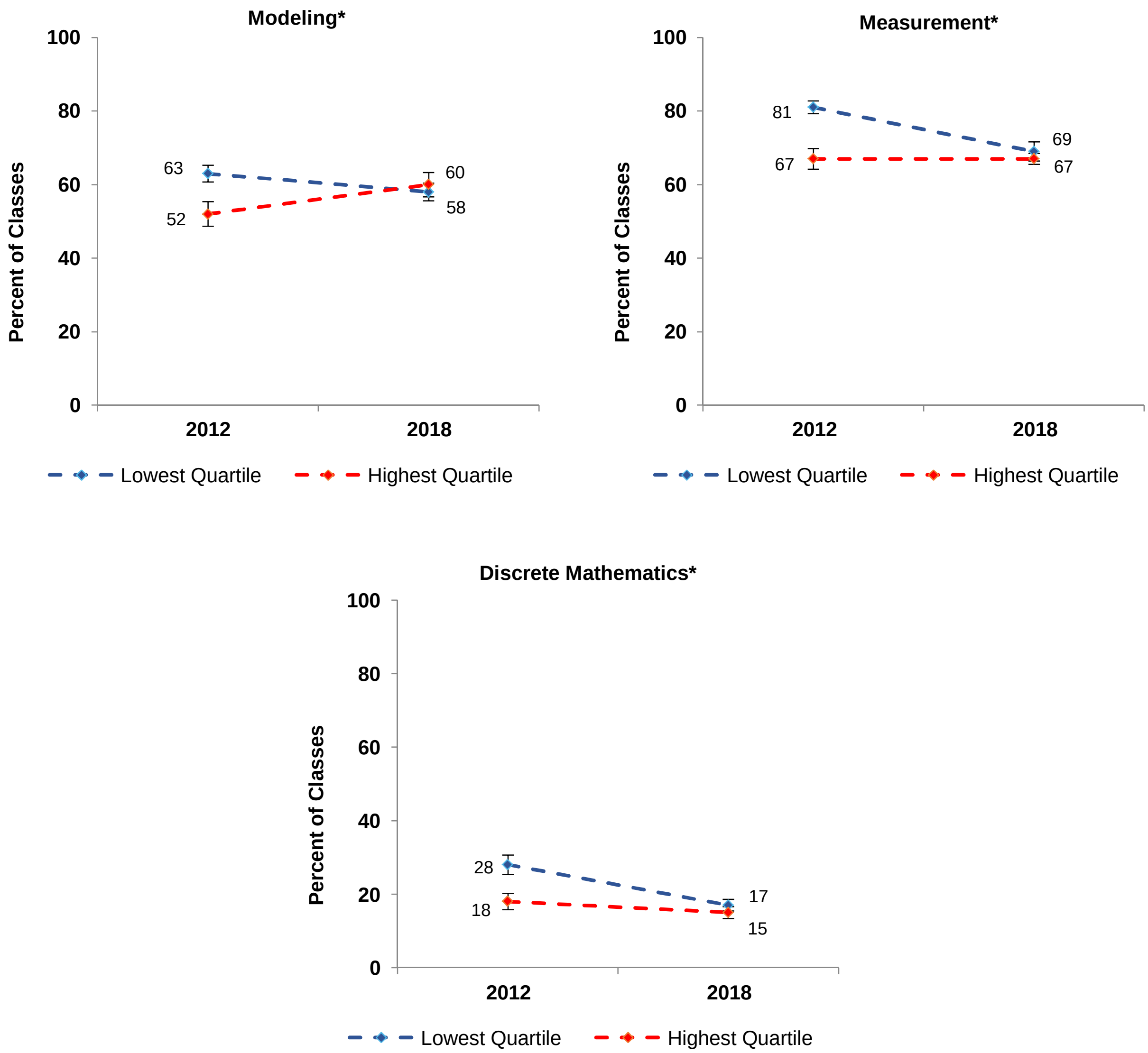
	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) The number system and operations*	90 (1.3)	88 (1.8)	87 (1.6)	85 (2.5)
(t) Algebraic thinking*	87 (1.9)	81 (1.7)	80 (2.4)	80 (2.4)
(t) Measurement	69 (2.6)	64 (2.3)	69 (2.1)	67 (2.9)
(t) Geometry	64 (2.5)	61 (2.5)	66 (2.8)	63 (3.1)
(t) Functions*	74 (2.3)	69 (2.5)	66 (3.2)	62 (3.4)
(t) Modeling	58 (2.4)	55 (2.1)	55 (2.8)	60 (3.3)
(t) Statistics and probability	36 (2.4)	36 (2.1)	36 (3.3)	32 (2.4)
(t) Discrete mathematics	17 (1.6)	18 (1.7)	14 (2.0)	15 (1.6)
Computer science/programming*	3 (0.8)	5 (1.0)	4 (0.7)	6 (1.3)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Figure 2.5 shows preparedness items with significant changes across time between classes in high-FRL and low-FRL schools. In each case, there is a narrowing of the gap. For modeling, the percentage of classes in high-FRL schools taught by teachers who felt very well prepared to teach this topic increased (from 52 to 60 percent) between 2012 and 2018, while the percentage decreased in low-FRL schools (from 63 to 58 percent). However, for measurement and discrete mathematics, the narrowing of the gap is due only to the percentage of classes in low-FRL schools taught by teachers who felt well prepared to teach these topics decreasing over time (from 81 to 69 percent and from 28 to 17 percent, respectively).

Change Over Time: Preparedness to Teach Secondary Mathematics, by FRL Quartile



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Figure 2.5

The survey asked teachers two series of items focused on their preparedness for a number of instructional tasks. First, they were asked how well prepared they feel to use a number of student-centered pedagogies, including encouraging participation of all students and differentiating their instruction to meet learners' needs. Second, they were asked how well prepared they feel to carry out a number of tasks related to monitoring and addressing student thinking in their most recent mathematics unit.

As can be seen in Table 2.25, classes in high-poverty and low-poverty schools were similar in some ways and different in others with regard to teachers' perceptions of pedagogical preparedness. In terms of similarities, nearly 60 percent of classes in both high-poverty and low-poverty schools were taught by teachers who felt very well prepared to develop students' abilities to do mathematics. Teachers in about 40 percent of classes in both quartiles felt very well prepared to encourage participation of all students in mathematics. In addition, a quarter of classes, regardless of school poverty level, were taught by teachers feeling very well prepared to provide instruction that is based on students' ideas.

However, differences by FRL quartile were also evident. Specifically, teachers of classes in high-poverty schools felt less well prepared than their low-poverty school counterparts to use formative assessment to monitor student learning (52 vs. 60 percent) and develop students' conceptual understanding (50 vs. 58 percent). Conversely, teachers of classes in high-poverty schools reported feeling better well prepared than teachers of classes in low-poverty schools to incorporate students' cultural backgrounds into mathematics instruction (23 vs. 12 percent). For the one trend item, there was no significant difference over time.

Table 2.25
Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared for Each of a Number of Tasks, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	59 (2.0)	54 (2.5)	50 (2.3)	55 (2.4)
Use formative assessment to monitor student learning*	60 (2.3)	56 (2.3)	57 (2.1)	52 (2.2)
Encourage participation of all students in mathematics	57 (2.5)	49 (2.5)	49 (2.3)	51 (2.0)
Develop students' conceptual understanding*	58 (1.8)	52 (2.3)	48 (2.2)	50 (2.8)
(t) Encourage students' interest in mathematics	45 (2.2)	37 (2.2)	40 (2.6)	39 (2.6)
Differentiate mathematics instruction to meet the needs of diverse learners	39 (2.5)	37 (2.3)	36 (2.3)	39 (2.3)
Provide mathematics instruction that is based on students' ideas	25 (1.8)	20 (1.7)	20 (1.7)	25 (2.1)
Incorporate students' cultural backgrounds into mathematics instruction*	12 (1.5)	13 (1.2)	13 (1.5)	23 (2.2)
Develop students' awareness of STEM careers	11 (1.6)	10 (1.3)	8 (1.0)	14 (1.6)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Table 2.26 shows the percentage of mathematics classes taught by teachers who felt very well prepared for each a number of tasks related to monitoring and addressing student thinking within a particular unit in a designated class. Here, the disparities between classes in the highest and lowest quartiles were numerable. Teachers of classes in the highest quartile of schools perceived themselves as less well prepared to implement each of the five tasks than their lowest quartile school counterparts. For example, 59 percent of teachers of classes in high-poverty schools felt very well prepared to assess student understanding at the conclusion of the unit compared to 71 percent of teachers of classes in low-poverty schools. When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 2.26
Mathematics Classes in Which Teachers Felt
Very Well Prepared for Various Tasks in the Most Recent Unit, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Assess student understanding at the conclusion of this unit*	71 (1.8)	65 (2.7)	63 (2.2)	59 (2.5)
(t) Monitor student understanding during this unit*	65 (1.9)	60 (2.6)	57 (2.8)	56 (2.5)
(t) Implement the instructional materials to be used during this unit*	62 (2.2)	58 (2.7)	52 (2.3)	55 (2.0)
(t) Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit*	55 (2.2)	50 (2.3)	47 (2.3)	44 (2.3)
(t) Find out what students thought or already knew about the key mathematical ideas*	49 (2.4)	44 (2.5)	39 (2.0)	38 (2.3)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

The preparedness items were used to create three composite variables: Perceptions of Content Preparedness, Perceptions of Pedagogical Preparedness, and Perceptions of Preparedness to Implement Instruction in a Particular Unit. As can be seen in Table 2.27, classes in high-poverty schools were taught by teachers with slightly weaker feelings of content preparedness and unit-specific pedagogical preparedness than classes in low-poverty schools. The 2018 data for the Perceptions of Content Preparedness and Perceptions of Preparedness to Implement Instruction in a Particular Unit are not significantly different from the 2012 data.[15]

Table 2.27
Mathematics Class Mean Scores for
Teachers' Perceptions of Preparedness Composites, by FRL Quartile

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Perceptions of Content Preparedness*	82 (0.7)	79 (0.8)	79 (0.9)	79 (0.9)
Perceptions of Pedagogical Preparedness	71 (0.8)	69 (0.8)	68 (0.9)	71 (0.8)
(t) Perceptions of Preparedness to Implement Instruction in a Particular Unit*	84 (0.8)	82 (1.0)	80 (0.9)	80 (0.7)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p < 0.05$).

Teacher Professional Development

Another important measure of teacher preparedness is the extent of their participation in professional growth opportunities. Mathematics teachers, like all professionals, need opportunities to keep up with advances in their field, in terms of both their disciplinary content knowledge and how to help students learn important mathematics content. The 2018 NSSME+ collected data on teachers' participation in professional development, including how long it has

[15] Too few items in the version of the 2018 Perceptions of Pedagogical Preparedness composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

been since they participated and characteristics of professional development they attended in the last three years.

In 2018, regardless of school poverty level, teachers in about 9 out of 10 mathematics classes participated in mathematics-focused professional development in the previous three years (see Table 2.28). Further, about 3 in 10 classes were taught by teachers with more than 35 hours of professional development in that timeframe. The 2018 data are not significantly different from the data in 2012.

Table 2.28
Professional Development Experiences of Teachers of Mathematics Classes, by FRL Quartile†

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Teacher has had professional development in the last three years	87 (1.8)	86 (1.9)	89 (1.8)	89 (1.7)
(t) Teacher has had more than 35 hours of professional development in the last three years	26 (2.1)	29 (2.3)	25 (2.1)	32 (2.2)

(t) Trend item

† There are no statistically significant differences between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p \geq 0.05$).

Of course, the effectiveness and impacts of professional development depend on how the time is spent—that is, how the experience is structured and facilitated to provide teachers with meaningful learning opportunities. 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 investigative 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.[16] 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 2.29, professional development experiences in both the highest and lowest quartiles of schools were similar. For example, over half of classes in both quartiles were taught by teachers who worked closely with other teachers from their school, or with other teachers who taught the same grade and/or subject whether or not they were from their school. Other relatively common experiences for teachers, regardless of FRL quartile, were examining classroom artifacts, experiencing lessons as their students would from the textbooks/units they

[16] 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.

use, and engaging in mathematics investigations. Opportunities to rehearse instructional practices was not a common feature of professional development in general.

Table 2.29
Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by FRL Quartile[†]

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Worked closely with other teachers from their school	65 (2.9)	71 (2.6)	72 (2.6)	68 (3.0)
(t) Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	53 (2.5)	59 (2.5)	60 (3.0)	58 (3.1)
(t) Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	45 (2.8)	41 (3.1)	47 (3.1)	52 (3.1)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	44 (3.2)	38 (2.7)	50 (2.7)	51 (3.3)
(t) Had opportunities to engage in mathematics investigations	48 (3.0)	47 (2.9)	47 (2.8)	46 (3.4)
(t) Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	41 (3.3)	44 (2.9)	51 (3.1)	46 (2.9)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	31 (3.0)	29 (2.5)	36 (2.5)	40 (3.6)

(t) Trend item

† There are no statistically significant differences between classes in the lowest quartile of schools and those in the highest quartile of schools (two-tailed independent samples t-test, $p \geq 0.05$).

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."

Interestingly, since 2012, more classes in the highest quartile of schools and fewer classes in the lowest quartile of schools were taught by teachers who worked closely with other teachers who taught the same grade and/or same subject whether or not they were from their school (see Figure 2.6). Specifically, 51 percent of classes in high-FRL schools and 60 percent in low-FRL schools were taught by teachers with this experience in 2012, compared to 58 and 53 percent of classes in 2018, respectively.

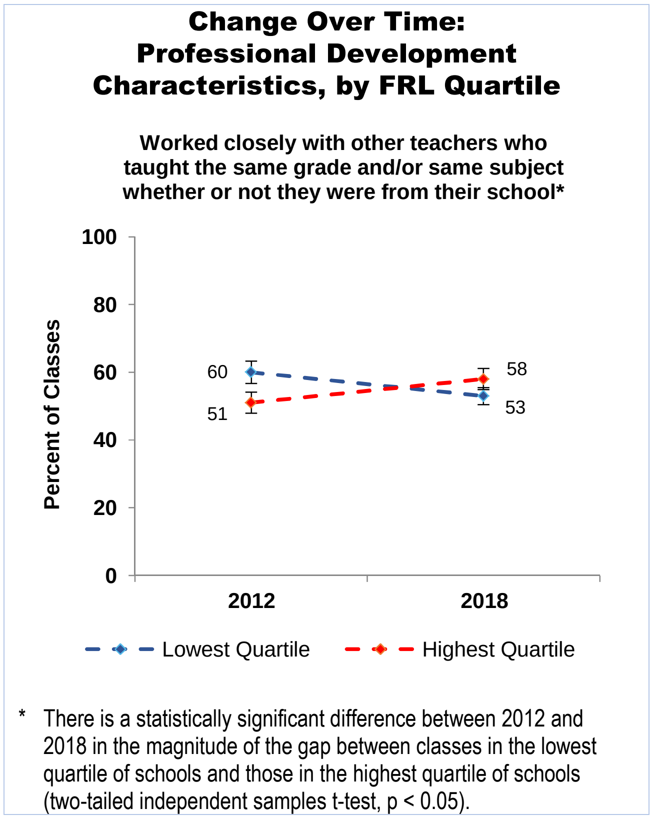


Figure 2.6

The focus of professional learning opportunities is another important factor in teachers' preparation. As can be seen in Table 2.30, there were a number of similarities in teachers' experiences between high-FRL and low-FRL schools. Teachers of about 60 percent of classes, regardless of FRL quartile, had professional development opportunities that gave heavy emphasis to monitoring student understanding during mathematics instruction, differentiating mathematics instruction to meet the needs of diverse learners, and deepening their own understanding of how mathematics is done. Other areas heavily emphasized were learning how to use hands-on activities/manipulatives, learning about difficulties students may have with particular mathematical ideas and procedures, and deepening their own mathematics content knowledge.

Classes in high-FRL schools were more likely than those in low-FRL schools to be taught by teachers whose professional development heavily emphasized incorporating students' cultural backgrounds into mathematics instruction (34 vs. 14 percent). In addition, 27 percent of classes in high-FRL schools compared to 18 percent of classes in low-FRL schools were taught by teachers whose professional development heavily focused on learning how to provide mathematics instruction that integrates engineering, science, and/or computer science. When looking at trends over time, the 2018 data are not significantly different than the 2012 data.

Table 2.30
Mathematics Classes in Which Teachers Reported That Their Professional Development in the Last Three Years Gave Heavy Emphasis[a] to Various Areas, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Monitoring student understanding during mathematics instruction	55 (2.9)	49 (3.2)	52 (2.4)	62 (3.3)
Differentiating mathematics instruction to meet the needs of diverse learners	55 (3.1)	49 (3.0)	56 (2.9)	60 (3.6)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	57 (3.7)	51 (3.2)	55 (2.6)	59 (3.7)
(t) Learning how to use hands-on activities/manipulatives for mathematics instruction	53 (3.4)	44 (3.5)	51 (2.6)	54 (3.4)
(t) Learning about difficulties that students may have with particular mathematical ideas and procedures	49 (2.7)	42 (2.6)	49 (2.8)	54 (3.4)
(t) Deepening their own mathematics content knowledge	45 (3.3)	41 (3.1)	49 (2.4)	52 (3.5)
(t) Finding out what students think or already know prior to instruction on a topic	45 (3.3)	35 (2.6)	43 (2.8)	46 (3.5)
(t) Implementing the mathematics textbook to be used in their classroom	34 (2.8)	33 (2.8)	35 (2.9)	40 (3.1)
Incorporating students' cultural backgrounds into mathematics instruction*	14 (2.2)	15 (2.2)	24 (2.5)	34 (3.3)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science*	18 (2.8)	20 (2.1)	19 (2.3)	27 (3.4)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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 the items in Table 2.29 were combined into a composite variable called Extent Professional Development Aligns with Elements of Effective Professional Development. Similarly, several items in Table 2.30 were combined into a composite called Extent Professional Development Supports Student-Centered Instruction. As can be seen in Table 2.31, regardless of school poverty level, the mean scores indicate that teachers' professional development was only somewhat aligned with elements of effective professional development and supportive of student-centered instruction. The 2018 data for the Extent Mathematics Teachers' Professional Development Aligns with Elements of Effective Professional Development are not significantly different from the 2012 data.[17]

[17] Too few of the items in the 2018 version of the Extent Professional Development Supports Student-Centered Instruction composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Table 2.31
Mathematics Class Mean Scores for Teachers' Professional Development Composites, by FRL Quartile†

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Extent Professional Development Aligns With Elements of Effective Professional Development[a]	57 (1.5)	56 (1.3)	60 (1.3)	60 (1.4)
Extent Professional Development Supports Student-Centered Instruction	58 (1.3)	55 (1.1)	59 (1.1)	62 (1.7)

(t) Trend item

† There are no statistically significant differences between classes in the lowest quartile of schools and those in the highest quartile of schools (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Summary

Overall, there were some differences between high-FRL and low-FRL schools in terms of teachers' backgrounds and experiences, though they tended to be small. Regardless of FRL quartile, a majority of classes were taught by teachers with more than five years of teaching experience and substantial coursework related to NCTM preparation standards. A majority of teachers of secondary classes also had a degree in mathematics or mathematics education. However, classes in high-FRL schools were more likely than those in low-FRL schools to be taught by teachers from race/ethnicity groups historically underrepresented in STEM.

Both reform-oriented beliefs and traditional beliefs about teaching and learning were significantly stronger among teachers of classes in high-poverty schools. For example, a greater percentage of classes in high-FRL schools than their low-FRL school counterparts were taught by teachers who agreed that students learn best when instruction is connected to their everyday lives, as well as those who also agreed that teachers should explain an idea to students before having them investigate the idea.

Teachers of classes in both high-FRL and low-FRL schools reported similar levels of pedagogical preparedness (e.g., developing students' abilities to do mathematics). However, teachers of classes in high-poverty schools were somewhat less likely to have strong feelings of preparedness to implement tasks related to monitoring and addressing student thinking within a particular unit in a designated class.

There were also a number of similarities among schools with regard to teachers' professional development experiences. For example, a large majority of classes in the highest and lowest quartiles of schools were taught by teachers who participated in mathematics-focused professional development in the last three years. Also, teachers of classes in both quartiles reported similar characteristics of their professional development experiences (e.g., working closely with other teachers from their schools) and similar emphases (e.g., learning how to monitor student understanding during mathematics instruction). Interestingly, classes in the highest quartile of schools were more likely than those in the lowest quartile to be taught by teachers whose professional development heavily emphasized incorporating students' cultural backgrounds into mathematics instruction and learning how to provide mathematics instruction that integrates engineering, science, and/or computer science.

Since 2012, there have been some significant changes in the distribution of well-prepared teachers between high-FRL schools and their low-FRL school counterparts, but not many. Two notable differences have become more pronounced between 2012 and 2018. The first is the difference between classes taught by teachers from race/ethnicity groups underrepresented in STEM; more classes in high-poverty schools and fewer classes in low-poverty schools were taught by teachers from these groups in 2018. The second significant change is the difference between classes taught by elementary teachers who reported feeling well prepared to teach geometry. In this case, fewer classes in high-poverty schools than those in low-poverty schools were taught by teachers feeling well prepared to teach this topic.

Other differences became less pronounced between 2012 and 2018, specifically in relation to secondary teachers' perceptions of preparedness to teach various mathematics topics, including modeling, measurement, and discrete mathematics. In most cases, the narrowing of the gaps can be attributed to teachers in low-poverty schools feeling less well prepared over time. Another difference between 2012 and 2018 was in terms of teachers' professional development experiences. In particular, more classes in high-poverty schools and fewer classes in low-poverty schools were taught by teachers who worked closely with other teachers who taught the same grade and/or same subject whether or not they were from their school.

Supportive Context for Learning

Student opportunity to learn mathematics is also affected by a number of contextual factors. The 2018 NSSME+ collected information on professional development opportunities offered by schools and districts, including workshops, teacher study groups, and formal induction programs. It also asked about mathematics programs and practices to enhance students' interest in mathematics, and factors that promote and inhibit mathematics instruction in the school, such as administrator and community support. This section presents these data, highlighting the similarities and differences between high-FRL and low-FRL schools.

Locally Offered Professional Development

School representatives were asked whether mathematics-focused professional development workshops have been offered by their school and/or district, possibly in conjunction with other school systems, colleges or universities, museums, professional associations, or commercial vendors. As can been seen in Table 2.32, over half of schools, regardless of poverty level, had locally offered workshops and study groups (ranging from 56–73 percent). However, high-poverty schools were almost twice as likely as low-poverty schools to offer mathematics-focused one-on-one coaching (54 vs. 29 percent), perhaps a reflection of additional Title 1 resources high-poverty schools may have received.

Table 2.32
Types of Locally Offered Mathematics Professional Development Available to Teachers in the Last Three Years, by FRL Quartile

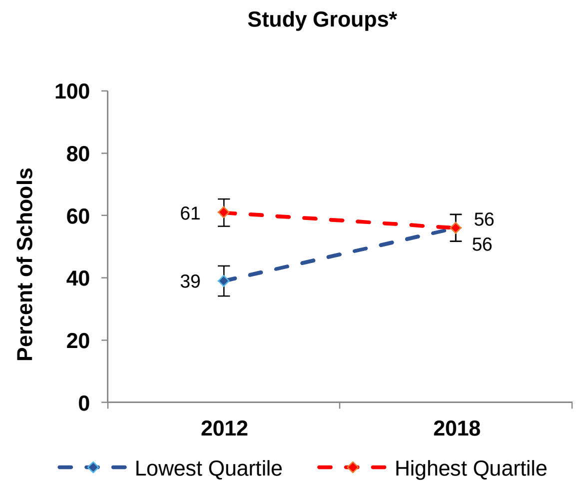
	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Workshops	61 (4.5)	63 (4.6)	67 (3.8)	73 (3.7)
(t) Study groups	56 (4.3)	63 (4.9)	57 (5.0)	56 (4.3)
(t) One-on-one coaching*	29 (4.1)	33 (4.7)	49 (4.5)	54 (4.6)

(t) Trend item

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

As can be seen in Figure 2.7, there has been a significant change in the difference between high-poverty and low-poverty schools offering study groups since 2012. The gap is narrowing as fewer high-poverty schools and more low-poverty schools were offering study groups in 2018 compared to 2012.

Change Over Time:
Professional Development Opportunities, by FRL Quartile



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

Figure 2.7

Mathematics program representatives who indicated that workshops have been offered locally in the last three years were asked about the extent to which that professional development emphasized each of a number of areas. As can be seen in Table 2.33, about 60–70 percent of high-FRL and low-FRL schools indicated that locally offered workshops emphasized deepening teachers' understanding of mathematics content and how mathematics is done. Deepening teachers' understanding of how students think about various mathematical ideas, learning how to engage students in doing mathematics, and learning how to monitor student understanding were also relatively common emphases (ranging from 41–58 percent of schools).

In contrast, the highest quartile of schools were more likely than their lowest-quartile counterparts to substantially emphasize other areas, such as deepening teachers' understanding of state mathematics standards (73 vs. 50 percent); learning how to differentiate mathematics instruction to meet the needs of diverse learners (55 vs. 34 percent); and learning how to incorporate students' cultural backgrounds into mathematics instruction (27 vs. 5 percent). When looking at trends, the 2018 data are not significantly different from the 2012 data.

Table 2.33
Locally Offered Mathematics Professional Development Workshops in the Last Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by FRL Quartile

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Deepening teachers' understanding of the state mathematics standards*	50 (5.8)	66 (5.7)	72 (5.6)	73 (4.8)
(t) Deepening teachers' understanding of mathematics concepts	60 (5.0)	54 (5.9)	59 (5.7)	70 (4.7)
Deepening teachers' understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	59 (5.5)	54 (6.6)	62 (5.6)	70 (4.8)
(t) Deepening teachers' understanding of how students think about various mathematical ideas	50 (5.8)	57 (5.9)	61 (5.6)	58 (5.5)
(t) How to use particular mathematics instructional materials (e.g., textbooks)*	40 (5.9)	47 (5.7)	52 (5.4)	58 (5.0)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	45 (6.3)	50 (5.6)	56 (5.5)	57 (5.1)
(t) How to monitor student understanding during mathematics instruction	41 (6.0)	52 (5.5)	58 (5.9)	57 (6.0)
How to differentiate mathematics instruction to meet the needs of diverse learners*	34 (5.5)	38 (6.3)	47 (5.3)	55 (4.7)
(t) How to use technology in mathematics instruction	43 (4.6)	52 (6.0)	54 (6.0)	46 (5.9)
(t) How to use investigation-oriented tasks in mathematics instruction	39 (5.1)	38 (5.4)	43 (5.4)	45 (5.8)
(t) How to adapt mathematics instruction to address student misconceptions	30 (5.1)	45 (5.5)	51 (5.7)	45 (5.6)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction	28 (5.3)	26 (5.0)	32 (4.9)	37 (5.5)
How to integrate science, engineering, mathematics, and/or computer science	24 (5.1)	36 (5.8)	30 (5.6)	28 (5.0)
How to connect instruction to mathematics career opportunities*	12 (3.6)	22 (5.4)	21 (4.9)	28 (4.6)
How to develop students' confidence that they can successfully pursue careers in mathematics	23 (4.2)	17 (4.2)	29 (5.0)	27 (5.3)
How to incorporate students' cultural backgrounds into mathematics instruction*	5 (1.8)	8 (2.5)	11 (3.4)	27 (4.5)

(t) Trend item

* There is a statistically significant difference between schools in the lowest quartile and those in the highest quartile (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."

Further, school program representatives were asked about the extent to which the teacher study groups have addressed each of a number of topics. These data are presented in Table 2.34. Similar to the pattern seen with locally offered workshops, learning how to engage students in doing mathematics, deepening teachers' understanding of how mathematics is done, and learning how to monitor student understanding during mathematics instruction was a common emphasis regardless of FRL quartile.

Differences between high-FRL and low-FRL schools were also evident. For example, three-fourths of high-FRL schools, compared to about half of low-FRL schools, had study groups that substantially emphasized deepening teachers' understanding of the state mathematics standards. Other significant differences included learning how to: (1) incorporate real-world issues into mathematics instruction; (2) integrate science, mathematics, and/or computer science; (3) incorporate students' cultural backgrounds in mathematics instruction; and (4) connect instruction to mathematics careers. Each of these topics was emphasized more in high-FRL schools than in low-FRL schools.

Table 2.34
Locally Offered Mathematics Teacher Study Groups in the Last Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by FRL Quartile

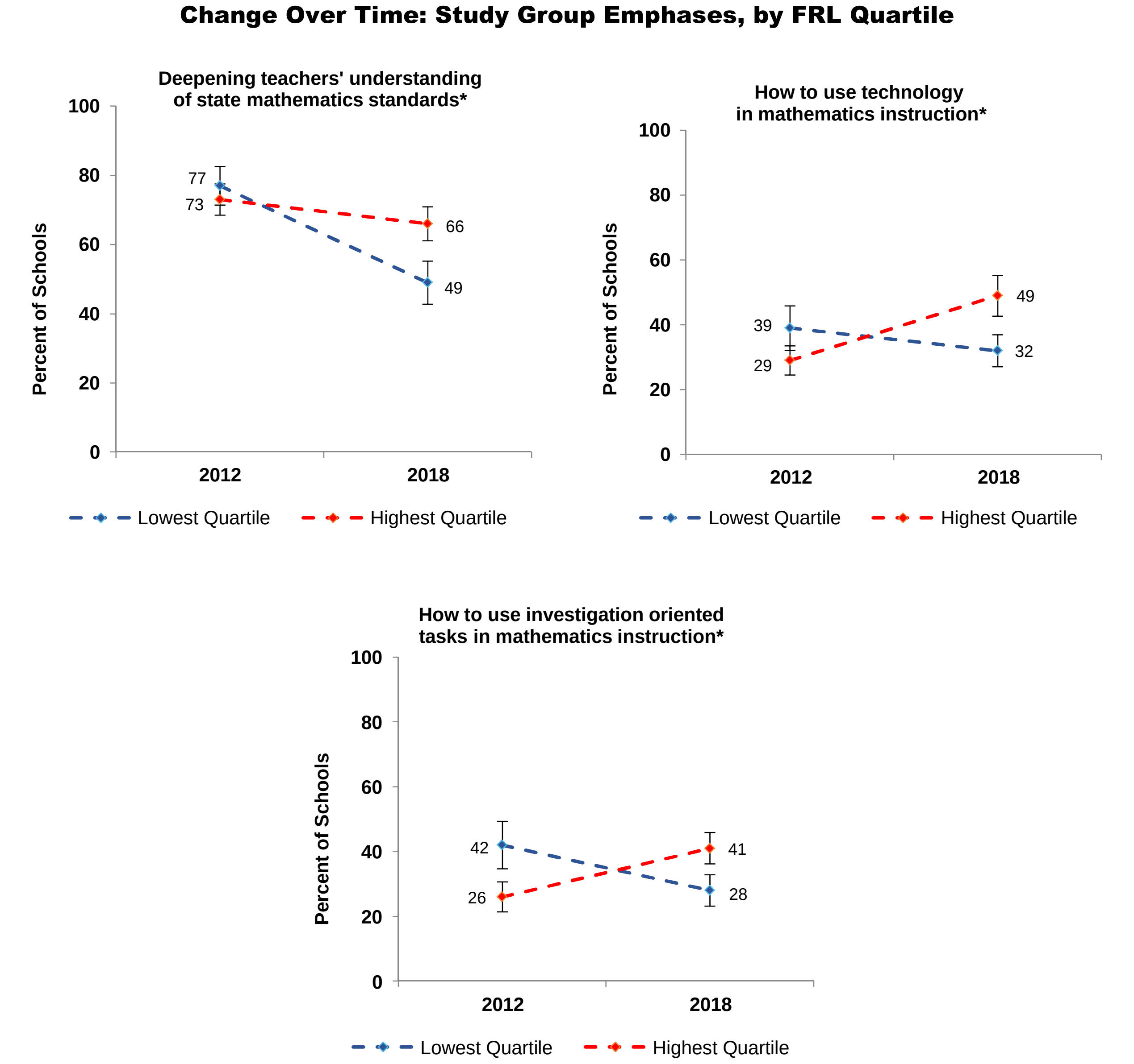
	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Deepening teachers' understanding of the state mathematics standards*	49 (6.2)	57 (5.5)	75 (4.4)	66 (4.9)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	56 (5.8)	55 (5.6)	67 (4.7)	60 (5.0)
Deepening teachers' understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	51 (6.0)	45 (5.9)	58 (5.6)	60 (4.9)
How to differentiate mathematics instruction to meet the needs of diverse learners	48 (5.8)	50 (5.3)	53 (5.2)	59 (4.9)
(t) How to monitor student understanding during mathematics instruction	46 (5.7)	52 (6.3)	58 (5.0)	55 (5.2)
(t) Deepening teachers' understanding of mathematics concepts	44 (5.9)	41 (6.5)	53 (5.5)	54 (5.0)
(t) Deepening teachers' understanding of how students think about various mathematical ideas	55 (6.4)	45 (6.2)	61 (4.8)	53 (5.4)
(t) How to use particular mathematics instructional materials (e.g., textbooks)	45 (5.1)	40 (5.9)	62 (5.0)	52 (6.2)
(t) How to use technology in mathematics instruction	32 (4.9)	31 (5.1)	47 (4.6)	49 (6.3)
(t) How to adapt mathematics instruction to address student misconceptions	47 (5.9)	47 (6.0)	61 (5.3)	47 (5.4)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction*	27 (5.1)	28 (5.1)	39 (5.7)	46 (5.0)
(t) How to use investigation-oriented tasks in mathematics instruction	28 (4.8)	30 (5.6)	43 (5.4)	41 (4.8)
How to integrate science, engineering, mathematics, and/or computer science*	16 (4.1)	28 (6.0)	28 (5.1)	31 (5.0)
How to incorporate students' cultural backgrounds into mathematics instruction*	8 (2.8)	15 (4.3)	15 (4.1)	31 (4.4)
How to connect instruction to mathematics career opportunities*	12 (3.6)	22 (5.4)	21 (4.9)	28 (4.6)
How to develop students' confidence that they can successfully pursue careers in mathematics	14 (3.9)	17 (4.7)	30 (5.6)	24 (4.3)

(t) Trend item

* There is a statistically significant difference between schools in the lowest quartile and those in the highest quartile (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."

From 2012 to 2018, fewer high-FRL and low-FRL schools emphasized deepening teachers' understanding of state mathematics standards during their study groups (see Figure 2.8). A different pattern exists for two other areas of emphasis. In 2012, 26 percent of high-FRL schools and 42 percent of low-FRL schools emphasized how to use investigation-oriented tasks in mathematics instruction during study groups, compared to 28 and 41 percent, respectively, in 2018. Similarly, study groups in 29 percent of high-FRL schools and 39 percent in low-FRL schools emphasized learning how to use technology in mathematics instruction in 2012, compared to 49 and 32 percent, respectively, in 2018.



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

Figure 2.8

School mathematics program representatives were also asked about services provided to teachers in need of special assistance. Interestingly, there were no significant differences in the types of services provided between high-FRL or low-FRL schools (see Table 2.35). About half of schools offered guidance from a formally designated mentor or coach; a higher level of supervision and seminars, classes, and/or study groups were each offered in about a third of schools. The 2018 data are not significantly different from the 2012 data.

Table 2.35
Services Provided to Teachers in Need of Special Assistance in Teaching, by FRL Quartile†

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Guidance from a formally designated mentor or coach	47 (4.2)	47 (4.8)	58 (4.2)	58 (4.6)
(t) A higher level of supervision than for other teachers	30 (3.9)	27 (3.6)	34 (3.6)	37 (4.5)
(t) Seminars, classes, and/or study groups	30 (4.5)	43 (4.9)	38 (4.8)	31 (4.2)

(t) Trend item

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

Formal induction programs provide critical support and guidance for beginning teachers and show promise for having a positive impact on teacher retention, instructional practices, and student achievement in schools.[18] However, the effectiveness of these programs greatly depends on their length and the nature of the supports offered to teachers. Accordingly, school coordinators were asked a series of questions about formal induction programs at the schools.

In 2018 the percentage of schools offering a formal teacher induction program was similar by school poverty level, with about three-fourths of schools having a program. About 3 in 10 schools, regardless of FRL quartile, had programs that lasted one year or less, and about 4 in 10 schools had programs that lasted two years or more (see Table 2.36). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 2.36
Typical Duration of Formal Induction Programs, by FRL Quartile†

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
No formal induction program	30 (3.6)	21 (3.9)	23 (4.1)	22 (3.8)
One year or less	32 (3.7)	29 (4.0)	36 (4.2)	36 (3.9)
Two years or more	38 (3.5)	49 (4.6)	41 (4.4)	42 (4.3)

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

The research on effective induction programs for beginning teachers also suggests a number of supports that are important for a program's success. One key element is having an experienced mentor, in particular one who teaches the same subject or grade level as the mentee. As can be

[18] Ingersoll, R., & Strong, M. (2011). *The impact of induction and mentoring programs for beginning teachers: A critical review of the research*. Retrieved from https://repository.upenn.edu/gse_pubs/127.

seen in Table 2.37, high- and low-FRL schools were equally likely to provide school-based mentors for new teachers.

Table 2.37
Schools Providing Formally Assigned School-Based Mentors, by FRL Quartile†

	PERCENT OF SCHOOLS[a]
Lowest Quartile Schools	85 (3.4)
Second Quartile Schools	87 (2.7)
Third Quartile Schools	87 (2.5)
Highest Quartile Schools	83 (3.4)

† There is not a statistically significant difference between schools in the lowest quartile and those in the highest quartile (two-tailed independent samples t-test, $p \geq 0.05$).

[a] Includes only those schools that provide a formal induction program.

Factors Affecting Student Opportunity to Learn

School programs and practices are important components of student opportunity to learn mathematics. The NSSME+ asked school program representatives about instructional arrangements, course formats, and other practices that promote interest in mathematics and support (or inhibit) effective mathematics instruction. Table 2.38 shows the prevalence of various instructional arrangements for students in elementary self-contained classrooms. The data are essentially the same in the highest quartile and lowest quartile of schools. For example, about 60 percent of schools in each quartile pulled students in self-contained classes out for remedial instruction in mathematics. Also, about a quarter of schools in these two quartiles had students in self-contained classes receive instruction from a mathematics specialist in addition to their regular teacher. Although the use of specialists in the highest and lowest quartiles was similar in 2018, it was more common in high-FRL schools than low-FRL schools (40 vs. 11 percent) in 2012 (see Figure 2.9).

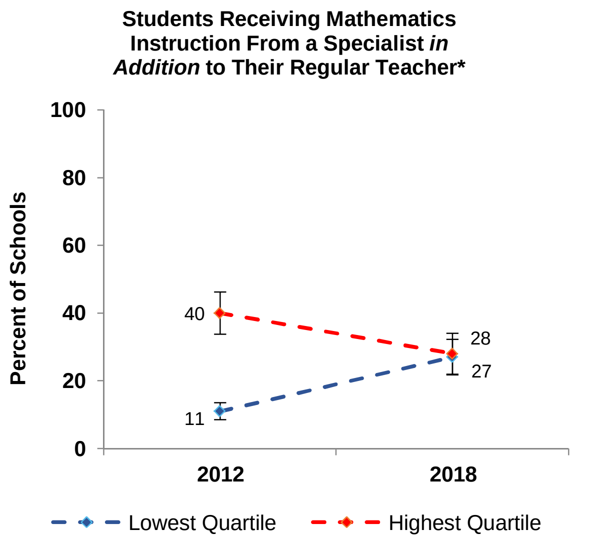
Table 2.38
Use of Various Instructional Arrangements in Elementary Schools, by FRL Quartile†

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Students in self-contained classes are pulled out for remedial instruction in mathematics.	61 (6.2)	64 (5.4)	68 (4.6)	56 (6.8)
(t) Students in self-contained classes are pulled out for enrichment in mathematics.	28 (5.8)	42 (5.7)	40 (6.0)	36 (6.2)
(t) Students in self-contained classes are pulled out from mathematics instruction for additional instruction in other content areas.	21 (5.3)	23 (5.4)	24 (5.3)	29 (6.0)
(t) Students in self-contained classes receive mathematics instruction from a district/diocese/school mathematics specialist *in addition* to their regular teacher.	27 (5.3)	17 (5.1)	22 (4.6)	28 (6.1)
(t) Students in self-contained classes receive mathematics instruction from a district/diocese/school mathematics specialist *instead of* their regular teacher.	15 (4.9)	2 (1.2)	3 (1.8)	9 (3.6)

(t) Trend item

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

Change Over Time: Elementary Grades Instructional Arrangements, by FRL Quartile



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

Figure 2.9

At the high school level, the NSSME+ asked about a number of specific course-taking opportunities and formats provided to students. The only difference between high-FRL and low-FRL schools on these items was in the access to virtual mathematics courses offered by other schools/institutions (see Table 2.39). High-FRL schools were more likely to offer this opportunity to students than their low-FRL school counterparts (66 vs. 48 percent).

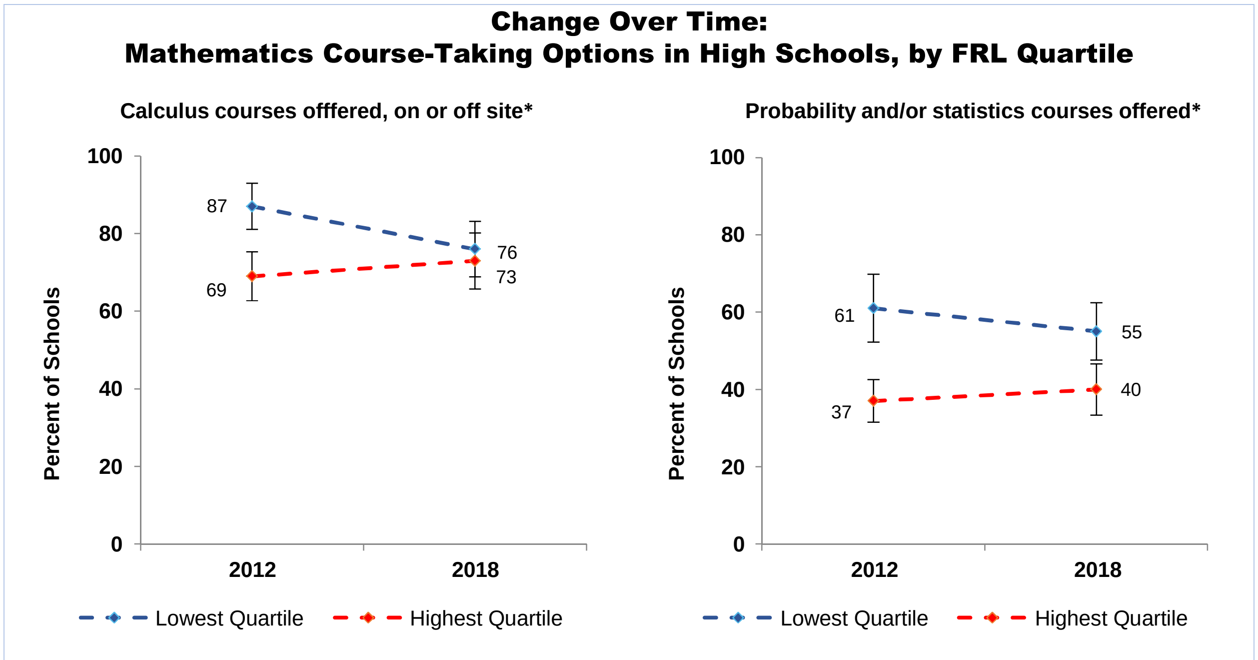
Table 2.39
Mathematics Course-Taking Options in High Schools, by FRL Quartile

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Students can go to a college or university for mathematics courses.	65 (5.7)	66 (5.2)	67 (7.4)	77 (6.2)
(t) Calculus courses (beyond pre-calculus) are offered this school year or in alternating years, on or off site.	76 (7.1)	86 (6.2)	69 (7.7)	73 (7.2)
(t) Concurrent college and high school credit/dual enrollment courses are offered this school year or in alternating years.	51 (6.0)	69 (6.7)	81 (4.9)	66 (7.1)
This school provides students access to virtual mathematics courses offered by other schools/institutions.*	48 (5.9)	62 (5.7)	61 (6.1)	66 (6.5)
(t) Algebra 1 course, or its equivalent, is offered over two years or as two separate block courses (e.g., Algebra A and Algebra B).	39 (6.9)	36 (6.5)	47 (6.7)	53 (7.1)
(t) Probability and/or statistics courses are offered.	55 (7.4)	64 (6.1)	47 (6.1)	40 (6.6)
(t) Students can go to a Career and Technical Education center for mathematics instruction.	14 (4.1)	21 (3.6)	30 (5.3)	26 (6.1)
This school provides its own mathematics courses virtually.	11 (2.7)	19 (6.4)	16 (5.1)	17 (5.6)
(t) Students can go to another K–12 school for mathematics courses.	8 (2.1)	15 (4.9)	9 (2.9)	10 (3.8)

(t) Trend item

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

Interestingly, the gap between the percentage of high-FRL and low-FRL schools offering calculus courses (on or off site) and probability and/or statistics courses has changed significantly since 2012 (see Figure 2.10). The narrowing of the gap appears to be due to both more high-FRL schools and fewer low-FRL schools offering these courses in 2018. Specifically, in 2012, 69 percent of high-FRL schools and 87 percent of low-FRL schools offered calculus courses, compared to 73 and 76 percent of schools, respectively, in 2018. Similarly, in 2012, 37 percent of high-FRL schools and 61 percent of low-FRL schools offered probability and/or statistics; in 2018 there was a smaller difference in these percentages (40 vs. 55 percent).



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

Figure 2.10

Program representatives were also asked to indicate which of several programs and practices their school employs to enhance student interest and/or achievement in mathematics. As can be seen in Table 2.40, the data are mixed. Although significantly more high-FRL schools than low-FRL schools offered after-school help (81 vs. 65 percent) and family nights (45 vs. 20 percent), significantly fewer of high-FRL schools offered opportunities to participate in mathematics competitions that often involve more advanced content (26 vs. 39 percent). Then again, similar percentages of schools in both high-FRL and low-FRL schools offered after school programs for enrichment and mathematics clubs (ranging from 24–36 percent). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 2.40
School Programs/Practices to Enhance Students' Interest in Mathematics, by FRL Quartile

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) After-school help*	65 (4.1)	70 (4.2)	76 (3.7)	81 (3.6)
(t) Family nights*	20 (3.9)	23 (4.2)	34 (4.0)	45 (4.1)
(t) After-school programs for enrichment	30 (3.8)	25 (4.0)	20 (3.5)	36 (4.1)
(t) Participation in mathematics competitions*	39 (4.3)	32 (3.9)	36 (4.0)	26 (3.7)
(t) Mathematics clubs	30 (3.8)	26 (3.6)	27 (3.6)	24 (3.4)

(t) Trend item

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

Table 2.41 presents school representatives' views on factors that promote mathematics instruction in schools. Overall, there was little variation in these factors among schools by FRL quartile. Representatives from about three-fourths of schools in the highest and lowest quartiles rated the importance the school places on mathematics as promoting effective instruction. Amount of time provided by the school/district for teachers to share ideas about mathematics instruction was also seen as a promoting factor by representatives in about one-half of schools in the highest and lowest quartiles. Not surprising given extra Title 1 resources, more high-poverty schools than low-poverty schools rated the amount of time provided by the school/district for teacher professional development as a promoting factor (58 vs. 44 percent).

Table 2.41
Factors Promoting Effective Mathematics Instruction, by FRL Quartile

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) The importance that the school places on mathematics	75 (3.7)	84 (3.1)	79 (3.6)	74 (3.7)
(t) The school/district/diocese mathematics professional development policies and practices	59 (4.2)	69 (4.6)	67 (4.1)	69 (4.5)
(t) The amount of time provided by the school/district/diocese for teacher professional development in mathematics*	44 (4.5)	53 (4.7)	54 (4.4)	58 (4.6)
How mathematics instructional resources are managed (e.g., distributing and replacing materials)	55 (4.3)	62 (4.2)	60 (4.4)	57 (4.3)
The amount of time provided by the school/district/diocese for teachers to share ideas about mathematics instruction	50 (4.2)	48 (4.0)	54 (4.1)	57 (4.7)
(t) Other school and/or district/diocese initiatives	44 (4.3)	48 (4.7)	51 (4.1)	42 (4.3)

(t) Trend item

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

Since 2012, the difference between high-FRL and low-FRL schools' views on the influence of the amount of time provided for professional development has significantly changed. As shown in Figure 2.11, 52 percent of high-FRL schools and 62 percent of low-FRL schools rated this factor as promoting in 2012, compared to 58 and 44 percent of schools in 2018, respectively. This finding suggests that between 2012 and 2018, mathematics-focused professional development became less of a priority in low-poverty schools.

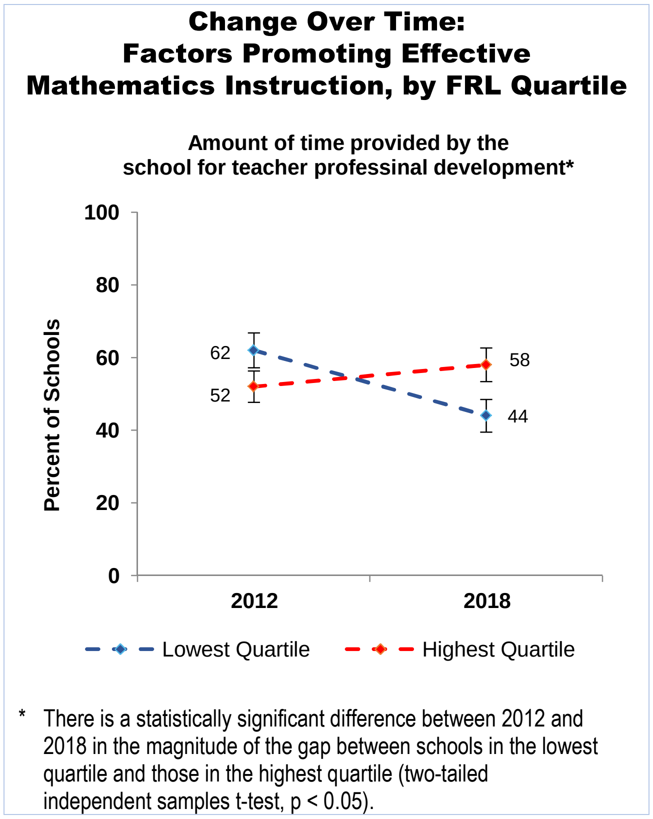


Figure 2.11

A subset of items from Table 2.41 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 2.42, regardless of FRL quartile, schools had a fairly supportive context for mathematics instruction.

Table 2.42
School Mean Scores for the Supportive Context for Mathematics Instruction Composite,[a] by FRL Quartile[(t),†]

	MEAN SCORE
Lowest Quartile Schools	69 (1.8)
Second Quartile Schools	71 (2.0)
Third Quartile Schools	73 (1.6)
Highest Quartile Schools	72 (2.2)

(t) Trend item

† There is not a statistically significant difference between schools in the lowest quartile and those in the highest quartile (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. Because there is a significant difference between the two time points for this factor, the data in this table are based on the recomputed composite definition.

However, the difference between the high-FRL schools and low-FRL schools mean scores for the Supportive Context composite has changed significantly since 2012 (see Figure 2.12). Interestingly, the narrowing of the gap appears to be due to the context for mathematics instruction in low-FRL schools becoming less supportive, dropping from a mean score of 81 in 2012 to 69 in 2018.

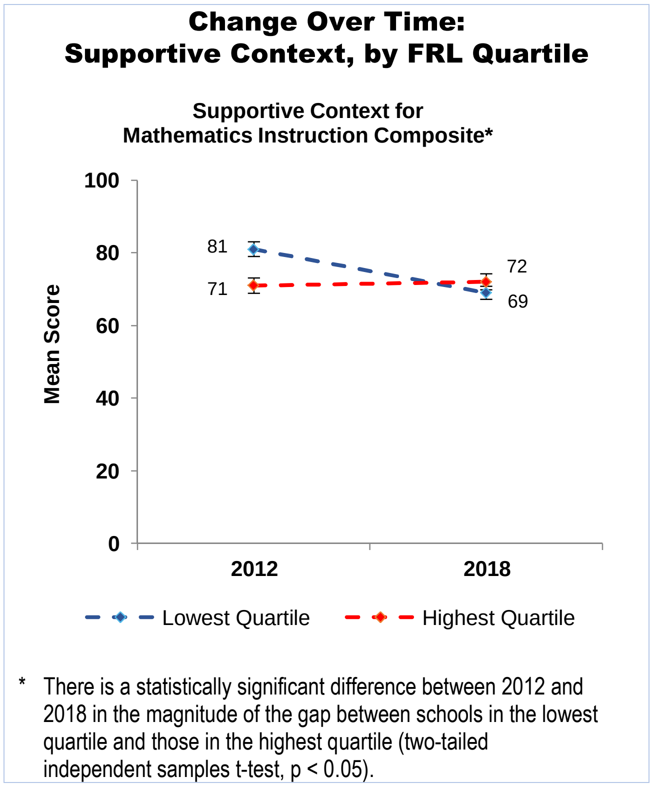


Figure 2.12

Program representatives were also asked to rate whether each of several factors is a problem for mathematics instruction in their school. Here a discouraging pattern exits. As can be seen in Table 2.43, significantly more high-poverty schools than low-poverty schools rated a number of factors as problematic. For example, 85 percent of high-FRL schools, compared to 62 percent of low-FRL schools, indicated that low student prior knowledge and skills was a problem. Lack of parent/guardian support and involvement was also viewed as problematic in 80 percent of high-FRL schools but only 41 percent of low-FRL schools. In addition, low student interest in mathematics, high student absenteeism, and inappropriate student behavior were more likely to be seen as problems in high-poverty schools. Furthermore, a higher percentage of high-FRL schools reported inadequate funds for purchasing mathematics equipment and supplies and lack of mathematics textbooks as problematic factors.

Table 2.43

Mathematics Program Representatives Viewing Each of a Number of Factors as a Problem[a] for Mathematics Instruction in Their School, by FRL Quartile

	PERCENT OF SCHOOLS			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Low student prior knowledge and skills*	62 (4.8)	68 (4.5)	86 (2.7)	85 (3.4)
(t) Lack of parent/guardian support and involvement*	41 (4.3)	57 (5.5)	81 (3.0)	80 (4.1)
(t) Low student interest in mathematics*	47 (5.2)	61 (4.3)	76 (4.2)	72 (4.6)
(t) High student absenteeism*	23 (3.7)	46 (5.3)	67 (3.8)	69 (4.5)
(t) Inappropriate student behavior*	25 (3.7)	46 (5.3)	66 (4.2)	63 (4.2)
(t) Inadequate mathematics-related professional development opportunities	52 (4.7)	48 (4.0)	49 (3.9)	55 (4.8)
(t) Inadequate materials for differentiating mathematics instruction	56 (4.0)	52 (4.4)	50 (4.1)	54 (4.8)
(t) Large class sizes*	37 (4.0)	35 (4.2)	41 (4.1)	52 (4.9)
High teacher turnover*	19 (3.8)	23 (3.5)	36 (4.8)	51 (4.7)
(t) Inadequate funds for purchasing mathematics equipment and supplies*	35 (4.1)	33 (4.1)	35 (4.4)	50 (4.5)
Community attitudes toward mathematics instruction*	29 (4.2)	39 (4.3)	51 (4.0)	46 (3.9)
(t) Insufficient instructional time to teach mathematics	39 (4.3)	34 (4.9)	37 (4.6)	42 (4.4)
(t) Inadequate teacher preparation to teach mathematics*	30 (3.7)	29 (4.8)	36 (4.8)	42 (4.7)
Poor quality mathematics textbooks	34 (4.0)	24 (3.3)	31 (4.3)	38 (4.3)
Lack of equipment and supplies and/or manipulatives for teaching mathematics (e.g., materials for students to draw, cut, and build in order to make sense of problems)	28 (3.7)	24 (4.4)	30 (4.3)	38 (4.6)
Lack of mathematics textbooks*	16 (3.0)	20 (3.1)	20 (3.6)	30 (4.3)
(t) Lack of teacher interest in mathematics	19 (3.4)	19 (3.8)	25 (4.1)	25 (4.1)

(t) Trend item

* There is a statistically significant difference between schools in the lowest quartile and those in the highest quartile (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."

In general, the differences in program representatives' views of problematic factors have not significantly changed since 2012. The one exception is low student interest in mathematics (see Figure 2.13). In 2012, 83 percent of high-poverty schools compared to 31 percent of low-poverty schools saw this factor as a problem. In 2018, these percentages changed to 72 and 47, respectively. While these data represent somewhat of an improvement in high-poverty schools, the percentage of schools that view this factor as problematic was still high in 2018, indicating a persistent challenge to be addressed in an effort to build student interest in the mathematics field.

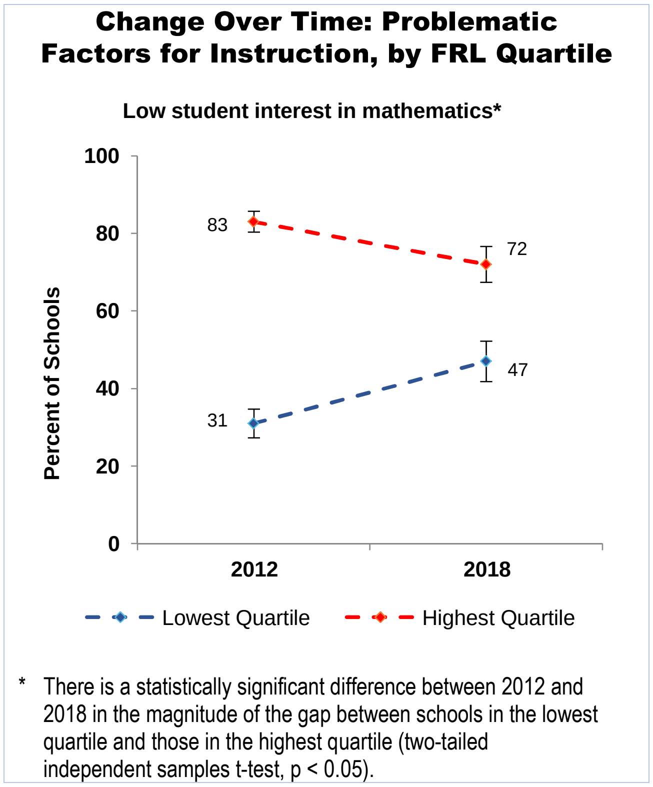


Figure 2.13

Composite variables created from the items in Table 2.43 allow for a summary of the factors affecting mathematics instruction (see Table 2.44). The Extent to Which Student Issues are Problematic composite consists of the following items:

- Low student interest in mathematics;
- Low student prior knowledge and skills;
- High student absenteeism;
- Inappropriate student behavior;
- Lack of parent/guardian support and involvement; and
- Community attitudes toward mathematics instruction.

For Extent to Which a Lack of Resources is Problematic, the items are:

- Lack of equipment and supplies and/or manipulatives for teaching mathematics;
- Inadequate funds for purchasing mathematics equipment and supplies;
- Lack of mathematics textbooks;
- Poor quality mathematics textbooks; and
- Inadequate materials for differentiating mathematics instruction.

Items for the Extent to Which Teacher Issues are Problematic composite are:

- Lack of teacher interest in mathematics;
- Inadequate teacher preparation to teach mathematics;
- Insufficient instructional time to teach mathematics; and
- Inadequate mathematics-related professional development opportunities.

The mean scores for the Extent to Which Student Issues are Problematic composite was higher for high-poverty schools than low-poverty schools (mean scores of 48 vs. 23). A similar pattern, though the difference was smaller, is seen on the Extent to Which Lack of Resources is Problematic composite (mean scores of 26 vs. 20). The 2018 data for these composites are not significantly different from the 2012 data.[19]

Table 2.44
School Mean Scores for Factors Affecting Mathematics Instruction Composites, by FRL Quartile

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Extent to Which Student Issues are Problematic*,[a]	23 (2.1)	32 (2.3)	46 (1.9)	48 (2.3)
(t) Extent to Which a Lack of Resources is Problematic*,[b]	20 (1.5)	18 (1.8)	20 (1.7)	26 (2.3)
Extent to Which Teacher Issues are Problematic	21 (2.0)	18 (1.9)	20 (1.6)	25 (2.0)

(t) Trend item

* There is a statistically significant difference between schools in the lowest quartile and those in the highest quartile (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

[b] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Teachers were also asked about factors that affect mathematics instruction. Similar to the findings from the program questionnaires, there was little variation in teachers' perceptions of support by FRL quartile (see Table 2.45). A majority of classes in high-FRL and low-FRL schools were taught by teachers who rated the amount of time available for mathematics instruction as a promoter of effective mathematics instruction. Also, current state standards, principal support, and amount of time for teachers to plan, individually and with colleagues, were viewed as promoting effective mathematics instruction by teachers in about 70 percent of mathematics classes regardless of school poverty level. There were significant differences between classes in high- and low-FRL schools on three items. Teachers of classes in high-FRL schools were less likely than those in classes of low-FRL school to rate students' prior knowledge and skills as promoting effective instruction (56 vs. 69 percent). Similarly, student motivation, interest, and effort in mathematics was less likely to be seen as promoting effective mathematics instruction in high-FRL schools than in low-FRL schools (54 vs. 69 percent). In addition, 42 percent of classes in high-FRL schools compared to 57 percent of classes in low-FRL schools were taught by teachers who rated parent/guardian expectations and involvement as promoting effective instruction.

[19] The 2012 data did not support the creation of the Extent to Which Teacher Issues are Problematic composite; thus, trend data are not available to report.

Table 2.45
Factors Promoting[a] Effective Instruction in Mathematics Classes, by FRL Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
Amount of instructional time devoted to mathematics[b]	85 (3.1)	83 (3.4)	83 (3.2)	83 (3.9)
(t) Current state standards	70 (2.6)	69 (2.5)	75 (2.5)	74 (2.7)
(t) Principal support	76 (2.7)	77 (2.1)	74 (2.8)	73 (2.7)
(t) Amount of time for you to plan, individually and with colleagues	73 (2.4)	71 (2.4)	70 (2.2)	68 (3.1)
(t) District/Diocese/School pacing guides	63 (2.4)	66 (2.6)	61 (3.3)	61 (2.7)
(t) Amount of time available for your professional development	57 (2.8)	55 (2.3)	57 (2.8)	57 (2.7)
Students' prior knowledge and skills*	69 (2.8)	64 (2.4)	65 (2.5)	56 (2.5)
(t) Students' motivation, interest, and effort in mathematics*	69 (3.0)	63 (2.3)	63 (2.7)	54 (2.5)
(t) College entrance requirements[c]	62 (3.7)	63 (3.5)	61 (4.4)	53 (6.1)
(t) Teacher evaluation policies	50 (2.8)	46 (2.7)	47 (2.8)	47 (3.1)
(t) State/district/diocese testing/accountability policies[d]	38 (2.8)	41 (2.8)	45 (2.8)	43 (2.4)
(t) Parent/guardian expectations and involvement*	57 (2.7)	49 (2.6)	43 (2.5)	42 (2.9)
(t) Textbook selection policies*	45 (3.0)	43 (2.5)	37 (3.1)	37 (3.0)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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 "inhibits effective instruction" to 5 "promotes effective instruction."

b This item was presented only to elementary school teachers.

c This item was presented only to high school teachers.

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

Since 2012, the difference between the percentages of classes in high-FRL schools and classes in low-FRL schools taught by teachers who rated parent/guardian expectations and involvement as a promoter of effective instruction has changed significantly (see Figure 2.14). The narrowing of the gap appears to be due to both more classes in high-FRL schools and fewer classes in low-FRL schools rating this factor as promoting effective instruction in 2018. Specifically, in 2012, teachers in 36 percent of classes in high-FRL schools and 66 percent of classes in low-FRL schools saw this factor as promoting, compared to teachers in 42 and 57 percent of classes in schools in 2018, respectively.

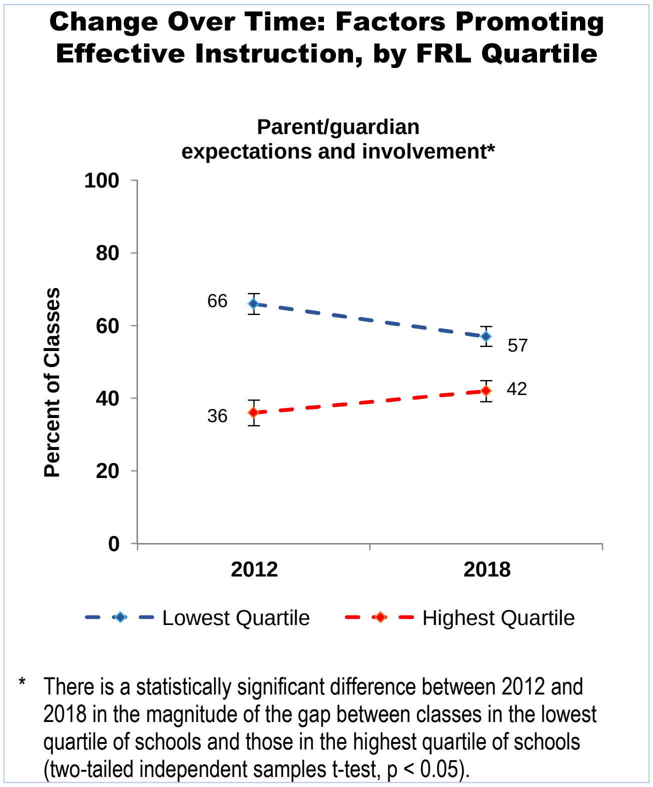


Figure 2.14

Three composites from the items in Table 2.45 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 means are shown in Table 2.46. There was a large gap for the stakeholder composite with regard to FRL quartile—classes in highest quartile of schools had lower mean scores than classes in lowest quartile of schools (mean scores of 60 vs. 72). When looking at trends, the 2018 data for the Extent to Which School Support Promotes Effective Instruction and Extent to Which the Policy Environment Promotes Effective Instruction composites are not significantly different than in 2012.[20]

[20] Too few items in the 2018 version of the Extent to Which Stakeholders Promote Effective Instruction composite were also asked in 2012; thus, trend data are not available to report.

Table 2.46
Mathematics Class Mean Scores for Factors Affecting Instruction Composites, by FRL Quartile

	MEAN SCORE			
	LOWEST QUARTILE SCHOOLS	SECOND QUARTILE SCHOOLS	THIRD QUARTILE SCHOOLS	HIGHEST QUARTILE SCHOOLS
(t) Extent to Which School Support Promotes Effective Instruction	72 (1.7)	71 (1.0)	70 (1.6)	71 (1.5)
(t) Extent to Which the Policy Environment Promotes Effective Instruction[a]	66 (1.0)	65 (1.2)	66 (1.2)	65 (1.3)
Extent to Which Stakeholders Promote Effective Instruction*	72 (1.4)	66 (1.4)	63 (1.5)	60 (1.7)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile of schools and those in the highest quartile of schools (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 for 2012 using the 2018 definition.

Summary

In 2018, workshops and teacher study groups were somewhat common locally offered professional development offerings, regardless of school poverty level. However, high-poverty schools were almost twice as likely as low-poverty schools to offer mathematics-focused one-on-one coaching. Areas emphasized in these professional development experiences were relatively similar among schools, with just a few exceptions. For example, workshops and teacher study groups in both high-FRL and low-FRL schools heavily emphasized deepening teachers' understanding of how to do mathematics and how to engage students in doing mathematics. However, professional learning experiences in high-poverty schools were more likely to emphasize deepening teachers' understanding of state mathematics standards. High- and low-poverty schools were also similar with regard to the services provided to support struggling teachers and those new to the profession.

Data on other contextual factors that affect student opportunity to learn, such as instructional arrangements in elementary schools and programs and practices to support and encourage students were mixed. The former was relatively the same across poverty levels. However, disparities existed in the latter. Although high-poverty schools were more likely to provide after-school help and family nights, they were also less likely to provide opportunities to participate in mathematics competitions that often involve more advanced content.

The climate for mathematics instruction was generally seen as supportive in both high-FRL and low-FRL schools. Interestingly, more high-poverty schools than low-poverty schools rated the amount of time provided by the school/district for teacher professional development in mathematics as promoting effective instruction. In contrast, student issues, such as low student interest in mathematics, high student absenteeism, and inappropriate student behavior were more likely to be viewed as inhibitors of effective instruction in high-FRL schools than in low-FRL schools.

Since 2012, there have been a number of significant changes in terms of the context for mathematics instruction between schools of different poverty levels, with schools becoming more similar in some areas and more different in others. For example, teacher study groups were just as likely to be offered in high-FRL and low-FRL schools in 2018, which was not the case in 2012. However, the topics being emphasized during these study groups have also changed over time. For example, more high-FRL schools and fewer low-FRL schools have focused on how to use investigation-oriented tasks in mathematics instruction since 2012. In addition, how high- and low-FRL schools view the effects of a number of factors on mathematics instruction has changed. Specifically, the difference related to the amount of time provided for teacher professional has become more pronounced, suggesting that over this 6-year span, mathematics-focused professional development has become a greater priority in high-poverty schools. Overall though, schools' views of the supportiveness of the context for mathematics instruction have become more similar.

Community Type

Table 3.1 provides information about the national distribution of schools in each community type in 2018. Suburban schools made up nearly half of all schools in the nation while rural and urban schools each made up about one-quarter of all schools. This chapter shows study data for schools in each community type and highlights differences found when making comparisons among the three groups.

Table 3.1
Percentage of Schools in Each Community Type

	PERCENT OF SCHOOLS
Rural	26 (0.8)
Suburban	45 (0.7)
Urban	29 (0.8)

Nature of Mathematics Instruction

As described in Chapter 2, the 2018 NSSME+ collected a variety of data about student opportunity to learn important mathematics. This section presents data on mathematics course offerings and instruction, highlighting the similarities and differences among the three community types.

Time Spent In Elementary Grades

Table 3.2 shows the average number of minutes per day typically spent on mathematics, science, social studies, and reading/language arts in elementary grades self-contained classes by community type. Classes in rural, suburban, and urban schools spent approximately the same amount of time on mathematics instruction per day. Looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 3.2
Average Number of Minutes per Day Spent Teaching Each Subject in Self-Contained Classes,[a] by Community Type

	NUMBER OF MINUTES		
	RURAL	SUBURBAN	URBAN
(t) Reading/Language Arts	86 (2.9)	85 (1.7)	92 (3.1)
(t) Mathematics	59 (2.0)	57 (1.0)	60 (1.7)
(t) Science*	18 (0.9)	19 (0.6)	22 (1.1)
(t) Social Studies	17 (0.8)	16 (0.5)	18 (0.8)

(t) Trend item

* There is a statistically significant difference between classes in schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

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

Course-Taking Opportunities in Secondary Grades

The study also collected data about course-taking opportunities provided to students at the secondary level. Mathematics program representatives were asked how many 8th grade students would complete Algebra 1 and Geometry prior to 9th grade. As can be seen in Table 3.3, students in rural schools were less likely than students in suburban or urban schools to complete Algebra 1 before entering 9th grade. Although few students in any community type completed geometry prior to 9th grade, students in rural and urban schools were less likely than students in suburban schools to do so. These data are not significantly different from the 2012 data.

Table 3.3
Average Percentage of 8th Graders Completing Algebra 1 and Geometry Prior to 9th Grade, by Community Type

	PERCENT OF STUDENTS		
	RURAL	SUBURBAN	URBAN
(t) Algebra 1*1	19 (3.5)	43 (3.7)	32 (4.9)
(t) Geometry*2	1 (0.3)	16 (5.3)	3 (1.0)

(t) Trend item

*1 There is a statistically significant difference between schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

*2 There are statistically significant differences among schools serving each of the community types (two-tailed independent samples t-tests, $p < 0.05$).

At the high school level, teachers were asked to provide information about a randomly selected class, including the course type, which allows for an estimate of the percentage of mathematics courses of each type in schools. As can be seen in Table 3.4, the distribution of courses was consistent across community types. Looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 3.4
Prevalence of High School Mathematics Courses, by Community Type(t),†

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	13 (2.7)	12 (1.4)	12 (2.8)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	21 (3.0)	22 (1.6)	14 (2.0)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	21 (2.9)	20 (1.7)	23 (3.4)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	21 (2.9)	21 (1.6)	26 (3.0)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	14 (2.1)	13 (1.3)	14 (2.2)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	9 (1.5)	11 (1.4)	9 (1.2)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (Chi-square test of independence, $p \geq 0.05$).

Teachers' Perceptions of Their Decision-Making Autonomy

Looking at pedagogical decisions, about two-thirds of classes, regardless of community type, were taught by teachers who perceived themselves as having strong control over determining the amount of homework to be assigned (see Table 3.5). Interestingly, classes in rural schools were more likely than classes in suburban and urban schools to be taught by teachers who felt strong control over other pedagogical decisions, including selecting teaching techniques (68, 60, and 57 percent, respectively) and choosing criteria for grading student performance (54, 39, and 43 percent, respectively).

Differences by community type were also evident for teachers' perceptions of control over curricular decisions, each in favor of classes in rural schools. For example, classes in rural schools were more likely than classes in suburban and urban schools to be taught by teachers who reported strong control over determining course goals and objectives (32, 20, and 21 percent, respectively) and selecting curriculum materials (26, 15, and 14 percent, respectively). These data are not significantly different from the 2012 data.

Table 3.5
Mathematics Classes in Which Teachers Reported Having Strong Control Over Various Curricular and Instructional Decisions, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Determining the amount of homework to be assigned	69 (2.6)	67 (1.9)	66 (2.7)
(t) Selecting teaching techniques*	68 (2.7)	60 (1.9)	57 (3.3)
(t) Choosing criteria for grading student performance*	54 (2.9)	39 (1.9)	43 (2.4)
Determining the amount of instructional time to spend on each topic*	46 (2.6)	30 (1.5)	28 (2.6)
Selecting the sequence in which topics are covered*	43 (2.6)	26 (1.4)	26 (2.2)
(t) Determining course goals and objectives*	32 (2.2)	20 (1.2)	21 (2.4)
(t) Selecting content, topics, and skills to be taught*	25 (2.1)	16 (1.2)	16 (2.1)
(t) Selecting curriculum materials (e.g., textbooks)*	26 (2.2)	15 (1.3)	14 (1.9)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Table 3.6 shows the mean scores on the Curriculum Control and Pedagogical Control composites by community type. The mean scores indicate that teachers across community types were more likely to report strong control over pedagogical decisions than over curricular decisions. Further, teachers of classes in rural schools were more likely to report strong pedagogy and curriculum control than teachers of classes in suburban or urban schools. Similar disparities were present in 2012.

Table 3.6
Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites, by Community Type

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
(t) Curriculum Control*,a	57 (1.7)	45 (1.2)	45 (1.8)
(t) Pedagogy Control*	85 (1.0)	81 (0.8)	81 (1.2)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

a This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Instructional Objectives

What teachers emphasize in their mathematics instruction heavily influences students' opportunities to learn. As can be seen in Table 3.7, classes in rural, suburban, and urban schools had relatively equal emphasis on many instructional objectives. For example, roughly 60–70 percent of classes emphasized understanding mathematical ideas and learning how to do mathematics, two key elements of high-quality mathematics teaching. Learning mathematical procedures and/or algorithms was also heavily emphasized in over half of all classes. Notably, increasing students' interest in mathematics was more likely to be heavily emphasized in classes in urban schools than in classes in suburban and rural schools (41, 34, and 32 percent, respectively).

Table 3.7
Mathematics Classes With Heavy Emphasis on Various Instructional Objectives, by Community Type

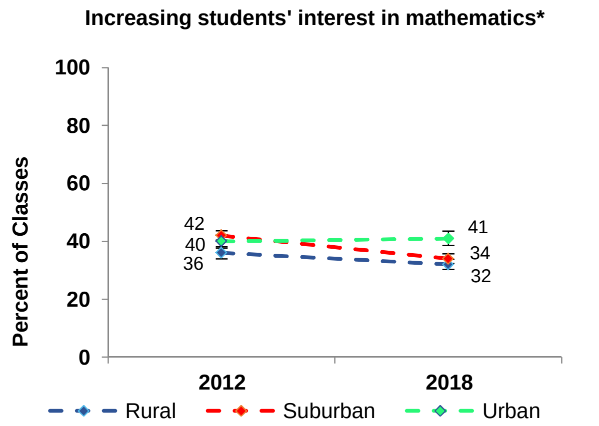
	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Understanding mathematical ideas	65 (2.1)	68 (1.6)	71 (2.2)
(t) Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	58 (2.3)	63 (1.6)	63 (2.6)
(t) Learning mathematical procedures and/or algorithms	57 (2.1)	52 (1.9)	51 (1.9)
(t) Increasing students' interest in mathematics*	32 (1.8)	34 (1.6)	41 (2.5)
Developing students' confidence that they can successfully pursue careers in mathematics	35 (1.8)	38 (1.6)	39 (2.4)
(t) Learning about real-life applications of mathematics	31 (2.1)	35 (1.7)	35 (2.6)
Learning mathematics vocabulary	31 (1.8)	33 (1.7)	31 (2.1)
(t) Learning test-taking skills/strategies	26 (1.8)	27 (1.6)	27 (1.9)
(t) Learning to perform computations with speed and accuracy	27 (2.2)	27 (1.7)	26 (1.9)

(t) Trend item

* There is a statistically significant difference between classes in schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0$.

Looking at trends, the gap between the percentage of classes in urban schools and those in suburban schools that heavily emphasized increasing students' interest in mathematics has changed since 2012 (see Figure 3.1). Specifically, 40 percent of classes in urban schools and 42 percent in suburban schools were taught by teachers who heavily emphasized this objective in 2012, compared to 41 and 34 percent of classes, respectively, in 2018.

Change Over Time: Instructional Objectives, by Community Type



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in schools serving urban communities and those serving suburban communities (two-tailed independent samples t-test, $p < 0.05$).

Figure 3.1

The objectives related to reform-oriented instruction (i.e., understanding mathematical ideas, learning how to do mathematics, learning about real-life applications of mathematics, increasing students' interest in mathematics, and developing students' confidence that they can successfully pursue careers in mathematics) were combined into a composite variable. The mean scores indicate that regardless of community type, mathematics classes were, on average, equally likely to emphasize reform-oriented instructional objectives (see Table 3.8). The 2018 data are not significantly different from the 2012 data.

Table 3.8
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite,[a] by Community Type[(t),†]

	MEAN SCORE
Rural	77 (0.7)
Suburban	78 (0.6)
Urban	80 (0.8)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Class Activities

The types of activities used in classrooms is an indicator of the nature of mathematics instruction students receive and their opportunities to learn. The 2018 NSSME+ included several sets of items that provided information about how mathematics was taught in a randomly selected class. One set of items asked how often different pedagogies were used. As can be seen in Table 3.9, at least 90 percent of classes across community types included explaining mathematical ideas to the whole class and engaging the whole class in discussions. Although small group work was also common in classes across community types, it was less likely to be utilized in rural schools than in suburban and urban schools (75, 81, and 84 percent respectively). The differences in the use of these activities by community type have not changed significantly since 2012.

Table 3.9
Mathematics Classes in Which Teachers Reported Using Various Activities at Least Once a Week, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Explain mathematical ideas to the whole class	96 (0.7)	95 (0.8)	93 (1.1)
(t) Engage the whole class in discussions	93 (0.9)	91 (1.0)	90 (1.1)
(t) Have students work in small groups*	75 (1.8)	81 (1.2)	84 (1.8)
(t) Provide manipulatives for students to use in problem-solving/investigations	48 (2.4)	51 (1.8)	54 (2.8)
(t) Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	28 (1.9)	33 (1.6)	34 (2.4)
(t) Focus on literacy skills (e.g., informational reading or writing strategies)	25 (1.9)	30 (1.6)	32 (2.3)
(t) Have students practice for standardized tests	28 (2.1)	28 (1.6)	28 (2.3)
(t) Have students read from a textbook or other material in class, either aloud or to themselves	24 (1.8)	23 (1.3)	25 (2.1)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	9 (1.4)	11 (1.3)	13 (1.9)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

In 2018, teachers were also asked how often they engage students in aspects of the practices of mathematics described in the CCSSM. As can be seen in Table 3.10, classes across community types had similar opportunities to engage in most of the mathematical practices at least once a week. For example, a large majority of classes had students: (1) determine whether their answer makes sense, (2) continue to work through a mathematics problem when they reach points of difficulty, and (3) develop representations of aspects of problems. The one difference by community type was in having students provide mathematical reasoning to explain, justify, or prove their thinking. This practice was less likely to occur in classes in rural schools than classes in suburban and urban schools (76, 85, and 83 percent, respectively). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 3.10
Mathematics Classes in Which Teachers Reported Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Determine whether their answer makes sense	84 (1.9)	85 (1.4)	84 (2.1)
Provide mathematical reasoning to explain, justify, or prove their thinking*	76 (2.4)	85 (1.2)	83 (1.5)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	80 (1.8)	80 (1.5)	82 (1.9)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	81 (2.1)	83 (1.2)	81 (2.1)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	71 (2.2)	73 (1.5)	77 (1.9)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	77 (1.8)	78 (1.0)	75 (1.9)
Figure out what a challenging problem is asking	69 (1.9)	73 (1.6)	75 (2.1)
Identify relevant information and relationships that could be used to solve a mathematics problem	74 (2.3)	74 (1.5)	72 (2.3)
Develop a mathematical model to solve a mathematics problem	71 (1.9)	71 (1.3)	70 (2.2)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	63 (1.8)	68 (1.9)	70 (2.4)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements	71 (1.9)	72 (1.6)	69 (1.9)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed	65 (2.1)	70 (1.7)	69 (2.2)
Determine what tools are appropriate for solving a mathematics problem	66 (1.8)	66 (1.6)	66 (2.4)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	61 (2.0)	63 (1.3)	63 (2.4)
Work on generating a rule or formula	59 (2.3)	63 (1.4)	62 (2.2)
Analyze the mathematical reasoning of others	56 (2.1)	62 (1.6)	62 (2.1)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations	53 (2.6)	58 (1.6)	59 (2.4)

* There is a statistically significant difference between classes in schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Table 3.11 shows the mean scores for the Engaging Students in the Practices of Mathematics composite formed from these items. The scores indicate that classes were generally likely to engage students in the practices of mathematics, regardless of community type.

Table 3.11
Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite, by Community Type†

	MEAN SCORE
Rural	72 (0.6)
Suburban	73 (0.5)
Urban	73 (0.8)

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

The survey also asked how often students in the randomly selected class were required to take assessments the teacher did not develop, such as state or district benchmark assessments. As can be seen in Table 3.12, about three-quarters of classes across community types were likely to be tested two or more times per year.

Table 3.12
Mathematics Classes Required to Take External Assessments Two or More Times per Year, by Community Type[(t),†]

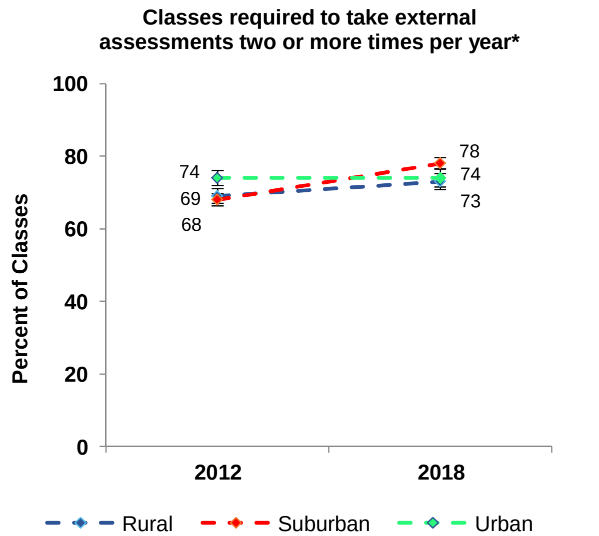
	PERCENT OF CLASSES
Rural	73 (2.2)
Suburban	78 (1.6)
Urban	74 (2.5)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Interestingly, the gap in the prevalence of external assessments between classes in urban and suburban schools has changed over time (see Figure 3.2). This change appears to be due to increased testing in classes in suburban schools from 2012 to 2018 (68 vs. 78 percent).

Change Over Time: External Assessments, by Community Type



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes in schools serving urban communities and those serving suburban communities (two-tailed independent samples t-test, $p < 0.05$).

Figure 3.2

Summary

There were a number of aspects of mathematics instruction that were similar across community types in 2018, such as amount of time on mathematics instruction per day at the elementary level and course taking opportunities (ranging from non-college prep courses to courses that might qualify for college credit) at the high school. However, there were also some notable differences. For example, students in rural schools were less likely than those in suburban and urban schools to complete Algebra 1 before entering 9^{th} grade. Also, students in rural and urban schools were less likely than students in suburban schools to complete geometry prior to 9^{th} grade.

Data about teachers' perceptions of control and emphasis on instructional objectives were also mixed. In general, teachers were more likely to report strong control over pedagogical decisions than over curricular decisions. However, teachers in rural schools reported more control over decisions related to pedagogy and curriculum than teachers in suburban and urban schools. Classes across community types had relatively equal emphasis on reform-oriented instructional objectives, such as understanding mathematical ideas, learning how to do mathematics, and learning mathematical procedures and/or algorithms.

Types of instructional activities used in classrooms were generally similar regardless of community type. Prominent classroom activities included the teacher explaining mathematical ideas to the class, engaging the class in discussions, and having students work in small groups. Students in classes across community types also had similar opportunities to engage in the mathematical practices. However, classes in rural schools were less likely than their suburban and urban counterparts to have students work in small groups and provide mathematical reasoning to explain, justify, or prove their thinking. In terms of external assessments, the majority of classes across community types were likely to be tested two or more times per year.

Since 2012, the nature of mathematics instruction provided across community types has remained largely consistent, with only two notable differences. First, the gap between the percentage of classes in urban schools and those in suburban schools that heavily emphasized increasing students' interest in mathematics has reversed since 2012, now advantaging students in urban schools. Second, the gap in the prevalence of external assessments between classes in urban and suburban schools has also reversed, due to increased testing in suburban schools from 2012 to 2018.

Material Resources

As described in Chapter 2, the 2018 NSSME+ included items on teachers' use of instructional materials—which one they use and how they use them—as well as the adequacy of other resources for mathematics instruction. This section of the report examines data about resources for instruction by community type.

Instructional Materials

In 2018, a large majority of mathematics classes, regardless of community type, had instructional materials designated for use by the district (see Table 3.13). Commercially published textbooks were by far the most frequently designated type of material, while the use of lessons or resources from websites that are free or have a subscription fee was less common. Comparing community types, there was only one significant difference in the types of designated instructional materials: classes in rural schools were less likely than classes in urban schools to be designated state, county, district, or diocese-developed units or lessons (33 vs. 44 percent). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 3.13
Types of Instructional Materials Designated for Mathematics Classes, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
District Designates Instructional Materials†			
No	23 (1.9)	19 (1.5)	16 (2.0)
Yes	77 (1.9)	81 (1.5)	84 (2.0)
Types of Designated Instructional Materials[a]			
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks	88 (2.1)	89 (1.4)	91 (1.9)
State, county, district, or diocese-developed units or lessons*	33 (2.8)	40 (2.1)	44 (2.6)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	25 (3.8)	28 (1.8)	32 (2.6)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	31 (2.4)	27 (1.7)	26 (2.8)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	25 (2.5)	26 (1.6)	24 (2.4)

† There are no statistically significant differences among classes in schools serving different community types (Chi-square test of independence, $p \geq 0.05$).

* There is a statistically significant difference between classes in schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

[a] Only mathematics classes for which instructional materials are designated by the state, district, or diocese are included in these analyses.

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction was based on various types of materials. Commercially published textbooks were the most commonly used material, serving as the basis of instruction at least once a week in roughly 70 percent of classes across community types (see Table 3.14). Units or lessons developed by teachers were also used at least once a week in about 60 percent of all classes. However, classes in rural schools were less likely than classes in suburban and urban schools to use state, county, district, or diocese-developed units or lessons (25, 33, and 36 percent, respectively). This series of items was also new to the 2018 NSSME+; thus, trend data are not available to report.

Table 3.14
Mathematics Classes Basing Instruction on Various Types of Instructional Materials at Least Once a Week, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks	71 (2.6)	70 (1.7)	68 (2.4)
Units or lessons you created (either by yourself or with others)	58 (2.3)	57 (2.1)	60 (2.8)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	39 (2.2)	40 (1.8)	40 (2.7)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	35 (2.1)	32 (1.7)	39 (2.2)
State, county, district, or diocese-developed units or lessons*	25 (2.2)	33 (1.7)	36 (1.9)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	32 (2.0)	30 (1.6)	35 (2.4)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	24 (2.9)	26 (1.8)	30 (2.1)

* There is a statistically significant difference between classes in schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Teachers who indicated that they used commercially published textbooks were asked to record the title, author, publication year, and ISBN of the textbook used most often in the class. As can be seen in Table 3.15, about half of classes that used textbooks, regardless of community type, used ones that were 6 or more years old. The 2018 data are not significantly different from the 2012 data.

Table 3.15
Age of Mathematics Textbooks in 2018, by Community Type(t),†

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
6 or more years	55 (3.5)	47 (2.8)	42 (3.8)
5 or fewer years	45 (3.5)	53 (2.8)	58 (3.8)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (Chi-square test of independence, $p \geq 0.05$).

Facilities and Resources

The 2018 NSSME+ included several questions about availability of computing resources. As can be seen in Table 3.16, all three community types had similar access to all but one type of resource. Rural schools were more likely than urban schools to have access to one or more computer labs for teachers to schedule for their classes (76 vs. 63 percent). For the trend items, the 2018 data are not significantly different from the 2012 data.

Table 3.16
Schools With Various Computing Resources, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
School-wide Wi-Fi	100 (0.4)	98 (1.0)	99 (1.0)
(t) Laptop/tablet carts available for teachers to use with their classes	83 (3.2)	87 (2.0)	86 (2.4)
(t) One or more computer labs available for teachers to schedule for their classes*	76 (4.0)	72 (2.7)	63 (3.8)
A 1-to-1 initiative (every student is provided with a laptop or tablet)	45 (3.9)	38 (2.7)	33 (3.4)

(t) Trend item

* There is a statistically significant difference between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

The 2018 NSSME+ also collected information about school spending on mathematics equipment, consumable supplies, and software. By dividing these amounts by school enrollment, per-pupil estimates were generated. As can be seen in Table 3.17, expenditures for mathematics were relatively even across community types.

Table 3.17
Median School Spending per Pupil on Mathematics Equipment, Consumable Supplies, and Software, by Community Type(t),†

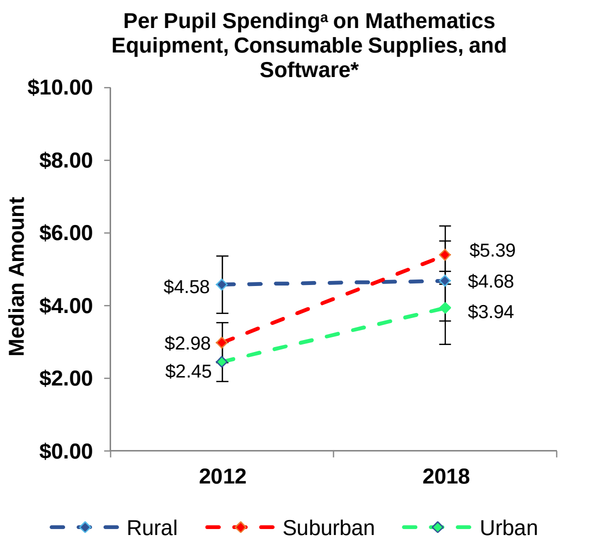
	MEDIAN AMOUNT
Rural	$4.68 (1.1)
Suburban	$5.39 (0.8)
Urban	$3.94 (1.0)

(t) Trend item

† There are no statistically significant differences among schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Looking at school spending over time, the gap between rural and suburban schools has changed significantly (see Figure 3.3). After adjusting for inflation, per-pupil spending in rural schools has remained relatively flat, but in suburban schools it has increased from $2.98 in 2012 to $5.39 in 2018.

Change Over Time: Per Pupil Spending, by Community Type



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between schools serving rural communities and those serving suburban communities (two-tailed independent samples t-test, $p < 0.05$).

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

Figure 3.3

Teachers were asked about the adequacy of the instructional resources they have available. As can be seen in Table 3.18, teacher perceptions of the availability of measurement tools, manipulatives, and consumable supplies were similar across classes in each community type. However, teachers of classes in rural schools were more likely than their counterparts in urban schools to rate the availability of instructional technology as adequate (80 vs. 70 percent). The 2018 data are not significantly different from the 2012 data.

Table 3.18
Adequacy[a] of Resources for Mathematics Instruction, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Measurement tools (e.g., protractors, rulers)	83 (1.9)	80 (1.5)	77 (2.3)
(t) Manipulatives (e.g., pattern blocks, algebra tiles)	67 (2.4)	72 (2.0)	73 (2.6)
(t) Instructional technology (e.g., calculators, computers, probes/sensors)*	80 (2.3)	75 (1.6)	70 (2.6)
(t) Consumable supplies (e.g., graphing paper, batteries)	71 (2.3)	71 (1.7)	68 (2.8)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving urban communities (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 adequate” to 5 “adequate.”

These items were combined into a composite variable called Adequacy of Resources for Mathematics Instruction. As shown in Table 3.19, teachers across community types generally had positive views about the adequacy of resources available to them. The 2018 data are not significantly different from the 2012 data.

Table 3.19
Mathematics Class Mean Scores for the Adequacy of Resources for Instruction Composite, by Community Type†

	MEAN SCORE
Rural	81 (1.0)
Suburban	80 (0.8)
Urban	77 (1.1)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Summary

Overall, differences among community types were minimal with regard to the distribution of material resources for mathematics instruction. Most schools across all three community types had instructional materials designated for use by the district. Commercially published textbooks were the most commonly designated and the most frequently used type of mathematics instructional material (whether designated or not) regardless of community type. In addition, about half of classes that used commercially published textbooks used ones that were at least six years old. Classes in rural schools were more likely than their suburban and urban counterparts to use state, county, district, or diocese-developed units or lessons.

Computing resources, including school-wide Wi-Fi and computers or tablets were equally available to students in rural, suburban, and urban settings. The amount of money spent on instructional resources was also similar across community types. Additionally, teachers generally had positive views about the adequacy of resources available to them for mathematics instruction regardless of community type.

Because items about material resources were either added, removed, or substantially modified for the 2018 study, trend analyses were limited. However, there was a significant change in per-pupil spending when comparing rural and suburban schools. This change appears to be due to increased spending in suburban schools from 2012 to 2018.

Well-Prepared Teachers

Of all the factors that affect students' mathematics education experience and their opportunity to learn, teachers are among the most important. The 2018 NSSME+ collected data on a number of indicators of teacher preparedness, including their years of teaching experience, content preparation, beliefs about teaching and learning, perceptions of preparedness to teach mathematics content and use classroom pedagogies, and professional development experiences. The distribution of well-prepared teachers among schools in each community type is described in the following sections.

Teacher Characteristics and Preparation

Table 3.20 provides information about the characteristics of teachers of mathematics classes. There were some commonalities across community types. For example, about two-thirds of secondary classes in each community type were taught by teachers with a degree in mathematics or mathematics education, and over half of classes were taught by teachers who completed a substantial amount of coursework related to the NCTM preparation standards for their grade band. In contrast, classes in urban schools were more likely than classes in rural schools to be taught by teachers with 0–5 years of experience teaching mathematics (34 vs. 27 percent). However, classes in urban schools were also more likely than those in suburban and rural schools to be taught by teachers from race/ethnicity groups historically underrepresented in STEM (26 percent of classes in urban schools, 14 percent in suburban schools, 8 percent in urban schools), a finding that highlights the racial/ethnic homogeneity of the teaching force in suburban and rural schools. Looking over time, there were no significant changes in these data since 2012.

Table 3.20
Teacher Characteristics, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) 0–5 years of experience teaching mathematics*1	27 (2.0)	30 (1.4)	34 (2.5)
(t) Historically underrepresented race/ethnicity group*2	8 (1.4)	14 (1.6)	26 (2.6)
(t) Degree in mathematics or mathematics education	63 (3.5)	70 (1.7)	67 (3.2)
(t) Substantial coursework related to NCTM preparation standards[b]	55 (3.0)	60 (1.8)	59 (2.4)

(t) Trend item

*1 There is a statistically significant difference between classes in schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

*2 There are statistically significant differences among classes in schools serving each of the community types (two-tailed independent samples t-tests, $p < 0.05$).

a Only secondary teachers are included in this analysis.

b Includes elementary mathematics teachers who have courses in 3 or more of the 5 areas, middle school mathematics teachers who have courses in 4 or more of the 6 areas, and high school mathematics teachers who have courses in 5 or more of the 7 areas.

Teacher Pedagogical Beliefs

Because beliefs are important mediators of behaviors, teachers were asked about their beliefs regarding effective teaching and learning. As can be seen in Table 3.21, reform-oriented beliefs were strong among teachers in 2018, regardless of community type. For example, over 90 percent of classes in rural, suburban, and urban schools were taught by teachers who agreed that: (1) teachers should ask students to justify their mathematical thinking, (2) students should learn mathematics by doing mathematics, (3) most class periods should provide opportunities for students to share their thinking and reasoning, and (4) students learn best when instruction is connected to their everyday lives. Interestingly, teachers across community types also held strong traditional beliefs. For example, approximately 80 percent of classes were taught by teachers who agreed students should be provided with definitions for new mathematics vocabulary at the beginning of a unit. Roughly 50–60 percent of classes were also taught by teachers who agreed that students learn mathematics best in classes with students of similar abilities and that hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned. The 2018 data are not significantly different from the 2012 data.

Table 3.21
Mathematics Classes in Which Teachers Agreed[a] With Various Statements About Teaching and Learning, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Reform-Oriented Teaching Beliefs			
Teachers should ask students to justify their mathematical thinking.	98 (0.6)	98 (0.5)	98 (0.7)
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 (1.2)	96 (0.7)	98 (0.5)
(t) Most class periods should provide opportunities for students to share their thinking and reasoning.	95 (1.0)	95 (0.7)	95 (1.2)
Students learn best when instruction is connected to their everyday lives.	93 (1.1)	93 (1.0)	93 (1.5)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts.	90 (1.6)	89 (1.1)	90 (1.5)
(t) It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	85 (2.0)	81 (1.7)	81 (2.1)
Traditional Teaching Beliefs			
(t) At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	84 (2.1)	80 (1.5)	79 (2.2)
(t) Students learn mathematics best in classes with students of similar abilities.	62 (2.8)	59 (1.9)	60 (3.1)
(t) Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	46 (3.2)	47 (1.8)	53 (2.8)
(t) Teachers should explain an idea to students before having them investigate the idea.	37 (3.1)	31 (1.7)	32 (2.6)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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

These items were combined into two composite variables: Reform-Oriented Teaching Beliefs and Traditional Teaching Beliefs. As can be seen in Table 3.22, the mean scores for each composite were similar across community types. The 2018 data for the Traditional Teaching Beliefs composite are not significantly different from the 2012 data.[21]

Table 3.22
Mathematics Class Mean Scores for Teachers' Beliefs About Teaching and Learning Composites, by Community Type

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
Reform-Oriented Teaching Beliefs	82 (0.6)	83 (0.5)	84 (0.6)
(t) Traditional Teaching Beliefs[a]	61 (1.0)	59 (0.7)	60 (1.1)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

[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.

[21] Too few of the items in the 2018 Reform-Oriented Beliefs composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Teachers' Perceptions of Preparedness

The 2018 NSSME+ asked teachers how well prepared they felt to teach each of a number of mathematics topics at their assigned grade level. As shown in Table 3.23, classes, regardless of community type, were equally likely to be taught by teachers who reported feeling very well prepared to teach each of the four topics at the elementary level. Looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 3.23
Elementary Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Various Mathematics Topics, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Number and operations	79 (3.3)	72 (2.4)	75 (4.0)
(t) Measurement and data representation	56 (4.6)	52 (3.0)	53 (3.4)
(t) Geometry	55 (4.4)	46 (3.1)	49 (4.0)
(t) Early algebra	43 (3.9)	40 (2.8)	43 (3.7)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Similarly, at the secondary level, classes in each community type were equally likely to be taught by teachers who considered themselves very well prepared to teach a variety of topics, such as the number system and operations, geometry, and discrete mathematics (see Table 3.24). However, classes in rural schools were less likely than classes in suburban schools to be taught by teachers who felt very well prepared to teach algebraic thinking (79 vs. 85 percent) or measurement (64 vs. 71 percent). The 2018 data are not significantly different from the 2012 data.

Table 3.24
Secondary Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Each of a Number of Topics, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) The number system and operations	85 (2.1)	90 (0.9)	86 (2.4)
(t) Algebraic thinking*	79 (2.0)	85 (1.2)	79 (2.5)
(t) Functions	64 (2.7)	70 (1.9)	68 (3.2)
(t) Measurement*	64 (2.2)	71 (1.7)	65 (3.2)
(t) Geometry	60 (2.4)	66 (1.7)	63 (3.3)
(t) Modeling	51 (2.4)	58 (1.9)	59 (2.8)
(t) Statistics and probability	36 (3.1)	35 (1.8)	33 (2.8)
(t) Discrete mathematics	15 (1.7)	18 (1.1)	14 (1.9)
Computer science/programming	4 (1.0)	5 (0.7)	4 (0.9)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving suburban communities (two-tailed independent samples t-test, $p < 0.05$).

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 use a number of student-centered pedagogies, including encouraging participation of all students and differentiating their instruction to meet learners' needs. Second, they were asked how well prepared they feel to carry out a number of tasks related to monitoring and addressing student thinking in their most recent mathematics unit. As can be seen in Table 3.25, there were many similarities across classes regardless of community type. For example, roughly half of all classes were taught by teachers who considered themselves very well prepared to: (1) use formative assessment to monitor student learning, (2) develop students' abilities to do mathematics, (3) encourage participation of all students in mathematics, and (4) develop students' conceptual understanding. Although classes were generally unlikely to be taught by teachers who felt very well prepared to incorporate students' cultural backgrounds into mathematics instruction, it was slightly more common in urban schools than in suburban schools (19 vs. 13 percent). For the one trend item, there was no significant difference over time.

Table 3.25
Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared for Each of a Number of Tasks, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Use formative assessment to monitor student learning	55 (2.4)	58 (1.5)	54 (2.2)
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	54 (2.5)	57 (1.4)	52 (2.3)
Encourage participation of all students in mathematics	48 (2.2)	54 (1.7)	50 (1.8)
Develop students' conceptual understanding	52 (2.1)	54 (1.6)	49 (2.0)
(t) Encourage students' interest in mathematics	37 (2.3)	43 (1.9)	39 (2.1)
Differentiate mathematics instruction to meet the needs of diverse learners	38 (2.4)	39 (1.9)	36 (2.1)
Provide mathematics instruction that is based on students' ideas	20 (1.8)	22 (1.2)	25 (2.2)
Incorporate students' cultural backgrounds into mathematics instruction*	15 (1.5)	13 (1.1)	19 (2.0)
Develop students' awareness of STEM careers	8 (1.0)	11 (1.0)	12 (1.6)

(t) Trend item

* There is a statistically significant difference between classes in schools serving urban communities and those serving suburban communities (two-tailed independent samples t-test, $p < 0.05$).

Table 3.26 shows the percentage of mathematics classes taught by teachers who felt very well prepared for each a number of tasks related to monitoring and addressing student thinking within a particular unit in a designated class. There were no significant differences among classes based on community type. For example, teachers in roughly 55–65 percent of classes, regardless of community type, reported feeling very well prepared to assess student understanding at the conclusion of the unit, monitor student understanding during the unit, and implement the instructional materials to be used during the unit.

Table 3.26
Mathematics Classes in Which Teachers Felt Very Well Prepared for Various Tasks in the Most Recent Unit, by Community Type†

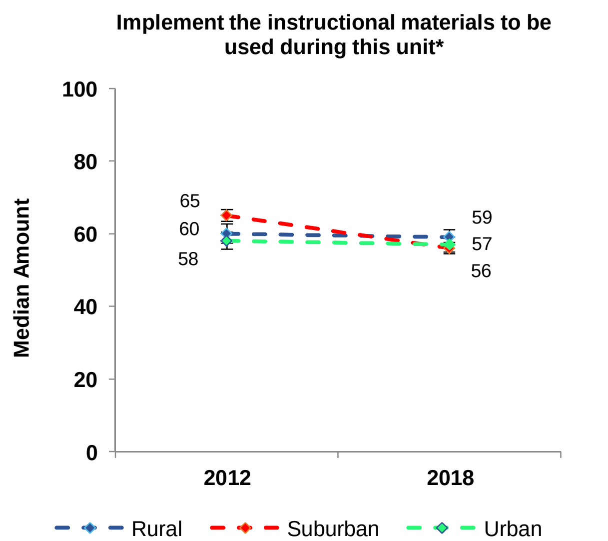
	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Assess student understanding at the conclusion of this unit	66 (2.2)	65 (1.6)	64 (2.2)
(t) Monitor student understanding during this unit	62 (2.1)	60 (1.6)	57 (2.0)
(t) Implement the instructional materials to be used during this unit	59 (2.1)	56 (1.6)	57 (2.1)
(t) Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit	49 (1.9)	49 (1.6)	48 (1.9)
(t) Find out what students thought or already knew about the key mathematical ideas	44 (2.1)	42 (1.7)	43 (2.0)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, p ≥ 0.05).

Over time, the gap between teachers' perceptions of preparedness to implement designated-instructional materials during a particular unit in urban and suburban schools has narrowed, with a decrease in perceptions of teachers in suburban schools (see Figure 3.4). In 2012, 58 percent of classes in urban schools compared to 65 percent of classes in suburban schools were taught by a teacher who felt very well prepared for this task. In 2018, these percentages changed to 57 and 56 percent, respectively.

Change Over Time: Preparedness for Most Recent Unit, by Community Type



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between schools serving urban communities and those serving suburban communities (two-tailed independent samples t-test, p < 0.05).

Figure 3.4

The items in Tables 3.24–3.26 were used to create three composite variables: Perceptions of Content Preparedness, Perceptions of Pedagogical Preparedness, and Perceptions of Preparedness to Implement Instruction in a Particular Unit. As can be seen in Table 3.27, the relatively high mean composite scores suggest that teachers generally felt well prepared in each of these areas, regardless of community type. The 2018 data for the Perceptions of Content Preparedness and Perceptions of Preparedness to Implement Instruction in a Particular Unit are not significantly different from the 2012 data.[22]

Table 3.27
Mathematics Class Mean Scores for Teachers' Perceptions of Preparedness Composites, by Community Type†

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
(t) Perceptions of Content Preparedness	79 (0.8)	80 (0.5)	79 (0.8)
Perceptions of Pedagogical Preparedness	69 (0.9)	70 (0.6)	70 (0.8)
(t) Perceptions of Preparedness to Implement Instruction in a Particular Unit	83 (0.8)	82 (0.5)	81 (0.8)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Teacher Professional Development

All professionals, including mathematics teachers, need opportunities to keep up with advances in their field. The 2018 NSSME+ collected data on teachers' participation in professional development, including duration and characteristics of the experiences.

Regardless of community type, teachers in roughly 9 out of 10 mathematics classes participated in mathematics-focused professional development in the previous three years (see Table 3.28). However, only about 3 in 10 classes were taught by teachers with more than 35 hours of professional development in that timeframe, suggesting that most mathematics teachers are not getting substantial opportunities to hone their skills. The 2018 data are not significantly different from the data in 2012.

Table 3.28
Professional Development Experiences of Teachers of Mathematics Classes, by Community Type†

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Teacher has had professional development in the last three years	87 (1.7)	88 (1.2)	88 (2.0)
(t) Teacher has had more than 35 hours of professional development in the last three years	27 (2.5)	27 (1.4)	30 (2.2)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

[22] Too few items in the version of the 2018 Perceptions of Pedagogical Preparedness composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

As described in the FRL chapter, there is a consensus that professional development should provide teachers with 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 investigative 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.[23] 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 3.29, professional development experiences were similar for teachers in all three community types. For example, over half of all classes were taught by teachers who attended professional development where they worked with other teachers from their school or with other teachers who taught the same grade and/or subject whether or not they were from their school. Conversely, only about a third of classes were taught by teachers who had opportunities to rehearse instructional practices during professional development. There are no significant differences in these data over time.

Table 3.29
Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by Community Type[†]

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Worked closely with other teachers from their school	67 (2.6)	70 (1.9)	68 (3.0)
(t) Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	58 (2.9)	59 (1.9)	54 (2.9)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	44 (2.7)	44 (1.7)	51 (3.2)
(t) Had opportunities to engage in mathematics investigations	47 (2.6)	47 (2.1)	47 (3.2)
(t) Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	44 (2.9)	48 (1.9)	45 (3.3)
(t) Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	49 (3.5)	45 (1.7)	43 (2.9)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	32 (2.7)	35 (2.0)	32 (2.9)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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."

[23] 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.

Further, teachers of classes across community types reported a number of similarities in the emphases of their professional development experiences (see Table 3.30). For example, over half of classes were taught by teachers who had professional development opportunities that gave heavy emphasis to: (1) monitoring student understanding during mathematics instruction, (2) deepening their understanding of how mathematics is done, and (3) differentiating mathematics instruction to meet the needs of diverse learners. Only one difference in professional development emphasis existed by community type. Teachers of classes in urban schools were more likely than teachers of classes in suburban schools to have had professional development that gave heavy emphasis to incorporating students' cultural backgrounds into mathematics instruction (28 vs. 19 percent). The 2018 data are not significantly different from the 2012 data.

Table 3.30
Mathematics Classes in Which Teachers Reported That Their Professional Development in the Last Three Years Gave Heavy Emphasis[a] to Various Areas, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
(t) Monitoring student understanding during mathematics instruction	50 (3.4)	55 (1.8)	58 (3.1)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	54 (3.4)	55 (2.3)	57 (3.0)
Differentiating mathematics instruction to meet the needs of diverse learners	61 (3.2)	55 (2.0)	51 (3.2)
(t) Learning how to use hands-on activities/manipulatives for mathematics instruction	49 (3.8)	52 (2.5)	50 (3.0)
(t) Learning about difficulties that students may have with particular mathematical ideas and procedures	46 (3.0)	49 (1.8)	50 (2.9)
(t) Deepening their own mathematics content knowledge	44 (3.3)	46 (2.5)	50 (2.5)
(t) Finding out what students think or already know prior to instruction on a topic	39 (2.6)	43 (1.9)	44 (3.4)
(t) Implementing the mathematics textbook to be used in their classroom	36 (3.0)	35 (2.0)	35 (2.9)
Incorporating students' cultural backgrounds into mathematics instruction*	21 (2.7)	19 (1.8)	28 (2.4)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	17 (1.7)	22 (1.9)	22 (2.7)

(t) Trend item

* There is a statistically significant difference between classes in schools serving urban communities and those serving suburban communities (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."

Survey items describing the characteristics and focus of teachers' professional development were combined into two composite variables: Extent Professional Development Aligns with Elements of Effective Professional Development and Extent Professional Development Supports Student-Centered Instruction. As can be seen in Table 3.31, there were no significant differences among community types in either of these areas. However, class mean scores of nearly 60 indicate that teachers' professional development opportunities were only somewhat aligned with elements of effective professional development and somewhat supportive of student-centered instruction.

Looking over time, the 2018 Extent Professional Development Aligns with Elements of Effective Professional Development score is not significantly different from the 2012 score.[24]

Table 3.31
Mathematics Class Mean Scores for Teachers' Professional Development Composites, by Community Type†

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
(t) Extent Professional Development Aligns With Elements of Effective Professional Development[a]	57 (1.2)	59 (0.9)	58 (1.2)
Extent Professional Development Supports Student-Centered Instruction	58 (1.2)	58 (1.0)	59 (1.4)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Summary

Although there were many similarities in the distribution of well-prepared teachers among community types, there were also several notable differences. A majority of classes in rural, suburban, and urban schools were taught by teachers who had completed the majority of NCTM-recommended courses (elementary and secondary grades) or had a degree in mathematics or mathematics education (secondary grades). Classes in urban schools were more likely than classes in rural schools to be taught by teachers with 0–5 years of experience teaching mathematics. Classes in urban schools were also more likely than those in suburban and rural schools to be taught by teachers from race/ethnicity groups historically underrepresented in STEM.

Teachers across community types held strong reform-oriented beliefs (e.g., teachers should ask students to justify their mathematical thinking, students should learn mathematics by doing mathematics). Interestingly, they also held relatively strong traditional beliefs, (e.g., students should be provided with definitions for new mathematics vocabulary at the beginning of a unit and hands-on/manipulatives should be used primarily to reinforce a mathematical idea already learned).

Additionally, regardless of school community type, teachers reported feeling well prepared to teach mathematics topics appropriate for their grade level. Algebraic thinking and measurement at the secondary level were the only two exceptions; teachers of classes in rural schools were less likely than their counterparts in suburban schools to consider themselves well prepared to teach these topics. Teachers' perceptions of preparedness to use student-centered pedagogies and implement tasks related to monitoring and addressing student thinking in their most recent mathematics unit were similar among classes across community types.

Further, there were a number of similarities among schools with regard to teachers' professional development experiences. For example, a large majority of mathematics classes were taught by

[24] Too few of the items in the 2018 version of the Extent Professional Development Supports Student-Centered Instruction composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

teachers who participated in mathematics-focused professional development in the last three years. Teachers of classes across community types also reported similar characteristics and emphasis of their professional development experiences.

Similar to other sections of this report, trend analyses were conducted to look for changes over time. The only significant change since 2012 was related to teachers' perceptions of preparedness to implement instructional materials for a particular unit. The gap between classes in urban and suburban schools taught by teachers who considered themselves well prepared for this task narrowed from 2012 to 2018.

Supportive Context for Learning

The 2018 NSSME+ collected information on a number of contextual factors that affect student opportunity to learn mathematics, including professional development opportunities offered by schools and districts (i.e., workshops, teacher study groups, and formal induction programs). The study also asked about mathematics programs and practices to enhance students' interest in mathematics and factors that promote and inhibit mathematics instruction in the school, such as administrator and community support. This section presents these data, highlighting the similarities and differences among rural, suburban, and urban schools.

Locally Offered Professional Development

School representatives were asked whether mathematics-focused professional development workshops have been offered by their school and/or district in the past three years. As can been seen in Table 3.32, over half of schools, regardless of community type, offered workshops and study groups in 2018. However, urban schools were more likely than suburban and rural schools to have locally offered workshops available for teachers (75, 63, and 62 percent, respectively). Although one-on-one coaching was less common overall, this form of professional development was significantly less likely to be offered in rural schools than in suburban and urban schools (25, 43, and 51 percent, respectively). When looking at trends, the 2018 data are not significantly different from the 2012 data.

Table 3.32
Types of Locally Offered Mathematics Professional Development Available to Teachers in the Last Three Years, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) Workshops*1	62 (4.6)	63 (2.9)	75 (3.6)
(t) Study groups	56 (4.1)	62 (3.5)	53 (3.9)
(t) One-on-one coaching*2	25 (3.6)	43 (3.1)	51 (4.0)

(t) Trend item

*1 There is a statistically significant difference between schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

*2 There is a statistically significant difference between schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Mathematics program representatives who indicated that workshops were offered locally in the last three years were asked about the extent to which those workshops emphasized each of a number of areas. As can be seen in Table 3.33, locally offered workshops in all three community types had a number of similar emphases. For example, 50–70 of schools had workshops with a substantial emphasis on deepening teachers' understanding of state mathematics standards, mathematics concepts, and how students think about various mathematical ideas. Deepening teachers' understanding of how mathematics is done was a fairly common emphasis, but was less common in rural schools than in suburban schools (50 vs. 66 percent). The 2018 data are not significantly different from the 2012 data.

Table 3.33
Locally Offered Mathematics Professional Development Workshops in the Last Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
Deepening teachers' understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)*	50 (5.7)	66 (3.2)	66 (5.3)
(t) Deepening teachers' understanding of the state mathematics standards	70 (5.5)	66 (4.5)	62 (5.5)
(t) Deepening teachers' understanding of mathematics concepts	59 (5.4)	65 (3.4)	58 (5.2)
(t) Deepening teachers' understanding of how students think about various mathematical ideas	50 (5.5)	61 (3.9)	57 (5.5)
(t) How to use particular mathematics instructional materials (e.g., textbooks)	42 (5.0)	49 (4.6)	57 (5.0)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	44 (4.8)	54 (4.0)	55 (5.4)
How to differentiate mathematics instruction to meet the needs of diverse learners	38 (5.2)	41 (4.1)	53 (5.5)
(t) How to monitor student understanding during mathematics instruction	52 (6.0)	53 (4.7)	50 (5.6)
(t) How to use investigation-oriented tasks in mathematics instruction	43 (5.2)	35 (4.0)	47 (5.2)
(t) How to adapt mathematics instruction to address student misconceptions	48 (5.5)	39 (4.2)	45 (5.3)
(t) How to use technology in mathematics instruction	54 (5.4)	50 (3.2)	42 (4.9)
How to integrate science, engineering, mathematics, and/or computer science	32 (5.1)	26 (3.8)	32 (5.3)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction	33 (4.6)	29 (3.3)	31 (5.1)
How to develop students' confidence that they can successfully pursue careers in mathematics	23 (4.2)	21 (3.3)	28 (4.9)
How to connect instruction to mathematics career opportunities	20 (5.6)	18 (3.1)	26 (5.5)
How to incorporate students' cultural backgrounds into mathematics instruction	10 (3.1)	13 (2.2)	15 (4.0)

(t) Trend item

* There is a statistically significant difference between schools serving rural communities and those serving suburban communities (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."

Mathematics program representatives who indicated that teacher study groups were offered locally in the last three years were also asked about the topics emphasized in those groups. As can be seen in Table 3.34, roughly 50–70 of local study groups across community types placed substantial emphasis on how to engage students in doing mathematics, how to monitor student understanding during mathematics instruction, deepening teachers' understanding of how mathematics is done, and deepening teachers' understanding of state mathematics standards. However, there were also several differences when comparing urban schools to their suburban and rural counterparts. For example, study groups in urban schools were more likely than study groups in suburban and rural schools to emphasize how to differentiate mathematics instruction (67, 48, and 46 percent, respectively) and how to adapt mathematics instruction to address student misconceptions (64, 50, and 37 percent, respectively). Study groups in urban schools were also more likely than study groups in rural schools to emphasize deepening teachers' understanding of how students think about various mathematical ideas (64 vs. 44 percent). Additionally, an emphasis on how to incorporate real-world issues into mathematics instruction was more common in study groups in urban schools than study groups in suburban schools (47 vs. 29 percent).

Table 3.34
Locally Offered Mathematics Teacher Study Groups Offered in the Last Three Years With a Substantial Emphasis[a] in Each of a Number of Areas, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
How to differentiate mathematics instruction to meet the needs of diverse learners*[1]	46 (5.4)	48 (3.5)	67 (5.2)
How to engage students in doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	50 (6.2)	60 (4.2)	66 (5.0)
(t) Deepening teachers' understanding of how students think about various mathematical ideas*[2]	44 (6.4)	52 (4.0)	64 (5.2)
(t) How to adapt mathematics instruction to address student misconceptions*[1]	37 (6.0)	50 (3.6)	64 (4.9)
(t) How to monitor student understanding during mathematics instruction	49 (6.1)	51 (3.6)	59 (4.8)
Deepening teachers' understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	44 (5.5)	55 (4.0)	58 (5.2)
(t) Deepening teachers' understanding of the state mathematics standards	66 (5.3)	61 (4.1)	57 (5.7)
(t) Deepening teachers' understanding of mathematics concepts	37 (5.1)	51 (4.3)	52 (5.8)
(t) How to use particular mathematics instructional materials (e.g., textbooks)	38 (5.0)	55 (4.2)	51 (5.7)
(t) How to use technology in mathematics instruction	40 (6.0)	34 (3.2)	48 (5.2)
How to incorporate real-world issues (e.g., current events, community concerns) into mathematics instruction*[3]	33 (5.3)	29 (3.5)	47 (5.9)
(t) How to use investigation-oriented tasks in mathematics instruction	33 (5.3)	33 (4.1)	42 (6.0)
How to integrate science, engineering, mathematics, and/or computer science	24 (6.1)	22 (3.4)	34 (6.1)
How to incorporate students' cultural backgrounds into mathematics instruction*[1]	11 (3.2)	12 (2.6)	32 (5.4)
How to connect instruction to mathematics career opportunities	20 (5.6)	18 (3.1)	26 (5.5)
How to develop students' confidence that they can successfully pursue careers in mathematics	20 (4.3)	19 (3.3)	25 (5.1)

(t) Trend item

*[1] There is a statistically significant difference between schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

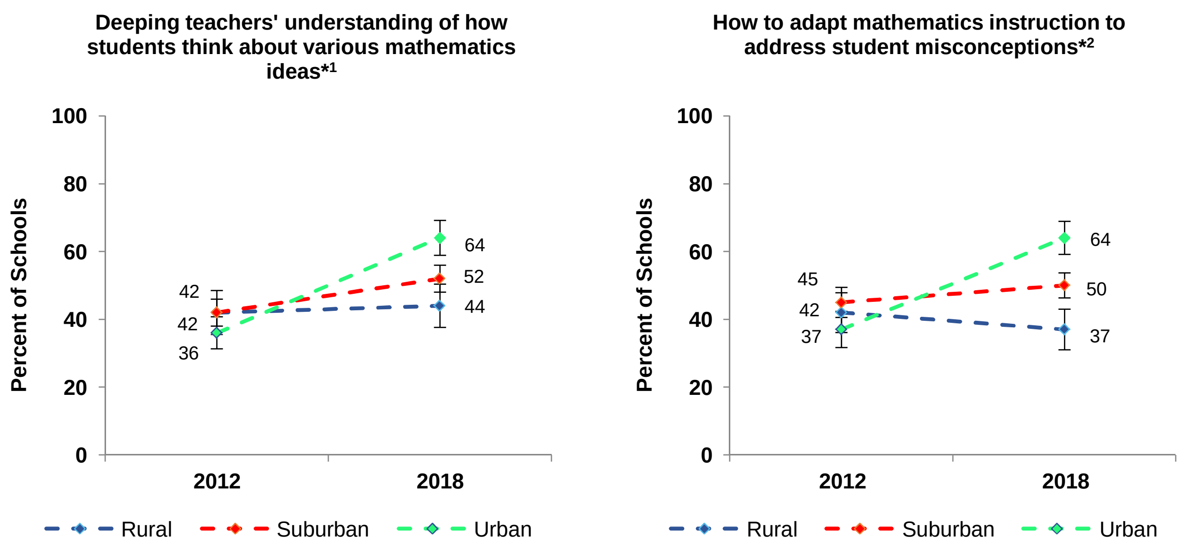
*[2] There is a statistically significant difference between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

*[3] There is a statistically significant difference between schools serving urban communities and those serving suburban communities (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."

Figure 3.5 shows changes since 2012 in the emphasis on some topics addressed in teacher study groups. Notably, these changes are all advantageous to urban schools. For example, there was a difference in the gap between study groups in urban schools and those in rural schools related to the emphasis on deepening teachers' understanding of how students think about various mathematics ideas. This difference appears to be due to a large increase in the emphasis on this topic in urban schools from 2012 to 2018 (36 vs. 64 percent). Additionally, adapting mathematics instruction to address student misconceptions was much more common in 2018 than 2012in urban schools than in both of the other community types.

Change Over Time: Study Group Emphasis, by Community Type



*1 There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Figure 3.5

Mathematics program representatives were also asked about services provided to teachers in need of special assistance. As can be seen in Table 3.35, roughly half of schools, regardless of community type, offered guidance from a formally designated mentor or coach. A higher level of supervision and seminars, classes, and/or study groups specifically for teachers in need of special assistance were each offered in about a third of schools. However, rural schools were less likely than urban schools to offer guidance from a formally designated mentor or coach (44 vs. 59 percent). Additionally, rural schools were less likely than suburban and urban schools to offer a higher level of supervision for teachers in need of special assistance (22, 35, and 37 percent, respectively). These same disparities were present in 2012.

Table 3.35
Services Provided to Teachers in Need of Special Assistance in Teaching, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) Guidance from a formally designated mentor or coach*1	44 (4.5)	52 (3.5)	59 (3.9)
(t) A higher level of supervision than for other teachers*2	22 (3.0)	35 (3.1)	37 (4.5)
(t) Seminars, classes, and/or study groups	39 (4.3)	33 (3.1)	34 (4.2)

(t) Trend item

*1 There is a statistically significant difference between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

*2 There is a statistically significant difference between schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

In 2018, the percentage of schools offering a formal teacher induction program was similar across community types, with about three-fourths of schools having such a program (see Table 3.36). About 3 in 10 schools, regardless of community type, had programs that lasted one year or less, and about 4 in 10 schools had programs that lasted two years or more. This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 3.36
Typical Duration of Formal Induction Programs, by Community Type†

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
No formal induction program	29 (4.0)	21 (2.5)	25 (3.7)
One year or less	34 (4.6)	35 (2.9)	30 (3.9)
Two years or more	36 (4.6)	44 (2.6)	45 (4.2)

† There are no statistically significant differences among schools serving different community types (Chi-square test of independence, $p \geq 0.05$).

The research on effective induction programs for beginning teachers also suggests a number of supports that are important for a program's success.[25] One key element is having an experienced mentor, in particular one who teaches the same subject or grade level as the mentee. Although a majority of all schools provided formally assigned school-based mentors to beginning teachers, as can be seen in Table 3.37, this support mechanism was provided in more rural schools than urban schools (90 vs. 78 percent).

[25] Ingersoll, R., & Strong, M. (2011). *The impact of induction and mentoring programs for beginning teachers: A critical review of the research.* Retrieved from https://repository.upenn.edu/gse_pubs/127.

Table 3.37
Schools Providing Formally Assigned School-Based Mentors, by Community Type

	PERCENT OF SCHOOLS[a]
Rural*	90 (3.1)
Suburban	87 (1.9)
Urban	78 (3.3)

* There is a statistically significant difference between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

[a] Includes only those schools that provide a formal induction program.

Factors Affecting Student Opportunity to Learn

The NSSME+ asked program representatives about instructional arrangements, course formats, and other practices that promote interest in mathematics and support (or inhibit) effective mathematics instruction. Table 3.38 shows the prevalence of various instructional arrangements for students in elementary self-contained classrooms. These data are similar across community types. For example, over half of schools pulled students in self-contained classes out for remedial instruction in mathematics and roughly one-third pulled students in self-contained classes out for enrichment.

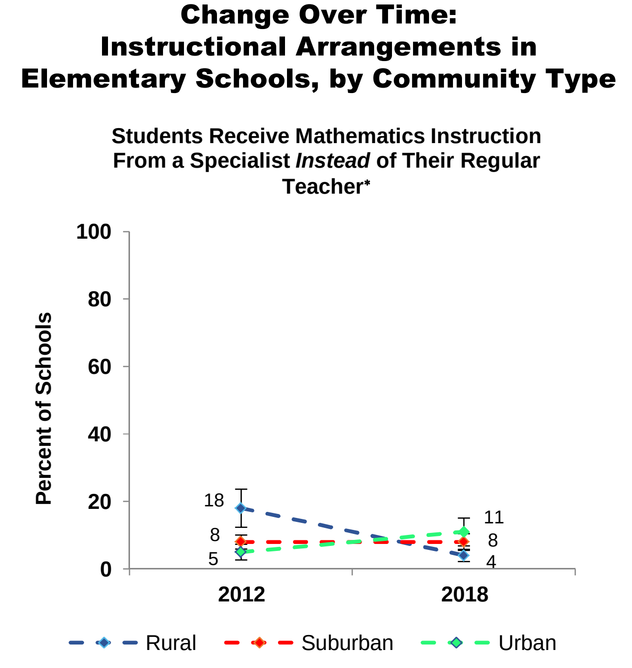
Table 3.38
Use of Various Instructional Arrangements in Elementary Schools, by Community Type†

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) Students in self-contained classes are pulled out for remedial instruction in mathematics.	71 (4.5)	63 (4.6)	53 (5.7)
(t) Students in self-contained classes are pulled out for enrichment in mathematics.	37 (5.4)	34 (4.2)	38 (5.6)
(t) Students in self-contained classes receive mathematics instruction from a district/diocese/school mathematics specialist *in addition* to their regular teacher.	15 (4.3)	23 (3.4)	30 (5.4)
(t) Students in self-contained classes are pulled out from mathematics instruction for additional instruction in other content areas.	27 (5.6)	21 (3.4)	27 (5.3)
(t) Students in self-contained classes receive mathematics instruction from a district/diocese/school mathematics specialist *instead of* their regular teacher.	4 (1.8)	8 (2.5)	11 (4.1)

(t) Trend item

† There are no statistically significant differences among schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

Although using mathematics specialists to provide instruction to students in self-contained classes was rare across community types in 2018, the gap between rural and urban schools changed over time (see Figure 3.6). The change appears to be due to a decline in the use of mathematics specialists in rural schools from 2012 to 2018 (18 vs. 4 percent) and an increase in use in urban schools within that same timeframe (5 vs. 11 percent).



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

Figure 3.6

At the high school level, the NSSME+ asked about a number of specific course-taking opportunities provided to students. As can be seen in Table 3.39, over half of high schools, regardless of community type, offered calculus courses, opportunities for students to go to a college or university for mathematics courses, access to virtual mathematics courses, and concurrent college and high school credit/dual enrollment courses. However, rural schools were less likely than suburban and urban schools to offer probability and/or statistics courses (31, 62, and 68 percent, respectively). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 3.39
Mathematics Course-Taking Options in High Schools, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) Calculus courses (beyond pre-calculus) are offered this school year or in alternating years, on or off site.	67 (6.6)	83 (4.6)	79 (6.8)
(t) Students can go to a college or university for mathematics courses.	65 (5.8)	70 (3.4)	71 (6.1)
(t) Probability and/or statistics course are offered.*	31 (5.1)	62 (4.6)	68 (7.6)
This school provides students access to virtual mathematics courses offered by other schools/institutions.	64 (5.0)	52 (4.4)	61 (5.9)
(t) Concurrent college and high school credit/dual enrollment courses are offered this school year or in alternating years.	77 (4.7)	64 (4.2)	57 (6.7)
(t) Algebra 1 course, or its equivalent, is offered over two years or as two separate block courses (e.g., Algebra A and Algebra B).	44 (6.1)	39 (4.5)	49 (6.4)
(t) Students can go to a Career and Technical Education center for mathematics instruction.	22 (4.2)	25 (3.3)	20 (4.9)
This school provides its own mathematics courses virtually.	14 (4.9)	14 (2.7)	20 (5.6)
(t) Students can go to another K–12 school for mathematics courses.	8 (3.4)	14 (2.6)	10 (2.9)

(t) Trend item

* There is a statistically significant difference between schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Program representatives were also asked to indicate which of several programs and practices their school employed to enhance student interest and/or achievement in mathematics. Roughly three-quarters of schools, across community types, offered after-school help (see Table 3.40). After-school programs for enrichment, mathematics competitions, and mathematics clubs were offered in 20–40 percent of schools. The only difference by community type is that rural schools were less likely than suburban and urban schools to offer family nights (17, 31, and 40 percent, respectively). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 3.40
School Programs/Practices to Enhance Students' Interest in Mathematics, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) After-school help	74 (4.2)	69 (2.4)	77 (4.1)
(t) Family nights*	17 (3.1)	31 (2.7)	40 (4.2)
(t) After-school programs for enrichment	21 (3.6)	27 (3.1)	35 (4.3)
(t) Participation in mathematics competitions	34 (4.0)	34 (2.9)	32 (3.7)
(t) Mathematics clubs	25 (3.3)	29 (3.1)	25 (2.9)

(t) Trend item

* There is a statistically significant difference between schools serving rural communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

Table 3.41 presents program representatives' views on factors that promote mathematics instruction in schools. Overall, there was little variation in these factors among schools by community type. For example, representatives from over three-fourths of schools rated the importance the school places on mathematics as promoting effective instruction. School/district professional development policies and practices and the amount of time provided for teacher professional development were also viewed as promoting factors in roughly 50–70 percent of schools. However, the management of mathematics instructional resources was more likely to be rated as a promoter of effective instruction in rural schools than in their urban counterparts (68 vs. 52 percent). The 2018 data are not significantly different from the 2012 data.

Table 3.41
Factors Promoting Effective Mathematics Instruction, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
(t) The importance that the school places on mathematics	79 (4.1)	77 (2.1)	79 (3.6)
(t) The school/district/diocese mathematics professional development policies and practices	63 (4.6)	66 (2.8)	68 (4.4)
(t) The amount of time provided by the school/district/diocese for teacher professional development in mathematics	54 (4.6)	49 (3.1)	56 (4.7)
How mathematics instructional resources are managed (e.g., distributing and replacing materials)*	68 (4.0)	58 (3.1)	52 (4.3)
The amount of time provided by the school/district/diocese for teachers to share ideas about mathematics instruction	50 (4.4)	55 (3.3)	50 (4.4)
(t) Other school and/or district/diocese initiatives	46 (3.6)	48 (2.8)	45 (4.8)

(t) Trend item

* There is a statistically significant difference between schools serving rural communities and those serving urban communities (two-tailed independent samples t-test, $p < 0.05$).

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 3.42, schools across community types had similarly supportive context for mathematics instruction. The 2018 data for this composite are not significantly different from the 2012 data.

Table 3.42
School Mean Scores for the Supportive Context for Mathematics Instruction Composite,[a] by Community Type[(t)]

	MEAN SCORE
Rural	68 (1.9)
Suburban	67 (1.1)
Urban	66 (2.1)

(t) Trend item

† There are no statistically significant differences among schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Program representatives were also asked to rate whether each of several factors was a problem for mathematics instruction in their school. There was a great deal of consistency across community types in these ratings, with low student prior knowledge and skills being viewed as problematic for mathematics instruction by representatives in about three-fourths of schools (see Table 3.43). Lack of parent/guardian support and involvement and low student interest in mathematics were also rated as problematic in over half of schools. However, some differences were apparent by community type. For example, inappropriate student behavior was more likely to be viewed as problematic in urban schools than in suburban and rural schools (60, 45, and 43 percent, respectively). Additionally, large class sizes and inadequate teacher preparation to teach mathematics were less likely to be rated as problematic in rural schools than in suburban schools (32 vs. 44 percent and 26 vs. 40 percent, respectively). These data are not significantly different from the 2012 data.

Table 3.43
Mathematics Program Representatives Viewing Each of a Number of Factors as a Problem[a] for Mathematics Instruction in Their School, by Community Type

	PERCENT OF SCHOOLS		
	RURAL	SUBURBAN	URBAN
Low student prior knowledge and skills	75 (4.0)	73 (2.9)	79 (3.6)
(t) Lack of parent/guardian support and involvement	60 (5.0)	61 (3.1)	70 (4.0)
(t) Low student interest in mathematics	70 (3.9)	59 (3.3)	66 (4.7)
(t) Inadequate materials for differentiating mathematics instruction	46 (4.2)	54 (3.0)	60 (4.6)
(t) Inappropriate student behavior*1	43 (4.7)	45 (3.1)	60 (3.9)
(t) High student absenteeism	54 (4.8)	45 (3.0)	55 (4.4)
(t) Inadequate mathematics-related professional development opportunities	48 (4.2)	53 (3.3)	51 (4.6)
(t) Inadequate funds for purchasing mathematics equipment and supplies	40 (4.3)	32 (2.9)	45 (4.4)
Community attitudes toward mathematics instruction	41 (4.5)	40 (2.9)	43 (4.5)
(t) Large class sizes*2	32 (4.1)	44 (3.4)	42 (4.2)
(t) Insufficient instructional time to teach mathematics	35 (4.2)	37 (2.8)	42 (4.5)
High teacher turnover	29 (3.7)	29 (3.1)	38 (4.0)
(t) Inadequate teacher preparation to teach mathematics*2	26 (4.1)	40 (3.5)	34 (4.1)
Lack of equipment and supplies and/or manipulatives for teaching mathematics (e.g., materials for students to draw, cut, and build in order to make sense of problems)	34 (4.5)	25 (2.7)	34 (4.9)
Poor quality mathematics textbooks	31 (3.7)	32 (2.8)	32 (4.3)
(t) Lack of teacher interest in mathematics	18 (3.2)	26 (2.9)	19 (3.7)
(t) Lack of mathematics textbooks	24 (3.1)	22 (2.4)	17 (3.5)

(t) Trend item

*1 There is a statistically significant difference between schools serving urban communities and those serving other community types (two-tailed independent samples t-tests, $p < 0.05$).

*2 There is a statistically significant difference between schools serving rural communities and those serving suburban communities (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.”

Three composite variables were created from these items: Extent to Which Student Issues are Problematic, Extent to Which a Lack of Resources is Problematic, and Extent to which Teacher Issues are Problematic. As can be seen in Table 3.44, there were no significant differences in scores on any of these composites by community type. The 2018 Extent to Which Lack of

Resources is Problematic and Extent to Which Student Issues Are Problematic composites are not significantly different from 2012.[26]

Table 3.44
School Mean Scores for Factors Affecting Instruction Composites, by Community Type†

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
(t) Extent to Which Student Issues are Problematic[a]	36 (2.4)	34 (1.5)	42 (2.2)
(t) Extent to Which a Lack of Resources is Problematic[b]	22 (1.9)	20 (1.2)	22 (2.1)
Extent to Which Teacher Issues are Problematic	19 (1.8)	22 (1.4)	21 (2.0)

(t) Trend item

† There are no statistically significant differences among schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

b This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Teachers were also asked about factors that affect mathematics instruction. As can be seen in Table 3.45, over two-thirds of classes, regardless of community type, were taught by teachers who rated the amount of instructional time devoted to mathematics, principal support, amount of planning time, and current state standards as promoters of effective mathematics instruction. However, classes in rural schools were more likely than classes in suburban schools to be taught by teachers rating principal support as promoting effective mathematics instruction. The 2018 data are not significantly different from the 2012 data.

26 The 2012 data did not support the creation of the Extent to Which Teacher Issues are Problematic composite; thus, trend data are not available to report.

Table 3.45
Factors Promoting[a] Effective Instruction in Mathematics Classes, by Community Type

	PERCENT OF CLASSES		
	RURAL	SUBURBAN	URBAN
Amount of instructional time devoted to mathematics[b]	88 (3.1)	83 (2.5)	83 (3.9)
(t) Principal support*	81 (1.9)	72 (2.0)	75 (2.4)
(t) Amount of time for you to plan, individually and with colleagues	70 (2.5)	69 (1.9)	73 (2.3)
(t) Current state standards	72 (2.2)	73 (1.4)	69 (2.7)
Students' prior knowledge and skills	70 (2.6)	62 (1.9)	62 (3.2)
(t) Students' motivation, interest, and effort in mathematics	62 (3.0)	62 (1.7)	62 (3.1)
(t) District/Diocese/School pacing guides	64 (2.6)	65 (1.7)	58 (2.6)
(t) College entrance requirements[c]	64 (4.4)	59 (2.6)	56 (6.3)
(t) Amount of time available for your professional development	55 (2.5)	58 (1.9)	55 (2.9)
(t) Parent/guardian expectations and involvement	47 (3.0)	47 (1.7)	50 (2.8)
(t) Teacher evaluation policies	50 (3.0)	46 (2.1)	48 (3.2)
(t) State/district/diocese testing/accountability policies[d]	46 (2.4)	40 (1.8)	43 (2.5)
(t) Textbook selection policies	45 (2.7)	40 (2.1)	38 (3.3)

(t) Trend item

* There is a statistically significant difference between classes in schools serving rural communities and those serving suburban communities (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 "inhibits effective instruction" to 5 "promotes effective instruction."

b This item was presented only to elementary school teachers.

c This item was presented only to high school teachers.

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

Three composites from these items were created to summarize the extent to which teachers see various factors supporting effective instruction: (1) Extent to Which School Support Promotes Effective Instruction; (2) Extent to Which the Policy Environment Promotes Effective Instruction; and (3) Extent to Which Stakeholders Promote Effective Instruction. As can be seen in Table 3.46, there were no differences in the composite mean scores by community type. When looking at trends, the 2018 data for the Extent to Which School Support Promotes Effective Instruction and Extent to Which the Policy Environment Promotes Effective Instruction composites are not significantly different from the 2012 data.[27]

[27] Too few items in the 2018 version of the Extent to Which Stakeholders Promote Effective Instruction composite were also asked in 2012; thus, trend data are not available to report.

Table 3.46
Mathematics Class Mean Scores for Factors Affecting Instruction Composites, by Community Type†

	MEAN SCORE		
	RURAL	SUBURBAN	URBAN
(t) Extent to Which School Support Promotes Effecting Instruction	69 (1.6)	71 (1.2)	71 (1.4)
Extent to Which Stakeholders Promote Effective Instruction[a]	65 (1.9)	66 (1.0)	65 (1.7)
(t) Extent to Which the Policy Environment Promotes Effective Instruction	67 (1.3)	66 (0.7)	64 (1.3)

(t) Trend item

† There are no statistically significant differences among classes in schools serving different community types (two-tailed independent samples t-tests, $p \geq 0.05$).

[a] This composite variable was computed differently in 2012 and 2018. To allow for comparisons across time, it was recomputed for 2012 using the 2018 definition.

Summary

There were both similarities and differences in the supportiveness of school context for mathematics learning among community types. In terms of school-level professional development offerings, mathematics-focused workshops and study groups were offered in over half of schools, regardless community type. However, urban schools were more likely than suburban and rural schools to offer workshops. Although one-on-one coaching was less common overall, this form of professional development was significantly less likely to be offered in rural schools than in suburban and urban schools.

The emphasis of mathematics-focused workshops was quite similar across community types. However, there were several differences in the emphasis of study groups when comparing urban to suburban and rural schools. For example, study groups in urban schools were more likely than those in suburban and rural schools to emphasize how to differentiate mathematics instruction and how to adapt mathematics instruction to address student misconceptions. Additionally, an emphasis on how to incorporate real-world issues into mathematics instruction was more common in study groups in urban schools than those in suburban schools.

A number of differences existed among community types in regard to the services provided to teachers in need of special assistance and those new to the profession. Rural schools were less likely than their urban counterparts to offer guidance from a formally designated mentor or coach for teachers in need of special assistance. Additionally, rural schools were less likely than suburban and urban schools to offer a higher level of supervision for teachers in need of special assistance. Although three-fourths of schools, across community types, offered a teacher induction program, rural schools were more likely than urban schools to provide school-based mentors as a part of that program.

The use of different instructional arrangements at the elementary level was similar in rural, suburban, and urban schools. There was also a great deal of consistency at the high school level in course-taking opportunities. Over half of all schools offered calculus courses, opportunities for students to go to a college or university for mathematics courses, access to virtual mathematics courses, and concurrent college and high school credit/dual enrollment courses. However, rural schools were less likely than suburban and urban schools to offer probability and/ or statistics courses.

Schools' use of programs and practices to enhance student interest and achievement in mathematics was relatively consistent across community types, with after-school help being a common offering. Program representatives' perceptions of factors that promote mathematics instruction in schools were also similar across community types.

School climate was seen as moderately supportive of effective mathematics instruction in all three community types. Over two-thirds of classes across community types were taught by teachers who rated the amount of instructional time devoted to mathematics, principal support, amount of planning time, and current state standards as promoters of effective mathematics instruction. However, over half of program representatives pointed to low student prior knowledge and skill, lack of parent/guardian support and involvement, and low student interest in mathematics as problematic for mathematics instruction.

Over time, there have been few significant changes in the distribution of a supportive context for mathematics instruction among community types. There were some changes in the emphases of teacher study groups, such as deepening teachers' understanding of how students think about various mathematics ideas and how to adapt mathematics instruction to address student misconceptions, both of which advantaged urban schools. Additionally, although the use of mathematics specialists was rare across community types in 2018, the gap between rural and urban schools changed over time due to a decline in the use of mathematics specialists in rural schools.

Students From Race/Ethnicity Groups Historically Underrepresented in STEM

Introduction

For this class-level factor, teachers were asked to respond to questions about a randomly selected mathematics class. Each randomly selected class was classified into 1 of 4 categories based on the percentage of students in the class identified as being from race/ethnicity groups historically underrepresented in STEM. As can be seen in Table 4.1, classes in the lowest quartile have an average of only 4 percent of students from these groups, compared to 94 percent in the highest quartile. This chapter shows study data for classes in each quartile and highlights differences between classes in the lowest and highest quartiles.

Table 4.1
Average Percentage of Students From Race/Ethnicity Groups Historically Underrepresented in STEM

	PERCENT HUS
Lowest Quartile	4 (0.2)
Second Quartile	20 (0.3)
Third Quartile	51 (0.6)
Highest Quartile	94 (0.4)

Nature of Mathematics Instruction

The 2018 NSSME+ collected a variety of data about mathematics instruction, including time spent on mathematics, course enrollment, and instructional objectives and activities. This section presents these data, highlighting similarities and differences between classes with the highest percentages of students from race/ethnicity groups historically underrepresented in STEM (high-HUS classes) and those containing the lowest percentages of students from these groups (low-HUS classes).

Time Spent In Elementary Grades

Student opportunity to learn mathematics is related to the amount of instructional time devoted to this subject. Table 4.2 shows the average number of minutes per day typically spent on mathematics, science, social studies, and reading/language arts in self-contained elementary grades classes that cover all four subjects. High-HUS classes spent more time on mathematics instruction per day than low-HUS classes (61 vs. 55 minutes). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 4.2
Average Number of Minutes per Day Spent Teaching Each Subject in Self-Contained Classes,[a] by HUS Quartile

	NUMBER OF MINUTES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Reading/Language Arts	85 (2.8)	88 (2.4)	90 (2.8)	88 (2.7)
(t) Mathematics*	55 (1.5)	57 (1.4)	60 (1.9)	61 (1.8)
(t) Science*	17 (0.9)	19 (0.8)	19 (1.1)	23 (1.0)
(t) Social Studies*	16 (0.8)	16 (0.7)	16 (0.8)	19 (0.8)

(t) Trend item

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

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

Course-Taking Opportunities in Secondary Grades

The study also collected data about the composition of classes in the nation's high schools. Despite making up about half of all students in 2018, students from race/ethnicity groups historically underrepresented in STEM made up 53 percent of students in non-college prep mathematics classes, with a pattern of decreasing enrollment in more advanced courses (see Table 4.3). When looking at trends in class composition over time, these same disparities were present in 2012, a disappointing finding that indicates a need to rethink efforts to ensure that all students are college and career ready when they graduate from high school.

Table 4.3
Average Percentage of Historically Underrepresented Students in High School Mathematics Courses[(t)]

	PERCENT OF STUDENTS
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	53 (4.4)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	38 (2.5)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	39 (3.2)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	37 (2.4)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	33 (2.5)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	22 (2.4)

(t) Trend item

Teachers of high school mathematics courses were also asked for the course type of a randomly selected class, which allows for an estimate of the percentages of mathematics courses of each type in the nation. As can be seen in Table 4.4, classes in the highest HUS quartile were more likely than classes in the lowest quartile to be non-college prep (23 vs. 8 percent) and less likely to be courses that might qualify for college credit, such as AP courses (3 vs. 13 percent). These data are not significantly different from the 2012 data.

Table 4.4
Prevalence of High School Mathematics Courses, by HUS Quartile(t)

	PERCENT OF CLASSES*			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	8 (1.4)	9 (1.3)	12 (1.7)	23 (3.0)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	14 (2.0)	16 (2.5)	23 (2.2)	28 (3.1)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	20 (2.5)	23 (2.1)	29 (2.5)	19 (2.5)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	23 (2.6)	23 (2.3)	19 (2.1)	17 (2.5)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	21 (2.6)	18 (2.0)	11 (1.3)	10 (2.2)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	13 (1.8)	11 (1.9)	5 (1.0)	3 (0.7)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (Chi-square test of independence, $p < 0.05$).

Teachers' Perceptions of Their Decision-Making Autonomy

The survey asked teachers about the extent to which they had control over a number of curriculum and instruction decisions for their classes. As can be seen in Table 4.5, a number of differences between the highest and lowest HUS quartiles were present in 2018. For example, teachers of high-HUS classes were less likely than their low-HUS class counterparts to perceive strong control over selecting the sequence in which topics are covered (18 vs. 46 percent) and determining the amount of instructional time to spend on each topic (23 vs. 46 percent). These data may suggest that teachers of high-HUS classes were more likely to have a mandated scope and sequence for their instruction. When looking at the trend items in this series, the same disparities were present in 2012.

Table 4.5
Mathematics Classes in Which Teachers Reported Having Strong Control Over Various Curricular and Instructional Decisions, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Determining the amount of homework to be assigned*	72 (2.4)	68 (2.5)	65 (3.2)	63 (3.0)
(t) Selecting teaching techniques*	68 (2.5)	64 (2.5)	59 (2.8)	51 (3.5)
(t) Choosing criteria for grading student performance	50 (2.9)	42 (2.4)	38 (3.0)	42 (3.1)
Determining the amount of instructional time to spend on each topic*	46 (2.6)	35 (2.5)	26 (2.6)	23 (2.9)
(t) Determining course goals and objectives*	29 (2.2)	25 (2.2)	16 (1.9)	20 (2.5)
Selecting the sequence in which topics are covered*	46 (2.5)	32 (2.4)	21 (1.9)	18 (2.2)
(t) Selecting curriculum materials (e.g., textbooks)*	23 (1.9)	17 (1.9)	14 (1.9)	14 (2.3)
(t) Selecting content, topics, and skills to be taught*	26 (1.9)	18 (2.1)	13 (1.7)	14 (2.4)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile ($p < 0.05$).

These items were combined into two composite variables—Curriculum Control and Pedagogy Control. The mean composite scores (see Table 4.6) indicate that teachers of high-HUS classes tended to report less control over decisions related to both curriculum and pedagogy than their counterparts in low-HUS classes. These data are not significantly different from the data in 2012.

Table 4.6
Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites, by HUS Quartile

	MEAN SCORE			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Curriculum Control*,[a]	56 (1.5)	50 (1.8)	41 (1.7)	42 (1.8)
(t) Pedagogy Control*	85 (1.0)	83 (0.9)	81 (1.3)	79 (1.3)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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 for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Instructional Objectives

Student opportunity to learn mathematics is also impacted by the objectives that teachers emphasize in their instruction. In 2018, classes in the highest and lowest quartiles had relatively equal emphasis on some instructional objectives but not others (see Table 4.7). Roughly two-thirds of high-HUS and low-HUS classes heavily emphasized learning how to do mathematics and understanding mathematical ideas. In addition, learning mathematical procedures and/or algorithms was emphasized in about half of high-HUS and low-HUS classes.

In terms of differences, classes in the highest quartile were more likely than those in the lowest quartile to heavily emphasize traditional instructional objectives such as learning mathematics vocabulary (38 vs. 30 percent) and learning test-taking skills (34 vs. 22 percent). However, these classes were also more likely to heavily emphasis increasing students' interest in mathematics (43 vs. 32 percent) and learning about real-life applications of mathematics (39 vs. 33 percent). These same differences between classes were present in 2012.

Table 4.7
Mathematics Classes With Heavy Emphasis on Various Instructional Objectives, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Understanding mathematical ideas	71 (1.8)	69 (2.2)	68 (2.0)	66 (2.6)
(t) Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	63 (2.3)	62 (2.6)	63 (2.2)	61 (2.4)
(t) Learning mathematical procedures and/or algorithms	55 (2.1)	51 (2.2)	49 (2.7)	55 (2.4)
(t) Increasing students' interest in mathematics*	32 (1.8)	32 (2.5)	35 (1.8)	43 (2.3)
Developing students' confidence that they can successfully pursue careers in mathematics	35 (2.1)	38 (2.4)	37 (2.2)	40 (2.5)
(t) Learning about real-life applications of mathematics*	33 (2.1)	31 (2.2)	33 (2.2)	39 (2.6)
Learning mathematics vocabulary*	30 (1.9)	28 (1.9)	32 (2.5)	38 (2.5)
(t) Learning test-taking skills/strategies*	22 (1.7)	24 (2.3)	26 (2.4)	34 (2.3)
(t) Learning to perform computations with speed and accuracy	27 (1.9)	25 (2.2)	23 (2.2)	30 (2.6)

(t) Trend item

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

Several of these items were combined into a Reform-Oriented Instructional Objectives composite variable. Table 4.8 displays the mean scores by HUS quartile. The data indicate that mathematics classes across quartiles were, on average, equally likely to emphasize reform-oriented instructional objectives. The 2018 data are not significantly different from the 2012 data.

Table 4.8
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite,[a] by HUS Quartile[(t),†]

	MEAN SCORE
Lowest Quartile	78 (0.5)
Second Quartile	78 (0.7)
Third Quartile	78 (0.6)
Highest Quartile	79 (0.8)

(t) Trend item

† There is not a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Class Activities

The 2018 NSSME+ included several sets of items that provide information about mathematics instruction. One asked how often different pedagogies were used. As can be seen in Table 4.9, nearly all high-HUS and low-HUS classes included the teacher explaining mathematical ideas and leading whole class discussions at least once a week. Having students work in small groups was also common, regardless of the percentage of students from historically underrepresented groups in the class.

Teachers of high-HUS classes were more likely than their counterparts in low-HUS classes to engage students in a number of activities that promote conceptual understanding; for example, teachers of these classes were more likely to have students use manipulatives (60 vs. 47 percent) and reflect on what they were learning in writing (44 vs. 26 percent) at least once a week. However, they were also more likely to have students focus on literacy skills (42 vs. 22 percent), practice for standardized tests (38 vs. 21 percent), and read from a textbook or other materials in class (33 vs. 20 percent). The differences in class activities between the lowest and highest quartiles of classes have not significantly changed since 2012.

Table 4.9
Mathematics Classes in Which Teachers Reported Using Various Activities at Least Once a Week, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Explain mathematical ideas to the whole class	95 (0.9)	96 (0.9)	94 (1.2)	93 (1.4)
(t) Engage the whole class in discussions	92 (0.9)	93 (1.0)	89 (1.6)	90 (1.6)
(t) Have students work in small groups	80 (1.9)	81 (1.5)	79 (1.8)	84 (2.0)
(t) Provide manipulatives for students to use in problem-solving/investigations*	47 (2.6)	46 (2.5)	53 (2.2)	60 (2.9)
(t) Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*	26 (2.0)	24 (2.1)	34 (2.4)	44 (2.8)
(t) Focus on literacy skills (e.g., informational reading or writing strategies)*	22 (1.9)	22 (2.0)	30 (2.3)	42 (2.5)
(t) Have students practice for standardized tests*	21 (1.9)	23 (2.0)	28 (2.5)	38 (2.5)
(t) Have students read from a textbook or other material in class, either aloud or to themselves*	20 (1.8)	19 (1.8)	21 (1.6)	33 (2.4)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)*	6 (1.4)	5 (1.6)	11 (3.8)	12 (2.7)

(t) Trend item

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

The 2018 NSSME+ also asked teachers how often they engage students in aspects of the mathematical practices described in the CCSSM. Students in high-HUS and low-HUS classes had similar opportunities to engage in most of the mathematical practices at least once a week (see Table 4.10). For example, a large majority of classes, regardless of HUS quartile, had students: (1) determine whether their answer makes sense, (2) develop representations of aspects of problems, (3) provide mathematical reasoning, and (4) continue to work through a mathematics problem when they reach points of difficulty. Interestingly, in cases where there are differences between high-HUS and low-HUS classes, the practice was more likely to occur in high-HUS classes. For example, students in high-HUS classes were more likely than those in low-HUS classes to: (1) analyze the mathematical reasoning of others (65 vs. 58 percent), (2) work on generating a rule or formula (64 vs. 58 percent), and (3) compare and contrast different solution strategies in terms of their strengths and limitations (62 vs. 52 percent). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 4.10
Mathematics Classes in Which Teachers Reported Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Determine whether their answer makes sense	86 (1.4)	84 (2.1)	83 (2.2)	84 (2.0)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	81 (1.9)	80 (2.0)	82 (1.7)	84 (2.2)
Provide mathematical reasoning to explain, justify, or prove their thinking	82 (2.0)	82 (1.8)	83 (2.0)	82 (1.9)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	82 (1.6)	79 (1.8)	78 (2.6)	82 (2.0)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	75 (1.8)	77 (2.0)	78 (1.6)	77 (2.4)
Identify relevant information and relationships that could be used to solve a mathematics problem	75 (2.2)	70 (3.0)	74 (2.2)	75 (2.4)
Figure out what a challenging problem is asking	70 (1.7)	74 (2.2)	72 (2.6)	75 (2.3)
Develop a mathematical model to solve a mathematics problem	69 (2.2)	68 (2.5)	71 (2.2)	75 (2.5)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	72 (2.1)	74 (2.3)	73 (2.2)	74 (2.2)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements	72 (2.1)	68 (2.4)	73 (2.1)	72 (2.0)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed	67 (2.0)	68 (2.4)	67 (2.9)	71 (2.5)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	65 (1.9)	64 (2.7)	69 (2.3)	70 (2.5)
Determine what tools are appropriate for solving a mathematics problem	66 (2.3)	64 (2.4)	66 (2.5)	68 (2.7)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	62 (2.3)	58 (2.2)	64 (2.2)	67 (2.2)
Analyze the mathematical reasoning of others*	58 (1.8)	57 (2.6)	62 (2.8)	65 (2.3)
Work on generating a rule or formula*	58 (1.9)	62 (1.9)	64 (2.5)	64 (2.2)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations*	52 (2.1)	53 (2.9)	61 (2.6)	62 (2.2)

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

Table 4.11 shows the mean scores for the Engaging Students in the Practices of Mathematics composite formed from these items. Although there were some item-level differences, overall, scores on the composite were similar for classes in the highest and lowest quartiles.

Table 4.11
Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite, by HUS Quartile†

	MEAN SCORE
Lowest Quartile	73 (0.5)
Second Quartile	72 (0.9)
Third Quartile	73 (0.8)
Highest Quartile	74 (0.9)

† There is not a statistically significant difference between classes in the lowest quartile and those in the highest quartile (two-tailed independent samples t-test, $p \geq 0.05$).

The survey also asked teachers how often students in the randomly selected class were required to take assessments the teacher did not develop (e.g., state or district benchmark assessments). As shown in Table 4.12, students in high-HUS classes were more likely to be tested two or more times per year than those in low-HUS classes (81 vs. 70 percent).

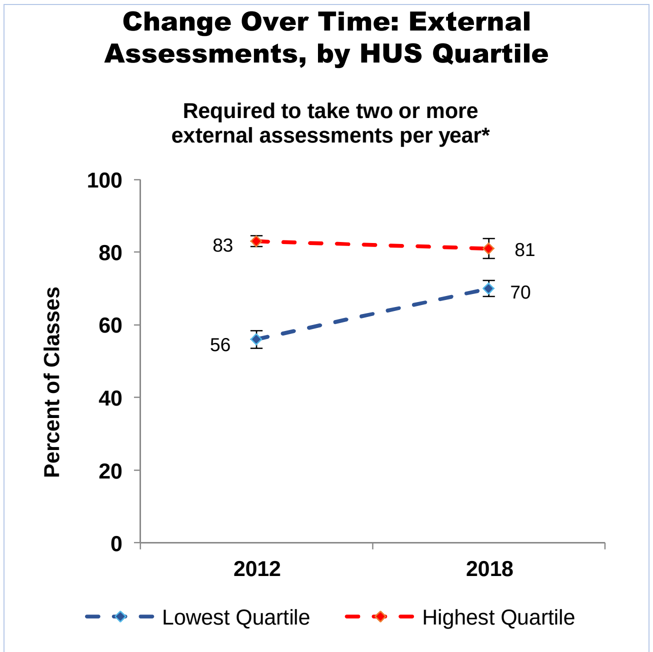
Table 4.12
Mathematics Classes Required to Take External Assessments Two or More Times per Year, by HUS Quartile(t)

	PERCENT OF CLASSES*
Lowest Quartile	70 (2.2)
Second Quartile	73 (2.2)
Third Quartile	78 (2.3)
Highest Quartile	81 (2.7)

(t) Trend item

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

As can be seen in Figure 4.1, there has been a significant change in the difference between high-HUS and low-HUS classes on this item since 2012. The narrowing of the gap appears to be due to more low-HUS classes being required to take two or more external assessments per year in 2018 than in 2012.



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

Figure 4.1

Summary

There were a number of aspects of mathematics instruction that were similar between classes in the highest and lowest HUS quartiles in 2018, but there were also several notable differences. At the elementary level, high-HUS classes spent significantly more time on mathematics instruction than low-HUS classes. Of course, whether that finding is positive or negative depends on how that additional time was being spent. In terms of course enrollment at the secondary level, students from race/ethnicity groups historically underrepresented in STEM made up a majority of students in non-college prep mathematics classes, but smaller percentages of the students in more advanced courses.

Data about teachers' perceptions of control and emphasis on instructional objectives are also mixed. For example, teachers of high-HUS classes reported less control over decisions related to curriculum and pedagogy than teachers of low-HUS classes. Overall, high-HUS and low-HUS mathematics classes had relatively equal emphasis on reform-oriented instructional objectives (e.g., understanding mathematical ideas, learning how to do mathematics); however, learning about real-life applications of mathematics and increasing students' interest in mathematics were more likely to be heavily emphasized in high-HUS classes. Still, some traditional instructional objectives (i.e., learning mathematics vocabulary and test-taking skills) were also more likely to be emphasized in high-HUS classes.

Types of instructional activities used in classrooms were relatively similar regardless of HUS quartile. The teacher explaining ideas, whole group discussion, and small group work were prominent activities at least once a week in both high-HUS and low-HUS classes. Also, students in high-HUS and low-HUS classes had similar opportunities to engage in a number of mathematical practices at least once a week. In contrast, high-HUS classes were more likely to have students practice for standardized tests and focus on literacy skills. Not surprisingly, external testing also occurred more frequently in high-HUS classes.

Since 2012, the nature of mathematics instruction provided in high-HUS and low-HUS classes has remained largely consistent. The one notable difference is the requirement of external testing. Since 2012, the gap between high-HUS classes and low-HUS classes has narrowed, though this change appears to be a result of increased testing in low-HUS classes.

Material Resources

As described in previous chapters, the 2018 NSSME+ included a number of items about the resources available for mathematics instruction. This section of the report provides information about material resources, disaggregated by HUS quartile.

Instructional Materials

In 2018, a large majority of both high-HUS and low-HUS mathematics classes had instructional materials designated for use by their district, though it was even more likely in high-HUS classes (see Table 4.13). Commercially published textbooks were by far the most frequently designated type of material, though somewhat less common in high-HUS classes than low-HUS classes (87 vs. 93 percent). In contrast, high-HUS classes were more likely than low-HUS classes to have other types of materials designated for their instruction: state, county, district-developed units (54 vs. 26 percent); online units that students work through at their own pace (41 vs. 22 percent); and lessons or resources from free or subscription-based websites (34 vs. 22 percent and 30 vs. 20 percent, respectively). This series of items was new to the 2018 NSSME+; thus, trend data are unavailable to report.

Table 4.13
Types of Instructional Materials
Designated for Mathematics Classes, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
District Designates Instructional Materials*1				
No	22 (1.8)	22 (2.1)	17 (1.9)	14 (1.8)
Yes	78 (1.8)	78 (2.1)	83 (1.9)	86 (1.8)
Types of Designated Instructional Materials[a]				
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks*2	93 (1.4)	87 (2.2)	89 (1.6)	87 (2.4)
State, county, district, or diocese-developed units or lessons*2	26 (2.6)	33 (3.2)	45 (2.9)	54 (2.9)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*2	22 (3.2)	24 (2.9)	27 (2.3)	41 (3.2)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)*2	22 (2.0)	23 (2.8)	29 (2.0)	34 (3.1)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*2	20 (2.3)	23 (2.5)	26 (2.3)	30 (2.7)

*1 There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (Chi-square test of independence, $p < 0.05$).

*2 There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (two-tailed independent samples t-test, $p < 0.05$).

[a] Only mathematics classes for which instructional materials are designated by the state, district, or diocese are included in these analyses.

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction was based on various types of materials. Aside from units or lessons developed by teachers, which were the basis of instruction at least once a week in 55–61 percent of classes across all quartiles, material use differed significantly between classes in the highest and lowest quartiles (see Table 4.14). For example, commercially published textbooks were the most commonly used material, but classes in the highest quartile were less likely than those in the lowest quartile to use textbooks at least once a week. In contrast, teachers of classes in the highest quartile were more likely than their lowest-quartile class counterparts to use all other material types at least once a week, including: state, county, or district-developed units or lessons; lessons or resources from websites; and online units or courses that students work through at their own pace. This series of items was new to the 2018 NSSME+; thus, trend data are unavailable to report.

Table 4.14
Mathematics Classes Basing Instruction on Various Types of Instructional Materials at Least Once a Week, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks*	75 (2.0)	68 (2.5)	67 (2.3)	68 (2.4)
Units or lessons you created (either by yourself or with others)	55 (2.1)	57 (2.6)	61 (2.3)	58 (2.4)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*	32 (2.5)	41 (2.4)	41 (2.6)	46 (2.7)
State, county, district, or diocese-developed units or lessons*	22 (1.8)	28 (2.1)	36 (2.6)	45 (2.5)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)*	29 (2.0)	30 (2.2)	37 (2.6)	43 (2.4)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*	20 (2.6)	20 (2.0)	29 (2.6)	37 (2.7)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)*	28 (1.9)	29 (2.2)	34 (2.3)	36 (2.6)

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

Teachers who indicated that they used commercially published textbooks were asked to record the title, author, publication year, and ISBN of the material used most often in the class. As can be seen in Table 4.15, teachers of high-HUS classes were more likely than those in low-HUS classes to use newer textbooks. The 2018 data are not significantly different from the 2012 data.

Table 4.15
Age of Mathematics Textbooks in 2018, by HUS Quartile(t)

	PERCENT OF CLASSES*			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
6 or more years	57 (3.1)	55 (3.4)	37 (4.1)	38 (3.5)
5 or fewer years	43 (3.1)	45 (3.4)	63 (4.1)	62 (3.5)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (Chi-square test of independence, $p < 0.05$).

Facilities and Equipment

Teachers were asked to rate the adequacy of a number of instructional resources available for instruction. Ratings of the availability of manipulatives (e.g., pattern blocks, algebra tiles) were similar between high- and low-HUS classes, with roughly 70 percent indicating adequate access (see Table 4.16). In contrast, teachers of high-HUS classes were less likely than their low-HUS class counterparts to rate all other listed instructional resources as adequate: measurement tools (75 vs. 84 percent), instructional technology (69 vs. 80 percent), and consumable supplies (62 vs. 78 percent). The same inequities between classes were present in 2012.

Table 4.16
Adequacy[a] of Resources for Mathematics Instruction, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Measurement tools (e.g., protractors, rulers)*	84 (2.0)	85 (1.7)	77 (2.0)	75 (2.7)
(t) Manipulatives (e.g., pattern blocks, algebra tiles)	69 (2.3)	75 (2.5)	70 (2.8)	73 (2.6)
(t) Instructional technology (e.g., calculators, computers, probes/sensors)*	80 (2.6)	77 (2.6)	75 (2.5)	69 (2.9)
(t) Consumable supplies (e.g., graphing paper, batteries)*	78 (2.2)	76 (2.4)	67 (2.7)	62 (3.3)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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 adequate" to 5 "adequate."

These items were combined into a composite variable named Adequacy of Resources for Mathematics Instruction. As can be seen in Table 4.17, teachers of classes with the highest percentages of students from race/ethnicity groups historically underrepresented in STEM had somewhat less positive views about their resources compared to those with the lowest percentages (mean scores of 76 vs. 81). The 2018 data are not significantly different from the 2012 data.

Table 4.17
Mathematics Class Mean Scores for the Adequacy of Resources for Instruction Composite, by HUS Quartile(t)

	MEAN SCORE*
Lowest Quartile	81 (1.0)
Second Quartile	82 (1.0)
Third Quartile	78 (1.2)
Highest Quartile	76 (1.4)

(t) Trend item

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

Summary

The distribution and use of material resources for mathematics instruction between classes in the highest and lowest HUS quartiles were similar in some ways, but there were also numerous differences. Commercially published textbooks were the most commonly designated and the most frequently used type of mathematics instructional material (whether designated or not), regardless of HUS quartile. Units or lessons developed by teachers were also used in a majority of classes across all quartiles. However, high-HUS classes were more likely to use other material types (e.g., state, county, or district-developed units or lessons; lessons or resources from websites; online units or courses that students work through at their own pace).

In addition, there were disparities related to teachers' perceptions of the adequacy of these resources. In particular, teachers of high-HUS classes were less likely to think the available resources for instruction (e.g., measurement tools, technology, consumable supplies) were adequate than teachers of low-HUS classes.

Because many of the items about material resources were different in the 2018 study than the 2012 study, trend analyses were limited. When trend analyses were conducted, there were no significant changes since 2012.

Well-Prepared Teachers

Teachers are clearly one of the most important factors affecting students' education experience. The 2018 NSSME+ collected data on a number of indicators of teacher preparedness, including their years of teaching experience, content preparation, beliefs about teaching and learning, perceptions of preparedness to teach mathematics content and use classroom pedagogies, and professional development experiences. The extent to which well-prepared teachers were equally distributed among classes with different percentages of students from race/ethnicity groups historically underrepresented in STEM is described in the following sections.

Teacher Characteristics and Preparation

Table 4.18 provides information about the characteristics of teachers of mathematics classes in 2018. Although mathematics classes in the highest and lowest quartiles were taught by teachers who have had comparable coursework related to the NCTM preparation standards, the teachers of these classes were different in a number of important ways. For example, high-HUS classes were far more likely than low-HUS classes to be taught by teachers from race/ethnicity groups historically underrepresented in STEM. Given that these groups have also been historically underrepresented in the teaching workforce,[28] it is encouraging that nearly half of classes in the highest quartile were taught by teachers from these groups. Less encouraging is the finding that classes in the highest quartile were more likely than those in the lowest quartile to be taught by teachers with five or fewer years of experience teaching mathematics (37 vs. 24 percent) and that secondary teachers of these classes were less likely to have a degree in mathematics or mathematics education (56 vs. 76 percent).

Table 4.18
Teacher Characteristics, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) 0–5 years of experience teaching mathematics*	24 (2.0)	33 (2.3)	30 (2.4)	37 (2.8)
(t) Historically underrepresented race/ethnicity group*	3 (0.7)	5 (0.9)	12 (1.4)	45 (3.4)
(t) Degree in mathematics or mathematics education*,[a]	76 (2.4)	73 (3.0)	63 (2.9)	56 (3.6)
(t) Substantial coursework related to NCTM preparation standards[b]	61 (2.5)	60 (2.0)	55 (2.6)	60 (2.3)

(t) Trend item

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

a Only secondary teachers are included in this analysis.

b Includes elementary mathematics teachers who have courses in 3 or more of the 5 areas, middle school mathematics teachers who have courses in 4 or more of the 6 areas, and high school mathematics teachers who have courses in 5 or more of the 7 areas.

[28] Ingersoll, R., & Merrill, L. (2017). A quarter century of changes in the elementary and secondary teaching force: From 1987 to 2012. Statistical Analysis Report. NCES 2017-092. *National Center for Education Statistics*.

Since 2012, the difference between the percentage of high-HUS and low-HUS classes taught by teachers from race/ethnicity groups historically underrepresented in STEM has changed significantly (see Figure 4.2). This change appears to be largely due to an increase in the percentage of high-HUS classes being taught by teachers from these groups. Specifically, in 2012, 33 percent of high-HUS classes and 1 percent of low-HUS classes were taught by teachers from race/ethnicity groups historically underrepresented in STEM, compared to 45 and 3 percent of classes, respectively, in 2018.

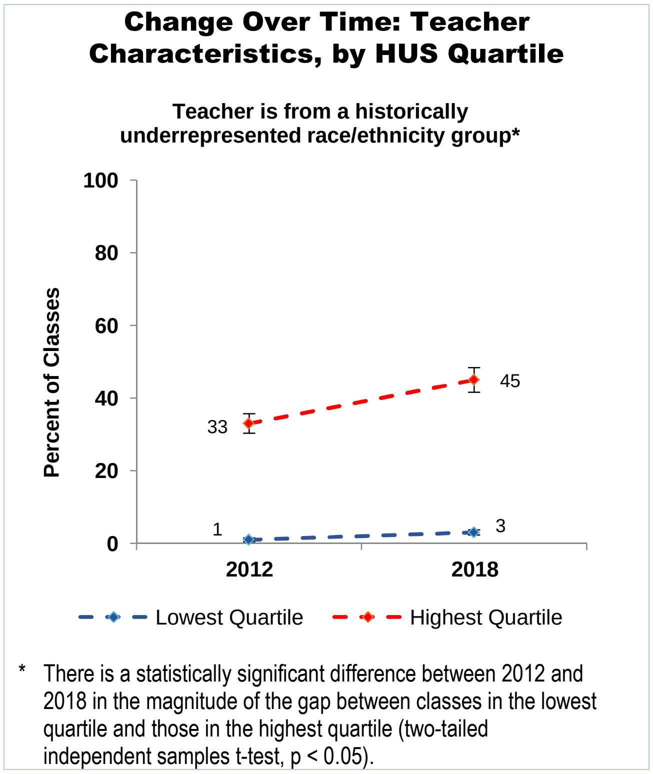


Figure 4.2

Teacher Pedagogical Beliefs

Because beliefs tend to influence behaviors, the 2018 NSSME+ asked teachers about their beliefs related to effective teaching and learning. As can be seen in Table 4.19, teachers tended to hold a number of reform-oriented beliefs, regardless of HUS quartile. For example, nearly all classes were taught by teachers who agreed that: (1) they 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. Although strongly held by most teachers, high-HUS classes were more likely than low-HUS classes to be taught by teachers who believed that students learn best when instruction is connected to their everyday lives (96 vs. 90 percent) and that most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts (94 vs. 86 percent).

However, high-HUS classes were also more likely than low-HUS classes to be taught by teachers who agreed with statements associated with traditional beliefs. Specifically, teachers of high-HUS classes were more likely than teachers of low-HUS classes to believe that: (1) hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea (58 vs. 40 percent) and (2) teachers should explain an idea to students before having them investigate the idea (40 vs. 27 percent). The 2018 data are not significantly different from the 2012 data.

Table 4.19
Mathematics Classes in Which Teachers Agreed[a] With Various Statements About Teaching and Learning, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Reform-Oriented Teaching Beliefs				
Teachers should ask students to justify their mathematical thinking.	98 (0.9)	99 (0.5)	97 (0.9)	99 (0.5)
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 (1.1)	96 (1.0)	98 (0.5)	98 (0.7)
Students learn best when instruction is connected to their everyday lives*	90 (1.4)	92 (1.6)	94 (1.0)	96 (1.1)
(t) Most class periods should provide opportunities for students to share their thinking and reasoning.	95 (1.5)	96 (1.0)	94 (1.0)	95 (1.0)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts*	86 (1.7)	86 (2.0)	91 (1.2)	94 (1.5)
(t) It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	84 (1.7)	76 (2.6)	86 (1.9)	80 (2.4)
Traditional Teaching Beliefs				
(t) At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	80 (1.8)	80 (2.5)	79 (2.1)	84 (1.8)
(t) Students learn mathematics best in classes with students of similar abilities.	62 (2.9)	61 (3.1)	58 (2.1)	58 (2.9)
(t) Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.*	40 (2.3)	48 (3.2)	47 (3.3)	58 (3.0)
(t) Teachers should explain an idea to students before having them investigate the idea.*	27 (2.4)	28 (2.4)	35 (3.2)	40 (2.8)

(t) Trend item

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

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

These items were combined into two composite variables: Reform-Oriented Teaching Beliefs and Traditional Teaching Beliefs. As can be seen in Table 4.20, both reform-oriented beliefs and traditional beliefs were significantly stronger among teachers of classes in the highest quartile, but not by much. The 2018 data for the Traditional Teaching Beliefs composite are not significantly different from the 2012 data.[29]

[29] Too few of the items in the 2018 Reform-Oriented Beliefs composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Table 4.20
Mathematics Class Mean Scores for Teachers' Beliefs About Teaching and Learning Composites, by HUS Quartile

	MEAN SCORE			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Reform-Oriented Teaching Beliefs*	81 (0.7)	82 (0.8)	84 (0.6)	85 (0.7)
(t) Traditional Teaching Beliefs*,[a]	58 (0.9)	60 (1.1)	59 (1.3)	63 (1.0)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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

The survey asked teachers how well prepared they felt to teach each of a number of mathematics topics at their assigned grade level. At the elementary level, teachers of high- and low-HUS classes reported feeling equally well prepared to teach various mathematics topics, with number and operations being a topic area that teachers in roughly three-fourths of classes felt very well prepared to teach (see Table 4.21).

Table 4.21
Elementary Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Various Mathematics Topics, by HUS Quartile†

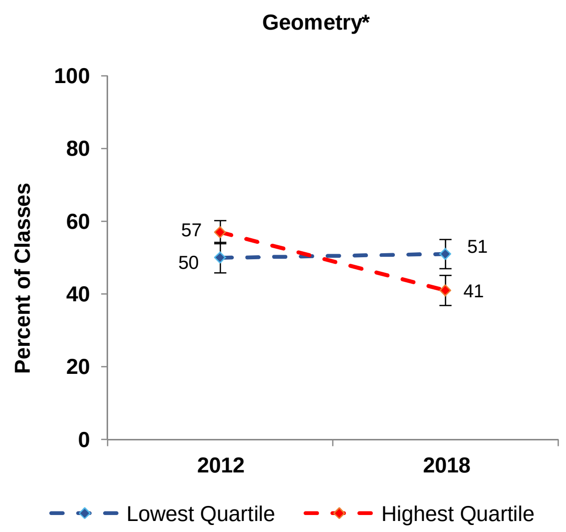
	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Number and operations	77 (3.0)	74 (3.8)	77 (2.9)	72 (4.4)
(t) Measurement and data representation	52 (3.6)	55 (3.5)	52 (4.1)	49 (3.3)
(t) Geometry	51 (4.0)	54 (3.9)	50 (4.0)	41 (4.1)
(t) Early algebra	45 (3.3)	43 (3.5)	39 (3.7)	38 (3.9)

(t) Trend item

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

Interestingly, since 2012, there has been a change between the two quartiles in elementary teachers' perceptions of preparedness to teach geometry (see Figure 4.3). Unfortunately, this change appears to be due to fewer high-HUS classes being taught by teachers feeling very well prepared to teach this topic (41 percent in 2018 compared to 57 percent in 2012).

Change Over Time: Preparedness to Teach Elementary Mathematics, by HUS Quartile



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

Figure 4.3

At the secondary level, teachers of classes in the highest and lowest HUS quartiles reported feeling equally well prepared to teach all but one mathematics topic (see Table 4.22). Teachers of high-HUS classes were less likely than those of low-HUS classes to feel very well prepared to teach functions (58 vs. 73 percent). The 2018 data are not significantly different from the 2012 data.

Table 4.22
Secondary Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Each of a Number of Topics, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) The number system and operations	89 (1.5)	90 (1.5)	87 (1.6)	85 (2.6)
(t) Algebraic thinking	83 (2.3)	86 (2.0)	79 (2.2)	79 (2.6)
(t) Measurement	69 (2.4)	69 (2.4)	68 (2.2)	63 (3.1)
(t) Geometry	63 (2.5)	64 (2.4)	65 (2.8)	61 (3.3)
(t) Functions*	73 (2.4)	73 (2.8)	65 (2.7)	58 (3.6)
(t) Modeling	56 (2.3)	57 (3.0)	54 (2.9)	58 (2.9)
(t) Statistics and probability	37 (3.1)	36 (3.0)	32 (2.8)	34 (2.8)
(t) Discrete mathematics	17 (1.5)	17 (1.6)	14 (1.9)	15 (1.6)
Computer science/programming	3 (0.7)	3 (1.0)	4 (1.0)	4 (1.0)

(t) Trend item

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

The survey also asked teachers how well prepared they felt to use a number of student-centered pedagogies. The data displayed in Table 4.23 indicate that teachers of both high- and low-HUS classes were similar in many ways, but significantly different in others. For example, the majority of classes in both the highest and lowest quartiles were taught by teachers who felt very well prepared to develop students' abilities to do mathematics and use formative assessment to monitor student learning. Similar percentages of classes in both quartiles were taught by teachers who felt very well prepared to develop students' conceptual understanding and encourage participation of all students.

However, differences by quartile were also evident and favored high-HUS classes. Specifically, teachers of high-HUS classes were more likely than teachers of low-HUS classes to feel very well prepared to provide mathematics instruction based on students' ideas (25 vs. 19 percent), incorporate students' cultural backgrounds into their instruction (24 vs. 9 percent), and develop students' awareness of STEM careers (15 vs. 8 percent). For the one trend item, there was no significant difference over time.

Table 4.23
Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared for Each of a Number of Tasks, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	54 (2.1)	56 (2.3)	57 (2.7)	52 (2.5)
Use formative assessment to monitor student learning	56 (2.1)	57 (2.3)	59 (2.2)	51 (2.4)
Develop students' conceptual understanding	53 (2.1)	54 (1.9)	55 (2.3)	48 (2.9)
Encourage participation of all students in mathematics	50 (2.0)	55 (2.2)	53 (2.4)	48 (2.4)
(t) Encourage students' interest in mathematics	39 (1.8)	45 (2.3)	39 (2.6)	39 (2.7)
Differentiate mathematics instruction to meet the needs of diverse learners	37 (2.2)	37 (2.2)	38 (2.7)	38 (2.3)
Provide mathematics instruction that is based on students' ideas*	19 (1.8)	24 (1.7)	22 (1.9)	25 (2.2)
Incorporate students' cultural backgrounds into mathematics instruction*	9 (1.3)	13 (1.6)	16 (1.9)	24 (2.4)
Develop students' awareness of STEM careers*	8 (1.4)	11 (1.3)	7 (1.2)	15 (1.6)

(t) Trend item

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

Table 4.24 shows the percentage of mathematics classes taught by teachers who felt very well prepared for each of a number of tasks related to monitoring and addressing student thinking within a particular unit in a designated class. Teachers of classes in both the top and bottom quartiles had similar perceptions of preparedness to implement the instructional materials to be used during this unit and find out what students thought or already knew about the key mathematical ideas. However, teachers of classes in the highest quartile were less likely than their lowest quartile counterparts to: (1) assess student understanding at the conclusion of the unit (60 vs. 70 percent), (2) monitor student understanding during the unit (56 vs. 63 percent), and (3) consider themselves very well prepared to anticipate difficulties that students may have (44 vs. 51 percent). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 4.24
Mathematics Classes in Which Teachers Felt Very Well Prepared for Various Tasks in the Most Recent Unit, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Assess student understanding at the conclusion of this unit*	70 (2.0)	67 (2.2)	64 (2.8)	60 (2.4)
(t) Monitor student understanding during this unit*	63 (2.1)	62 (2.3)	59 (3.2)	56 (2.4)
(t) Implement the instructional materials to be used during this unit	60 (2.0)	58 (2.3)	56 (2.6)	54 (2.0)
(t) Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit*	51 (2.1)	52 (2.3)	49 (2.6)	44 (2.2)
(t) Find out what students thought or already knew about the key mathematical ideas	44 (2.1)	46 (2.5)	42 (2.4)	40 (2.5)

(t) Trend item

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

The preparedness items were used to create three composite variables: Perceptions of Content Preparedness, Perceptions of Pedagogical Preparedness, and Perceptions of Preparedness to Implement Instruction in a Particular Unit. As can be seen in Table 4.25, significant differences between the highest and lowest quartiles were evident in all three composites. High-HUS classes tended to be taught by teachers with stronger feelings of pedagogical preparedness, but weaker feelings of content preparedness and unit-specific pedagogical preparedness than low-HUS classes. The 2018 data for the Perceptions of Content Preparedness and Perceptions of Preparedness to Implement Instruction in a Particular Unit are not significantly different from the 2012 data.[30]

Table 4.25
Mathematics Class Mean Scores for Teachers' Perceptions of Preparedness Composites, by HUS Quartile

	MEAN SCORE			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Perceptions of Content Preparedness*	81 (0.7)	80 (0.8)	78 (0.7)	79 (0.9)
Perceptions of Pedagogical Preparedness*	68 (0.7)	70 (0.8)	70 (1.0)	71 (0.8)
(t) Perceptions of Preparedness to Implement Instruction in a Particular Unit*	83 (0.7)	83 (0.9)	81 (1.1)	80 (0.7)

(t) Trend item

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

Teacher Professional Development

It is important that mathematics teachers have opportunities to continue to develop their disciplinary content knowledge and pedagogical skills. Accordingly, the 2018 NSSME+ collected data on teachers' participation in professional development.

[30] Too few items in the version of the 2018 Perceptions of Pedagogical Preparedness composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Table 4.26 shows the percentages of classes taught by teachers who have had: (1) any mathematics-focused professional development in the last three years and (2) more than 35 hours of mathematics-focused professional development in the last three years. In 2018, classes in the highest quartile were more likely than those in the lowest quartile to be taught by teachers who participated in professional development in the last three years (91 vs. 86 percent) and who had more than 35 hours of professional development in that time frame (33 vs. 25 percent). The 2018 data are not significantly different from the data in 2012.

Table 4.26
Professional Development Experiences of Teachers of Mathematics Classes, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Teacher has had professional development in the last three years*	86 (1.7)	83 (1.7)	89 (1.6)	91 (1.4)
(t) Teacher has had more than 35 hours of professional development in the last three years*	25 (1.9)	26 (2.0)	25 (1.8)	33 (2.3)

(t) Trend item

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

The effectiveness of professional development depends on the extent to which the experience is structured and facilitated to provide teachers with meaningful learning opportunities. As described in previous chapters, there is consensus that teachers should have opportunities to work with colleagues, engage in investigations, examine student work, and apply what they have learned in their classrooms and subsequently discuss how it went.[31] Thus, 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 4.27, teachers' professional development experiences in both the highest and lowest quartiles of classes were similar. For example, over half of classes in both quartiles were taught by teachers who worked closely with other teachers from their school, or with other teachers who taught the same grade and/or subject whether or not they were from their school. Opportunities to engage in mathematics investigations were also relatively common in teachers' professional development experiences, regardless of HUS quartile. Rehearsing instructional practices was not a common feature of professional development overall.

[31] 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 4.27
Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by HUS Quartile[†]

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Worked closely with other teachers from their school	66 (2.4)	66 (3.2)	73 (2.8)	70 (3.2)
(t) Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	54 (2.5)	56 (2.6)	62 (3.0)	61 (2.9)
(t) Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	46 (2.6)	40 (3.3)	46 (3.0)	55 (3.3)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	46 (2.9)	41 (2.8)	45 (2.2)	52 (3.5)
(t) 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 (3.1)	40 (2.6)	49 (2.6)	46 (3.4)
(t) Had opportunities to engage in mathematics investigations	51 (3.1)	45 (3.2)	47 (3.1)	45 (3.1)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)	32 (3.2)	27 (2.7)	38 (2.6)	36 (3.2)

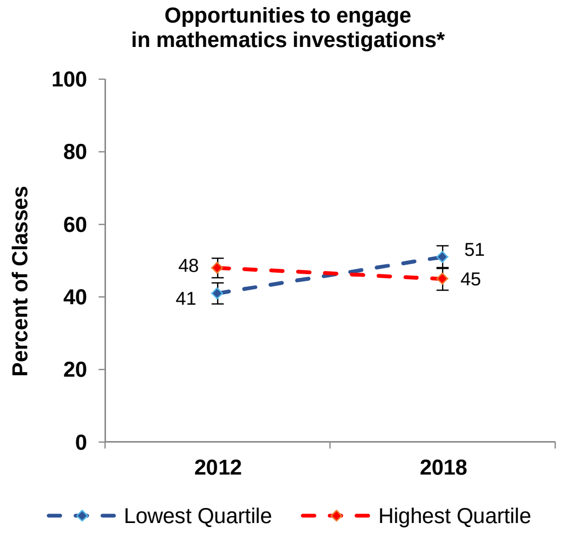
(t) Trend item

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

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."

Interestingly, the comparison of 2018 and 2012 data shows that opportunities during professional development for teachers of high-HUS and low-HUS classes to engage in mathematics investigations have reversed (see Figure 4.4). Specifically, in 2012, 48 percent of high-HUS classes and 41 percent of low-HUS classes were taught by teachers with this experience, compared to 45 and 51 percent of classes in 2018, respectively.

Change Over Time: Professional Development Characteristics, by HUS Quartile



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

Figure 4.4

Further, there were a number of similarities related to the emphasis of professional development attended by teachers of high-HUS and low-HUS classes (see Table 4.28). For example, roughly 60 percent of classes in both quartiles were taught by teachers who had professional development opportunities that heavily emphasized monitoring student understanding during mathematics instruction, differentiating mathematics instruction to meet the needs of diverse learners, and deepening their own understanding of how mathematics is done.

However, there were also differences. Classes in the highest quartile were more likely than those in the lowest quartile to be taught by teachers whose professional development heavily emphasized learning about difficulties that students may have with particular mathematical ideas and procedures (57 vs. 46 percent), and incorporating students' cultural backgrounds into mathematics instruction (34 vs. 16 percent). In addition, 28 percent of high-HUS classes, compared to 17 percent of low-HUS classes, were taught by teachers whose professional development focused on learning how to provide mathematics instruction that integrates engineering, science, and/or computer science.

Table 4.28
Mathematics Classes in Which Teachers Reported That Their Professional Development in the Last Three Years Gave Heavy Emphasis[a] to Various Areas, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Monitoring student understanding during mathematics instruction	55 (2.8)	45 (3.3)	55 (2.7)	62 (3.1)
Differentiating mathematics instruction to meet the needs of diverse learners	57 (2.6)	47 (3.0)	55 (2.9)	60 (3.1)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	60 (2.9)	48 (3.6)	57 (3.1)	57 (3.4)
(t) Learning about difficulties that students may have with particular mathematical ideas and procedures*	46 (3.1)	43 (2.9)	50 (2.8)	57 (3.4)
(t) Deepening their own mathematics content knowledge	47 (3.0)	34 (2.8)	50 (2.9)	53 (3.5)
(t) Learning how to use hands-on activities/manipulatives for mathematics instruction	54 (3.3)	46 (2.8)	50 (3.3)	53 (3.2)
(t) Finding out what students think or already know prior to instruction on a topic	42 (3.1)	34 (2.9)	42 (3.0)	50 (3.4)
(t) Implementing the mathematics textbook to be used in their classroom	38 (2.8)	33 (3.2)	35 (2.3)	36 (3.0)
Incorporating students' cultural backgrounds into mathematics instruction*	16 (2.2)	11 (1.8)	23 (2.8)	34 (3.4)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science*	17 (2.4)	17 (2.2)	18 (2.1)	28 (3.5)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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."

Since 2012, the difference between high-HUS classes and low-HUS classes changed in one area of professional development emphasis: implementing the mathematics textbook (see Figure 4.5). The gap is closing, apparently due to fewer high-HUS classes and more low-HUS classes being taught by teachers whose professional development heavily emphasized this area, compared to six years ago.

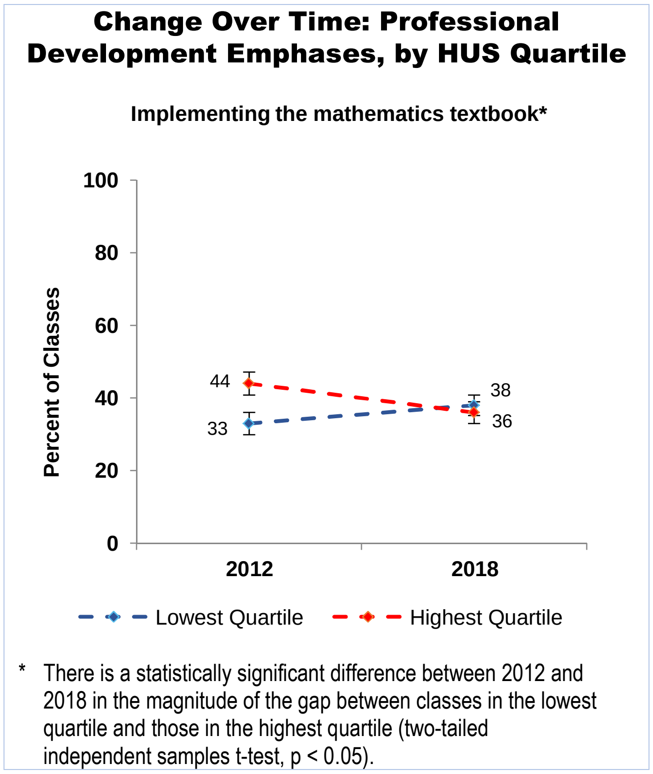


Figure 4.5

These items were combined into two composite variables: Extent Professional Development Aligns with Elements of Effective Professional Development and Extent Professional Development Supports Student-Centered Instruction. The mean scores shown in Table 4.29, ranging from 53 to 62, indicate that teachers' professional development was only somewhat aligned with elements of effective professional development and supportive of student-centered instruction, regardless of HUS quartile. The 2018 data for the Extent Professional Development Aligns with Elements of Effective Professional Development are not significantly different from the 2012 data.[32]

[32] Too few of the items in the 2018 version of the Extent Professional Development Supports Student-Centered Instruction composite were also asked in 2012 to allow for a comparison over time.

Table 4.29
Mathematics Class Mean Scores for Teachers' Professional Development Composites, by HUS Quartile†

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Extent Professional Development Aligns With Elements of Effective Professional Development[a]	58 (1.2)	54 (1.4)	60 (1.3)	61 (1.2)
Extent Professional Development Supports Student-Centered Instruction	59 (1.1)	53 (1.2)	59 (1.1)	62 (1.5)

(t) Trend item

† There are no statistically significant differences between classes in the lowest quartile and those in the highest quartile (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Summary

Overall, there were several differences between high-HUS and low-HUS classes in terms of teachers' backgrounds and experiences. High-HUS classes were more likely than low-HUS classes to be taught by teachers from race/ethnicity groups historically underrepresented in STEM. However, these classes were also more likely to be taught by inexperienced teachers and those without a degree in mathematics or mathematics education.

Both reform-oriented beliefs and traditional beliefs about teaching and learning were significantly stronger among teachers of high-HUS classes. For example, a greater percentage of high-HUS classes than low-HUS classes were taught by teachers who agreed that most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts and that manipulatives should be used primarily to reinforce an idea that students have already learned.

Teachers of high-HUS and low-HUS classes also reported varying levels of preparedness for teaching mathematics. High-HUS classes were slightly more likely to be taught by teachers who had strong feelings of pedagogical preparedness (e.g., incorporating students' cultural backgrounds), but less likely to be taught by those who had strong feelings of content preparedness and preparedness to monitor and address student thinking during instruction.

In terms of professional development, teachers in the highest quartile were somewhat more likely than those in the lowest quartile to have participated in mathematics-focused professional development in the last three years. Although the nature of the professional development experiences (e.g., working closely with other teachers from their schools) were similar, regardless of HUS quartile, some of the emphases (e.g., incorporating students' cultural backgrounds into mathematics instruction) were more likely to be a feature of professional development attended by teachers of high-HUS classes.

Since 2012, there have been a number of significant changes in the distribution of well-prepared teachers between high-HUS and low-HUS classes. More high-HUS classes and fewer low-HUS classes were taught by teachers from race/ethnicity groups underrepresented in STEM between 2012 and 2018, making this difference more pronounced over time. In terms of teachers' preparedness to teach various mathematics topics, there are two notable differences that disadvantage high-HUS classes: (1) at the elementary level, fewer high-HUS classes than low-HUS classes were taught by teachers feeling very well prepared to teach geometry, and (2) teachers of high-HUS classes were less likely to report opportunities to engage in mathematics investigations during professional development.

Another difference between 2012 and 2018 was in terms of teachers' professional development experiences. Fewer high-HUS and more low-HUS classes in 2018 were taught by teachers who participated in professional development that heavily emphasized how to implement the designated mathematics textbook.

Supportive Context for Learning

The 2018 NSSME+ collected information about a range of contextual factors that may impact mathematics instruction. This section presents these data, highlighting the similarities and differences between high- and low-HUS classes.

Factors Affecting Student Opportunity to Learn

Table 4.30 displays the percentages of classes taught by teachers who rated various factors as promoters of effective instruction. The vast majority of high-HUS and low-HUS classes were taught by teachers who considered the amount of time available for mathematics instruction as a promoter of effective mathematics instruction. Principal support, current state standards, and amount of time for teachers to plan, individually and with colleagues, were also viewed as promoting effective mathematics instruction by teachers in at least two-thirds of mathematics classes, regardless of HUS quartile.

In contrast, teachers of high-HUS classes were less likely than those teaching low-HUS classes to rate students' prior knowledge and skills, or student motivation, interest, and effort in mathematics as promoting effective instruction (55 vs. 71 percent and 54 vs. 64 percent, respectively). Similarly, college entrance requirements were less likely to be seen as promoting effective mathematics instruction in high-HUS classes than in low-HUS classes (51 vs. 69 percent). The 2018 data are not significantly different from the data in 2012.

Table 4.30
Factors Promoting[a] Effective Instruction in Mathematics Classes, by HUS Quartile

	PERCENT OF CLASSES			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
Amount of instructional time devoted to mathematics [b]	90 (2.1)	84 (3.3)	80 (4.8)	84 (3.3)
(t) Principal support	77 (2.6)	75 (2.6)	75 (2.9)	73 (2.9)
(t) Current state standards	74 (2.2)	72 (2.7)	73 (2.6)	70 (2.9)
(t) Amount of time for you to plan, individually and with colleagues	72 (2.5)	71 (2.4)	69 (3.1)	69 (3.6)
(t) Amount of time available for your professional development	57 (2.8)	54 (2.9)	56 (3.4)	58 (3.0)
(t) District/Diocese/School pacing guides	62 (2.3)	67 (2.1)	62 (3.3)	57 (2.7)
Students' prior knowledge and skills*	71 (2.8)	67 (2.6)	61 (2.8)	55 (2.8)
(t) Students' motivation, interest, and effort in mathematics*	64 (2.6)	68 (2.2)	62 (2.7)	54 (3.2)
(t) College entrance requirements*,[c]	69 (3.9)	61 (4.1)	57 (4.3)	51 (7.9)
(t) Teacher evaluation policies	51 (3.0)	47 (2.6)	43 (2.8)	49 (3.4)
(t) State/district/diocese testing/accountability policies [d]	45 (2.8)	42 (3.2)	38 (2.9)	42 (3.0)
(t) Parent/guardian expectations and involvement*	51 (2.9)	52 (2.1)	48 (3.0)	41 (3.2)
(t) Textbook selection policies*	47 (3.1)	45 (2.6)	32 (3.0)	36 (3.2)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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 "inhibits effective instruction" to 5 "promotes effective instruction."

[b] This item was presented only to elementary school teachers.

[c] This item was presented only to high school teachers.

[d] This item was presented only to teachers in public and Catholic schools.

Three composites were created from these items: (1) Extent to Which School Support Promotes Effective Instruction; (2) Extent to Which the Policy Environment Promotes Effective; and (3) Extent to Which Stakeholders Promote Effective Instruction. The mean scores, shown in Table 4.31, range from 59 to 71, indicating that the climate was somewhat supportive for mathematics instruction across all quartiles. There was a significant difference for the stakeholder composite with regard to HUS quartile—classes in highest quartile tended to have lower scores than classes in lowest quartile (mean scores of 59 vs. 69). When looking at trends over time, the 2018 data for the Extent to Which School Support Promotes Effective Instruction and Extent to Which the Policy Environment Promotes Effective Instruction composites are not significantly different than in 2012.[33]

[33] Too few items in the 2018 version of the Extent to Which Stakeholders Promote Effective Instruction composite were also asked in 2012; thus, trend data are not available to report.

Table 4.31
Mathematics Class Mean Scores for Factors Affecting Instruction Composites, by HUS Quartile

	MEAN SCORE			
	LOWEST QUARTILE	SECOND QUARTILE	THIRD QUARTILE	HIGHEST QUARTILE
(t) Extent to Which School Support Promotes Effecting Instruction	70 (1.6)	71 (1.6)	71 (1.8)	71 (1.7)
(t) Extent to Which the Policy Environment Promotes Effective Instruction[a]	67 (1.2)	67 (1.0)	64 (1.4)	64 (1.5)
Extent to Which Stakeholders Promote Effective Instruction*	69 (1.6)	69 (1.4)	65 (1.7)	59 (2.1)

(t) Trend item

* There is a statistically significant difference between classes in the lowest quartile and those in the highest quartile (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 for 2012 using the 2018 definition.

Summary

Overall, the 2018 data indicate that the school climate, in terms of school support, policies, and stakeholders, was generally supportive of effective mathematics instruction, regardless of HUS quartile. Factors seen as promoting effective instruction in a majority of mathematics classes across quartiles included the amount of available instructional time, principal support, current state standards, and planning time.

However, there were also significant differences between high-HUS and low-HUS classes on a handful of items (e.g., students' prior knowledge and skills; student motivation, interest, and effort in mathematics; college entrance requirements), with teachers of high-HUS classes consistently less likely to view these factors as promoting effective instruction. Since 2012, contextual factors affecting students' opportunity to learn in high-HUS and low-HUS classes have remained consistent.

Prior Achievement Level

Introduction

For this class-level factor, teachers were asked to indicate the prior achievement level of students in a randomly selected class, relative to other students in the school. Classes were classified into 1 of 3 categories: mostly high-prior-achieving (HPA) students, average/mixed-prior-achieving students,[34] and mostly low-prior-achieving (LPA) students. As can be seen in Table 5.1, two-thirds of K–12 mathematics classes are composed of mostly average or mixed levels of prior achievement. Classes of mostly HPA and LPA students each make up about a sixth of all mathematics classes. This chapter presents data by prior achievement group, noting differences between classes of LPA students and classes of HPA students.

Table 5.1
Percentage of Classes in Each Prior Achievement Group(t),†

	PERCENT OF CLASSES
Mostly High	16 (0.7)
Average/Mixed	66 (1.0)
Mostly Low	18 (1.0)

(t) Trend item

† There are no statistically significant differences between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p \geq 0.05$).

Nature of Mathematics Instruction

As described in previous chapters, the 2018 NSSME+ collected a large amount of data about mathematics instruction. This section presents these data, highlighting the similarities and differences between classes of mostly LPA and HPA students.

Time Spent In Elementary Grades

Table 5.2 shows the average number of minutes per day typically spent on mathematics, science, social studies, and reading/language arts in elementary grades self-contained classes that cover all four subjects. Notably, classes of LPA students spent more time on mathematics instruction per day than classes of HPA students (64 vs. 51 minutes).

[34] For analysis purposes, classes composed of mostly average prior-achieving students and a mixture of levels were combined into one category.

Table 5.2
Average Number of Minutes per Day Spent Teaching Each Subject in Self-Contained Classes,[a] by Prior Achievement

	NUMBER OF MINUTES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Reading/Language Arts	78 (6.0)	87 (1.6)	93 (4.9)
(t) Mathematics*	51 (3.5)	58 (0.9)	64 (2.5)
(t) Science	22 (2.0)	19 (0.5)	22 (1.5)
(t) Social Studies	18 (1.7)	17 (0.4)	19 (1.0)

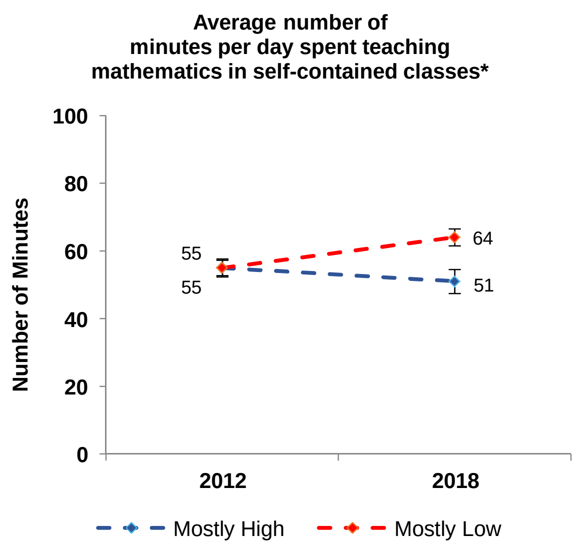
(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

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

The comparison of 2018 and 2012 data shows that a gap has emerged in the average number of minutes spent teaching mathematics, by prior achievement level (see Figure 5.1). In 2012, classes with low levels of prior achievement and those with high levels both spent an average of 55 minutes per day on mathematics instruction, compared to 64 and 51 minutes per day in 2018, respectively.

Change Over Time: Elementary Time for Instruction, by Prior Achievement



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Figure 5.1

Course-Taking Opportunities in Secondary Grades

At the high school level, teachers were asked to provide information about a randomly selected class, including the course type, which allows for an estimate of the percentages of mathematics classes of each type. Perhaps not surprisingly, classes of LPA students were much more likely than classes of HPA students to be categorized as non-college prep courses (33 vs. 3 percent) and much less likely to be considered advanced courses such as those that qualify for college credit (0 vs. 26 percent). The 2018 data are not significantly different from the 2012 data.

Table 5.3
Prevalence of High School Mathematics Courses, by Prior Achievement(t)

	PERCENT OF CLASSES*		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	3 (1.3)	9 (1.5)	33 (3.4)
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	5 (1.4)	21 (1.7)	33 (3.3)
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	20 (2.5)	24 (2.0)	15 (2.4)
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	21 (2.7)	27 (2.0)	15 (2.3)
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	24 (2.3)	13 (1.2)	4 (1.1)
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	26 (2.2)	6 (1.0)	0 (0.2)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (Chi-square test of independence, $p < 0.05$).

Teachers' Perceptions of Their Decision-Making Autonomy

The survey asked teachers about the extent to which they had control over a number of curricular and instructional decisions. As can be seen in Table 5.4, teachers of classes with low levels of prior achievement were significantly less likely to perceive themselves as having strong control over a range of decisions compared to teachers of classes with high levels of prior achievement. For example, teachers of classes with low levels of prior achievement were less likely than teachers of classes with high levels of prior achievement to perceive strong control over selecting the sequence in which topics are covered (24 vs. 49 percent) and determining course goals and objectives (21 vs. 35 percent). Similarly, teachers of classes with low levels of prior achievement were less likely to feel strong control over determining the amount of homework assigned (67 vs. 82 percent) and selecting teaching techniques (61 vs. 79 percent). When looking at the trend, these same disparities were present in 2012.

Table 5.4
Mathematics Classes in Which Teachers Reported Having Strong Control Over Various Curricular and Instructional Decisions, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Determining the amount of homework to be assigned*	82 (2.3)	64 (1.7)	67 (2.8)
(t) Selecting teaching techniques*	79 (2.6)	57 (1.7)	61 (2.8)
(t) Choosing criteria for grading student performance*	54 (3.1)	41 (1.8)	44 (2.9)
Determining the amount of instructional time to spend on each topic*	53 (2.9)	29 (1.6)	31 (2.5)
Selecting the sequence in which topics are covered*	49 (3.0)	26 (1.4)	24 (2.4)
(t) Determining course goals and objectives*	35 (2.6)	20 (1.3)	21 (2.1)
(t) Selecting curriculum materials (e.g., textbooks)*	28 (2.7)	14 (1.1)	19 (2.5)
(t) Selecting content, topics, and skills to be taught*	28 (2.8)	15 (1.0)	18 (2.3)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

These items were combined into Curriculum Control and Pedagogy Control composite variables. The mean scores, shown in Table 5.5, indicate that teachers of classes of mostly LPA students tended to report less control over decisions related to both curriculum and pedagogy than teachers of HPA classes. These data are not significantly different from the data in 2012.

Table 5.5
Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites, by Prior Achievement

	MEAN SCORE		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Curriculum Control*,[a]	59 (1.7)	45 (1.1)	45 (1.8)
(t) Pedagogy Control*	88 (1.1)	81 (0.6)	81 (1.0)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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 for 2018 using the 2012 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Instructional Objectives

The survey provided a list of possible instructional objectives and asked teachers how much emphasis each would receive in the targeted class. Regardless of the prior achievement level of the class, mathematics classes had relatively equal emphasis on many of the instructional objectives (see Table 5.6). For example, learning mathematical procedures and/or algorithms was emphasized in over half of all classes. In addition, a third or more of classes emphasized increasing students' interest in mathematics and learning about real-life applications of mathematics. Further, fewer than a third all classes of emphasized learning test-taking skills.

There were also significant differences between classes of LPA students and classes of HPA students on a few objectives. Notably, classes of LPA students were less likely than classes of

HPA students to emphasize understanding mathematical ideas (61 vs. 85 percent), learning how to do mathematics (58 vs. 72 percent), and learning to perform computations with speed and accuracy (22 vs. 29 percent). These same differences were present in 2012.

Table 5.6
Mathematics Classes With Heavy Emphasis on Various Instructional Objectives, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Understanding mathematical ideas*	85 (1.7)	67 (1.4)	61 (2.7)
(t) Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)*	72 (2.3)	61 (1.4)	58 (2.7)
(t) Learning mathematical procedures and/or algorithms	58 (2.8)	52 (1.6)	53 (2.7)
Developing students' confidence that they can successfully pursue careers in mathematics	47 (2.8)	35 (1.2)	41 (3.1)
(t) Increasing students' interest in mathematics	39 (2.4)	35 (1.2)	34 (2.9)
(t) Learning about real-life applications of mathematics	39 (2.5)	33 (1.3)	34 (2.7)
Learning mathematics vocabulary	35 (2.5)	32 (1.4)	30 (2.7)
(t) Learning test-taking skills/strategies	27 (2.3)	26 (1.3)	30 (2.6)
(t) Learning to perform computations with speed and accuracy*	29 (2.3)	27 (1.6)	22 (1.9)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

The objectives related to reform-oriented instruction were combined into a composite variable. As can be seen in Table 5.7, mathematics classes with low levels of prior achievement were, on average, less likely than those with high levels of prior achievement to emphasize reform-oriented instructional objectives (mean scores of 77 vs. 83). The 2018 data are not significantly different from the 2012 data.

Table 5.7
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite,[a] by Prior Achievement[(t)]

	MEAN SCORE*
Mostly High	83 (0.6)
Average/Mixed	78 (0.4)
Mostly Low	77 (0.9)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Class Activities

As can be seen in Table 5.8, nearly all mathematics classes, regardless of prior achievement level, included the teacher explaining mathematical ideas to the whole class at least once a week. Additionally, more than three-quarters of all classes included small group work on a weekly basis. However, classes of LPA students were significantly more likely than classes of HPA students to have manipulatives provided for students to use in problem solving (48 vs. 31 percent) and have students write their reflections (33 vs. 24 percent), both of which have the ability to promote sense making. However, teachers of classes of LPA students were also more likely to have students practice for standardized tests (36 vs. 28 percent).

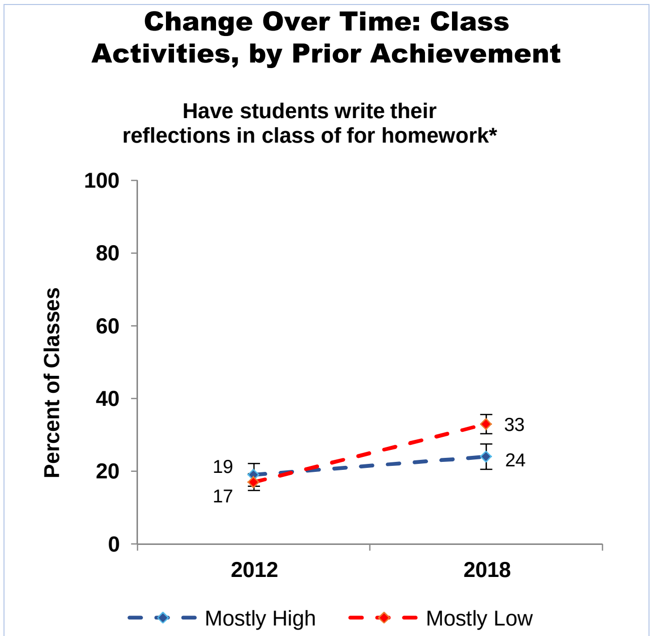
Table 5.8
Mathematics Classes in Which Teachers Reported Using Various Activities at Least Once a Week, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Explain mathematical ideas to the whole class	95 (1.1)	95 (0.6)	91 (2.0)
(t) Engage the whole class in discussions*	90 (1.2)	93 (0.5)	85 (1.9)
(t) Have students work in small groups	78 (1.7)	82 (1.0)	79 (2.5)
(t) Provide manipulatives for students to use in problem-solving/ investigations*	31 (2.5)	57 (1.5)	48 (3.0)
(t) Have students practice for standardized tests*	28 (2.1)	26 (1.3)	36 (2.8)
(t) Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework*	24 (2.0)	34 (1.3)	33 (2.8)
(t) Focus on literacy skills (e.g., informational reading or writing strategies)*	22 (2.4)	31 (1.3)	29 (2.4)
(t) Have students read from a textbook or other material in class, either aloud or to themselves	20 (2.1)	24 (1.3)	25 (2.1)
Use flipped instruction (have students watch lectures/ demonstrations outside of class to prepare for in-class activities)	12 (1.6)	11 (1.0)	14 (2.1)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

With the exception of having students write reflections, the differences in class activities between classes of LPA students and classes of HPA students have not changed between the two iterations of the study. In 2012, 17 percent of classes of LPA students and 19 percent of classes of HPA students included students writing their reflections, compared to 33 and 24 percent, respectively, in 2018 (see Figure 5.2).



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Figure 5.2

The 2018 survey also asked teachers how often they engage students in aspects of the mathematical practices described in the CCSSM. These data are shown in Table 5.9. Regardless of prior achievement level of the class, students had similar opportunities to engage in a number of the mathematical practices at least once a week, such as determine whether their answer makes sense, represent aspects of problems, and identify patterns that may be helpful in solving problems. In contrast, classes of LPA students were less likely than classes of HPA students to have students provide mathematical reasoning (77 vs. 85 percent), work on challenging problems (68 vs. 85 percent), and reflect on their solution strategies as they work through a mathematics problem (64 vs. 72 percent).

Table 5.9
Mathematics Classes in Which Teachers Reported Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Determine whether their answer makes sense	88 (1.8)	84 (1.3)	83 (2.2)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	81 (2.2)	83 (1.0)	79 (1.8)
Provide mathematical reasoning to explain, justify, or prove their thinking*	85 (2.2)	83 (1.1)	77 (2.0)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error*	88 (1.5)	79 (1.3)	77 (2.2)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	78 (2.1)	77 (1.1)	74 (2.6)
Identify relevant information and relationships that could be used to solve a mathematics problem	79 (2.4)	72 (1.5)	74 (2.4)
Develop a mathematical model to solve a mathematics problem	70 (2.5)	71 (1.5)	71 (2.0)
Determine what tools are appropriate for solving a mathematics problem	67 (2.5)	66 (1.6)	65 (2.6)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements*	77 (1.8)	70 (1.4)	69 (2.0)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures*	85 (1.6)	73 (1.3)	68 (2.1)
Figure out what a challenging problem is asking*	82 (1.8)	73 (1.4)	66 (2.8)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	69 (2.5)	67 (1.6)	66 (2.3)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed*	72 (2.3)	69 (1.4)	64 (2.6)
Work on generating a rule or formula	65 (2.5)	61 (1.4)	63 (2.2)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	68 (2.5)	62 (1.4)	62 (2.5)
Analyze the mathematical reasoning of others	63 (2.5)	61 (1.3)	58 (3.2)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations	61 (2.7)	57 (1.4)	56 (3.0)

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Table 5.10 shows the mean scores for the Engaging Students in the Practices of Mathematics composite formed from these items. Despite differences on some of the individual items, overall, composite scores were similar for classes of LPA and HPA students.

Table 5.10
Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite, by Prior Achievement†

	MEAN SCORE
Mostly High	75 (0.8)
Average/Mixed	73 (0.5)
Mostly Low	72 (0.9)

† There are no statistically significant differences between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p \geq 0.05$).

The survey also asked how often students in the randomly selected class were required to take external assessments (ones teachers did not choose to administer such as state or district benchmark tests). As can be seen in Table 5.11, classes of LPA students were more likely to be tested two or more times per year than classes of HPA students (78 vs. 66 percent). This imbalance in testing between classes of LPA and HPA students was present in 2012, highlighting a persistent focus on assessment preparation for students who are historically disadvantaged.

Table 5.11
Mathematics Classes Required to Take External Assessments Two or More Times per Year, by Prior Achievement(t)

	PERCENT OF CLASSES*
Mostly High	66 (2.4)
Average/Mixed	78 (1.6)
Mostly Low	78 (2.7)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Summary

There were a number of aspects of mathematics instruction that were relatively similar between classes of LPA and HPA students in 2018, but there were also notable differences. At the elementary level, classes of LPA students spent significantly more time on mathematics instruction per day than classes of HPA students. In terms of course-taking opportunities at the high school level, LPA students were more likely than HPA students to be enrolled in non-college prep courses and less likely to be enrolled in advanced mathematics courses.

Data about teachers' perceptions of control and emphasis on instructional objectives also reflect differences between mathematics classes by prior achievement level. For example, teachers of classes of LPA students reported less control over decisions related to curriculum and pedagogy than their counterparts teaching classes of HPA students. In addition, classes of LPA students were less likely than classes of HPA students to emphasize reform-oriented instructional objectives (e.g., understanding mathematical ideas, learning how to do mathematics).

Several instructional activities were prominent in mathematics classes regardless of the prior achievement level of the class, including the teacher explaining ideas, whole group discussion, and small group work. However, classes of LPA students were more likely to have students focus on literacy skills and practice for standardized tests; external testing also occurred more frequently in these classes. In terms of students' engagement in the mathematical practices, there were a number of similarities between classes of LPA and HPA students (e.g., determining whether an answer makes sense, representing aspects of problems). However, there were also some differences (e.g., providing mathematical reasoning and working on challenging problems), disadvantaging classes of LPA students.

Since 2012, the nature of mathematics instruction provided in classes of LPA and HPA students has remained largely consistent. One notable difference is the amount of time spent on mathematics instruction, with classes of LPA students spending more time in 2018 than 2012 on mathematics instruction relative to classes of HPA students.

Material Resources

The 2018 NSSME+ collected information about material resources for instruction as well as teachers' perceptions of the adequacy of these resources. This section provides data about the distribution and adequacy of material resources by the prior achievement of level of mathematics classes.

Instructional Materials

A large majority of mathematics classes, regardless of prior achievement level, had instructional materials designated for use by the district in 2018 (see Table 5.12). Commercially published textbooks were by far the most frequently designated type of material, though they were less likely to be designated for classes of LPA students compared to classes of HPA students (87 vs. 96 percent). In contrast, classes of LPA students were more likely than classes of HPA students to be designated units or lessons developed by the state, county, district, or diocese (46 vs. 31 percent). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 5.12
Types of Instructional Materials Designated for Mathematics Classes, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
District Designates Instructional Materials†			
No	22 (2.2)	16 (1.1)	24 (2.3)
Yes	78 (2.2)	84 (1.1)	76 (2.3)
Types of Designated Instructional Materials[a]			
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks*	96 (0.9)	88 (1.3)	87 (1.9)
State, county, district, or diocese-developed units or lessons*	31 (2.8)	40 (1.8)	46 (3.0)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	23 (2.9)	29 (1.7)	31 (2.8)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)	25 (2.5)	27 (1.6)	29 (3.0)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	19 (2.3)	27 (1.6)	25 (2.7)

† There is not a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (Chi-square test of independence, $p \geq 0.05$).

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

[a] Only mathematics classes for which instructional materials are designated by the state, district, or diocese are included in these analyses.

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction was based on various types of materials. As can be seen in Table 5.13, textbooks and teacher-developed lessons and units were the most commonly used materials by far. However, classes of LPA students were less likely than classes of HPA students to use textbooks (64 vs. 73 percent) and more likely to use other designated materials, such as lessons or resources from websites that are free (39 vs. 27 percent) and state, county, district, or diocese-developed units or lessons (35 vs. 21 percent). This series of items was new to the 2018 NSSME+; thus, trend data are not available to report.

Table 5.13
Mathematics Classes Basing Instruction on Various Types of Instructional Materials at Least Once a Week, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets) that accompany the textbooks*	73 (2.5)	70 (1.4)	64 (2.6)
Units or lessons you created (either by yourself or with others)	70 (2.7)	54 (1.6)	62 (2.8)
Lessons or resources from websites that are free (e.g., Khan Academy, Illustrative Math)*	27 (2.2)	35 (1.5)	39 (2.7)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)*	27 (2.4)	43 (1.5)	38 (3.0)
State, county, district, or diocese-developed units or lessons*	21 (1.9)	34 (1.5)	35 (2.9)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	32 (2.2)	31 (1.4)	35 (2.8)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)*	16 (2.1)	28 (1.6)	30 (2.3)

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Teachers who indicated that they used commercially published textbooks were asked to provide information about the textbook used most often in the class, including publication year. As can be seen in Table 5.14, classes of LPA students were more likely than classes of HPA students to use newer textbooks (i.e., those published in the previous 5 years). The 2018 data are not significantly different from the 2012 data.

Table 5.14
Age of Mathematics Textbooks in 2018, by Prior Achievement(t)

	PERCENT OF CLASSES*		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
6 or more years	59 (3.3)	45 (2.1)	42 (4.1)
5 or fewer years	41 (3.3)	55 (2.1)	58 (4.1)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (Chi-square test of independence, $p < 0.05$).

Facilities and Equipment

Because access to appropriate and adequate resources is an important factor in students' opportunity to learn, teachers were asked to rate the adequacy of the instructional resources they have available. As can be seen in Table 5.15, ratings of the availability of manipulatives were similar between classes of LPA students and classes of HPA students, with teachers of roughly two-thirds of classes indicating adequate access. However, teachers of classes of LPA students were less likely than teachers of classes of HPA students to rate the other instructional resources as adequate: measurement tools (76 vs. 87 percent), instructional technology (74 vs. 84 percent), and consumable supplies (70 vs. 77 percent). The same inequities between classes were present in 2012.

Table 5.15
Adequacy[a] of Resources for Mathematics Instruction, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Measurement tools (e.g., protractors, rulers)*	87 (1.9)	79 (1.5)	76 (2.2)
(t) Instructional technology (e.g., calculators, computers, probes/ sensors)*	84 (2.2)	72 (1.7)	74 (3.1)
(t) Consumable supplies (e.g., graphing paper, batteries)*	77 (2.4)	69 (1.7)	70 (2.8)
(t) Manipulatives (e.g., pattern blocks, algebra tiles)	62 (3.0)	76 (1.6)	64 (3.3)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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 adequate" to 5 "adequate."

These items were combined into a composite variable named Adequacy of Resources for Mathematics Instruction. As shown in Table 5.16, teachers of classes with low levels of prior achievement had somewhat less positive views about their resources compared to teachers of classes with high levels of prior achievement (mean scores of 76 vs. 82). The 2018 data are not significantly different from the 2012 data.

Table 5.16
Mathematics Class Mean Scores for the Adequacy of Resources for Instruction Composite, by Prior Achievement[(t)]

	MEAN SCORE*
Mostly High	82 (1.0)
Average/Mixed	79 (0.8)
Mostly Low	76 (1.4)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Summary

The distribution and use of material resources for mathematics instruction between classes of LPA and HPA students were similar in some ways and different in others. Commercially published textbooks were the most commonly designated and the most frequently used type of mathematics instructional material (whether designated or not), regardless of the prior achievement level of the class. However, textbooks were somewhat less likely to be designated for classes of LPA students than classes of HPA students. Units or lessons developed by teachers were also used in a majority of classes, regardless of prior achievement level. In contrast, classes of LPA students were more likely than those of HPA students to use other types of instructional materials, such as lessons or resources from websites that are free and state, county, district, or diocese-developed units or lessons.

There were also disparities related to teachers' perceptions of the adequacy of these resources. In particular, teachers of classes of LPA students had less positive views about the resources available to them than their counterparts who teach HPA students. Specifically, teachers of classes of LPA students were less likely to rate their measurement tools, instructional technology, and consumable supplies as adequate.

Because questions on the survey in this topic area were substantively different in 2018 than in 2012, opportunities for trend analysis were limited. When trend analyses were conducted, there were no significant changes since 2012.

Well-Prepared Teachers

As described in previous chapters, the 2018 NSSME+ collected data on a number of indicators of teacher preparedness. The distribution of well-prepared teachers among classes with different levels of prior achievement is described in the following sections.

Teacher Characteristics and Preparation

As can be seen in Table 5.17, there are several differences in characteristics of teachers of classes of LPA students and those of HPA students. For example, classes of LPA students were more likely than classes of HPA students to be taught by teachers with five or fewer years of experience teaching mathematics (36 vs. 25 percent). Conversely, secondary classes of LPA students were less likely than classes of HPA students to be taught by teachers with a degree in mathematics or mathematics education (59 vs. 74 percent) or teachers who had completed a substantial amount of coursework related to the NCTM preparation standards for their grade band (62 vs. 73 percent). These data are not significantly different from the 2012 data, indicating persistent disparities in the distribution of well-prepared teachers among classes with different levels of prior achievement.

Table 5.17
Teacher Characteristics, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) 0–5 years of experience teaching mathematics*	25 (2.6)	31 (1.4)	36 (3.1)
(t) Historically underrepresented race/ethnicity group*	12 (1.8)	17 (1.3)	18 (2.4)
(t) Degree in mathematics or mathematics education*,[a]	74 (2.6)	68 (1.9)	59 (2.8)
(t) Substantial coursework related to NCTM preparation standards*,[b]	73 (2.6)	54 (1.7)	62 (2.4)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

[a] Only secondary teachers are included in this analysis.

[b] Includes elementary mathematics teachers who have courses in 3 or more of the 5 areas, middle school mathematics teachers who have courses in 4 or more of the 6 areas, and high school mathematics teachers who have courses in 5 or more of the 7 areas.

Teacher Pedagogical Beliefs

Because beliefs impact behaviors, teachers were asked about their beliefs related to mathematics teaching and learning. As can be seen in Table 5.18, teachers tended to hold a number of reform-oriented beliefs, regardless of the prior achievement level of the class. For example, nearly all classes were taught by teachers who agreed that: (1) they 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. However, classes of LPA students were more likely than classes of HPA students to be taught by teachers who believe that students learn best when instruction is connected to their everyday lives (93 vs. 86 percent).

Despite having strongly held reform-oriented beliefs, teachers of both class types also held a number of traditional beliefs. For example, approximately 80 percent of classes, regardless of prior achievement level, were taught by teachers who agreed that students should be provided with definitions for new mathematics vocabulary at the beginning of instruction on a mathematical idea. Further, roughly 60–70 percent of classes were taught by teachers who agreed that students learn mathematics best in classes with students of similar abilities. The 2018 data are not significantly different from the 2012 data.

Table 5.18
Mathematics Classes in Which Teachers Agree[a] With Various Statements About Teaching and Learning, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Reform-Oriented Teaching Beliefs			
Teachers should ask students to justify their mathematical thinking.	99 (0.7)	98 (0.4)	97 (1.2)
Students should learn mathematics by doing mathematics (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models).	98 (0.6)	96 (0.6)	97 (1.1)
(t) Most class periods should provide opportunities for students to share their thinking and reasoning.	95 (1.0)	95 (0.8)	95 (0.9)
Students learn best when instruction is connected to their everyday lives.*	86 (2.0)	94 (0.8)	93 (1.5)
Most class periods should provide opportunities for students to apply mathematical ideas to real-world contexts.	84 (1.9)	91 (0.9)	89 (1.9)
(t) It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics.	83 (2.3)	81 (1.4)	84 (2.6)
Traditional Teaching Beliefs			
(t) At the beginning of instruction on a mathematical idea, students should be provided with definitions for new mathematics vocabulary that will be used.	77 (2.3)	81 (1.3)	82 (2.4)
(t) Students learn mathematics best in classes with students of similar abilities.	69 (2.7)	57 (1.8)	64 (2.7)
(t) Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned.	43 (3.0)	49 (1.8)	50 (3.3)
(t) Teachers should explain an idea to students before having them investigate the idea.	26 (2.6)	34 (1.4)	34 (2.8)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

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

These items were combined into two composite variables: Reform-Oriented Teaching Beliefs and Traditional Teaching Beliefs. As can be seen in Table 5.19, the mean scores for each composite were similar across prior achievement levels. The 2018 data for the Traditional Teaching Beliefs composite are not significantly different from the 2012 data.[35]

[35] Too few of the items in the 2018 Reform-Oriented Beliefs composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

Table 5.19
Mathematics Class Mean Scores for Teachers' Beliefs About Teaching and Learning Composites, by Prior Achievement†

	MEAN SCORE		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Reform-Oriented Teaching Beliefs	82 (0.8)	83 (0.5)	83 (0.7)
(t) Traditional Teaching Beliefs[a]	60 (0.9)	60 (0.7)	61 (1.1)

(t) Trend item

† There are no statistically significant differences between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p \geq 0.05$).

a This composite variable was not originally computed for the 2012 report. To allow for comparisons across time, it was computed for 2012 using the 2018 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Teachers' Perceptions of Preparedness

Teachers were asked how well prepared they felt to teach each of a number of mathematics topics at their assigned grade level. With the exception of measurement and data representation, for which classes of LPA students had teachers who felt less well prepared, elementary classes of different prior achievement levels had teachers with similar perceptions of preparedness to teach these topics (see Table 5.20). When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 5.20
Elementary Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Various Mathematics Topics, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Number and operations	78 (5.5)	75 (1.9)	71 (5.3)
(t) Measurement and data representation*	67 (6.6)	53 (2.2)	46 (6.0)
(t) Geometry	56 (6.7)	49 (2.4)	41 (5.3)
(t) Early algebra	55 (7.3)	41 (2.0)	39 (6.2)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

A different pattern exists at the secondary level (see Table 5.21). Fewer classes of LPA students than those of HPA students were taught by teachers considering themselves very well prepared to teach the listed topics, with the exception of computer science/programming—a topic that few teachers of either type of class feel well prepared to teach.

Table 5.21
Secondary Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared to Teach Each of a Number of Topics, by Prior Achievement

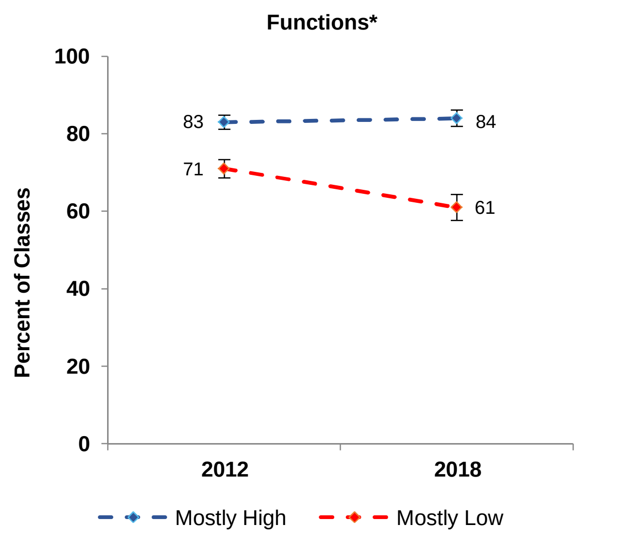
	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) The number system and operations*	94 (1.1)	87 (1.2)	84 (2.7)
(t) Algebraic thinking*	91 (1.7)	80 (1.5)	77 (2.9)
(t) Measurement*	76 (2.7)	67 (1.9)	61 (3.1)
(t) Functions*	84 (2.1)	64 (1.9)	61 (3.4)
(t) Geometry*	69 (2.6)	64 (1.8)	58 (3.5)
(t) Modeling*	63 (2.6)	55 (2.0)	54 (3.0)
(t) Statistics and probability*	41 (2.6)	33 (1.9)	32 (3.0)
(t) Discrete mathematics*	23 (1.9)	15 (1.3)	12 (1.8)
Computer science/programming	5 (1.2)	4 (0.6)	4 (0.9)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Since 2012, the gap between the percentage of classes of LPA students and classes of HPA students taught by teachers who felt very well prepared to teach functions has changed significantly (see Figure 5.3). This difference appears to be due to fewer classes of LPA students being taught by teachers who felt very well prepared in this area (71 percent in 2012 compared to 61 percent in 2018).

Change Over Time: Secondary Teachers' Content Preparedness, by Prior Achievement



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Figure 5.3

The survey also asked teachers how well prepared they felt to use a number of student-centered pedagogies. Roughly half of classes of both LPA and HPA students were taught by teachers who felt very well prepared to encourage participation of all students, and about a third were taught by teachers who felt very well prepared to differentiate instruction to meet the needs of diverse learners (see Table 5.22). In addition, about a quarter of classes of LPA and HPA students were taught by teachers who reported feeling very well prepared to provide instruction based on students' ideas.

Teachers were also asked how well prepared they felt to carry out a number of tasks related to monitoring and addressing student thinking in their most recent mathematics unit. As can be seen in Table 5.22, teachers of classes of LPA students were less likely than those of classes of HPA students to feel very well prepared to develop students' abilities to do mathematics (50 vs. 68 percent), develop students' conceptual understanding (48 vs. 62 percent), use formative assessment to monitor student learning (54 vs. 62 percent), and encourage students' interest in mathematics (36 vs. 45 percent). For the one trend item, there was no significant difference over time.

Table 5.22
Mathematics Classes in Which Teachers Considered Themselves Very Well Prepared for Each of a Number of Tasks, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Use formative assessment to monitor student learning*	62 (2.7)	55 (1.4)	54 (2.4)
Develop students' abilities to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)*	68 (2.2)	53 (1.5)	50 (2.5)
Encourage participation of all students in mathematics	52 (2.8)	52 (1.5)	48 (2.4)
Develop students' conceptual understanding*	62 (2.4)	51 (1.4)	48 (2.9)
Differentiate mathematics instruction to meet the needs of diverse learners	34 (2.8)	38 (1.6)	40 (2.6)
(t) Encourage students' interest in mathematics*	45 (2.5)	41 (1.6)	36 (2.8)
Provide mathematics instruction that is based on students' ideas	25 (2.2)	22 (1.2)	22 (2.1)
Incorporate students' cultural backgrounds into mathematics instruction	14 (1.7)	15 (1.0)	17 (2.3)
Develop students' awareness of STEM careers	13 (1.6)	10 (0.9)	11 (1.5)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Table 5.23 shows the percentage of mathematics classes taught by teachers who felt very well prepared for each of a number of tasks related to monitoring and addressing student thinking within a particular unit in a designated class. The disparities between classes of LPA students and classes of HPA students were numerous, with teachers of classes of LPA students perceiving themselves as less well prepared than teachers of classes of HPA students to implement each of the five tasks. For example, 60 percent of teachers of classes of LPA students felt very well prepared to assess student understanding at the conclusion of the unit compared to 71 percent of teachers of classes of HPA students. When looking at trends over time, the 2018 data are not significantly different from the 2012 data.

Table 5.23
Mathematics Classes in Which Teachers Felt Very Well Prepared for Various Tasks in the Most Recent Unit, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Assess student understanding at the conclusion of this unit*	71 (2.5)	64 (1.5)	60 (2.9)
(t) Monitor student understanding during this unit*	65 (2.6)	60 (1.6)	54 (3.0)
(t) Implement the instructional materials to be used during this unit*	62 (2.6)	58 (1.6)	48 (2.9)
(t) Anticipate difficulties that students may have with particular mathematical ideas and procedures in this unit*	58 (2.5)	48 (1.5)	43 (2.4)
(t) Find out what students thought or already knew about the key mathematical ideas*	51 (2.4)	42 (1.6)	37 (2.6)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

The preparedness items were used to create three composite variables: Perceptions of Content Preparedness, Perceptions of Pedagogical Preparedness, and Perceptions of Preparedness to Implement Instruction in a Particular Unit. As can be seen in Table 5.24, classes with low levels of prior achievement were taught by teachers with weaker feelings of content preparedness and unit-specific pedagogical preparedness than classes with high levels of prior achievement. The 2018 data for the Perceptions of Content Preparedness and Perceptions of Preparedness to Implement Instruction in a Particular Unit are not significantly different from the 2012 data.[36]

Table 5.24
Mathematics Class Mean Scores for Teachers' Perceptions of Preparedness Composites, by Prior Achievement

	MEAN SCORE		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Perceptions of Content Preparedness*	84 (0.8)	79 (0.5)	78 (1.1)
Perceptions of Pedagogical Preparedness	71 (0.9)	70 (0.6)	69 (1.1)
(t) Preparedness to Implement Instruction in Particular Unit*	85 (0.8)	82 (0.6)	79 (1.0)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Teacher Professional Development

In 2018, teachers of about 9 in 10 mathematics classes participated in mathematics-focused professional development in the previous three years, regardless of the prior achievement level of the class (see Table 5.25). Further, about 3 in 10 classes were taught by teachers with more than 35 hours of professional development in that timeframe. These data are not significantly different from the data in 2012.

Table 5.25
Professional Development Experiences of Teachers of Mathematics Classes, by Prior Achievement†

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Teacher has had professional development in the last three years	88 (1.7)	86 (1.3)	91 (1.2)
(t) Teacher has had more than 35 hours of professional development in the last three years	36 (2.6)	24 (1.1)	34 (2.5)

(t) Trend item

† There are no statistically significant differences between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p \geq 0.05$).

As described in previous chapters, there is consensus that professional development experiences should include a number of elements, including opportunities to work with colleagues, engage in

[36] Too few items in the version of the 2018 Perceptions of Pedagogical Preparedness composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

investigations, examine student work, and rehearse instructional practices.[37] Therefore, teachers who had participated in professional development in the last three years were asked a series of questions about the nature of those experiences.

As can be seen in Table 5.26, teacher professional development experiences were similar in many ways, regardless of the prior achievement level of the class. For example, over half of all classes were taught by teachers who attended professional development where they worked closely with other teachers from their school or with other teachers who taught the same grade and/or subject whether or not they were from their school. Having opportunities to engage in mathematics investigations was another relatively common experience for teachers in general. However, differences by prior achievement level were also evident. Teachers of classes of LPA students were more likely than teachers of classes of HPA students to examine classroom artifacts (51 vs. 43 percent) and rehearse instructional practices (41 vs. 30 percent) during professional development. The 2018 data are not significantly different from the 2012 data.

Table 5.26
Mathematics Classes in Which Teachers' Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,[a] by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Worked closely with other teachers from their school	68 (3.1)	69 (1.8)	71 (2.7)
(t) Worked closely with other teachers who taught the same grade and/ or subject whether or not they were from their school	56 (3.4)	58 (1.7)	59 (3.6)
(t) Had opportunities to engage in mathematics investigations	48 (3.7)	46 (1.8)	51 (3.2)
(t) Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)*	43 (3.0)	46 (1.8)	51 (3.2)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	45 (3.1)	45 (1.6)	51 (3.3)
(t) Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	43 (3.3)	45 (1.6)	49 (3.5)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect of those practices)*	30 (2.8)	33 (1.5)	41 (3.6)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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."

As can be seen in Table 5.27, there were a number of similarities in the focus of teachers' professional development experiences. Teachers of half or more of mathematics classes,

[37] 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.

regardless of the prior achievement level, had professional development experiences that gave heavy emphasis to monitoring student understanding during mathematics instruction, deepening their understanding of how mathematics is done, and differentiating mathematics instruction to meet the needs of diverse learners. Other areas heavily emphasized were learning how to use hands-on activities/manipulatives, learning about difficulties students may have with particular mathematical ideas and procedures, and deepening teachers' own mathematics content knowledge.

In contrast, classes of LPA students were more likely than classes of HPA students to be taught by teachers whose professional development heavily emphasized finding out what students think or already know prior to instruction on a topic (49 vs. 37 percent) and incorporating students' cultural backgrounds into mathematics instruction (26 vs. 17 percent). The 2018 data are not significantly different from the 2012 data.

Table 5.27
Mathematics Classes in Which Teachers Reported That Their Professional Development in the Last Three Years Gave Heavy Emphasis[a] to Various Areas, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Monitoring student understanding during mathematics instruction	51 (3.4)	55 (1.7)	57 (3.6)
Deepening their understanding of how mathematics is done (e.g., considering how to approach a problem, explaining and justifying solutions, creating and using mathematical models)	54 (3.2)	56 (1.9)	56 (3.7)
Differentiating mathematics instruction to meet the needs of diverse learners	50 (3.2)	56 (1.9)	56 (3.5)
(t) Learning about difficulties that students may have with particular mathematical ideas and procedures	47 (3.1)	48 (1.5)	54 (3.4)
(t) Deepening their own mathematics content knowledge	44 (3.6)	46 (1.9)	51 (3.5)
(t) Finding out what students think or already know prior to instruction on a topic*	37 (3.0)	42 (1.6)	49 (3.8)
(t) Learning how to use hands-on activities/manipulatives for mathematics instruction	47 (3.6)	53 (1.9)	47 (3.2)
(t) Implementing the mathematics textbook to be used in their classroom	33 (2.9)	37 (1.8)	31 (3.1)
Incorporating students' cultural backgrounds into mathematics instruction*	17 (2.5)	22 (1.4)	26 (3.1)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	20 (3.0)	21 (1.7)	22 (3.7)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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 a subset of these items were combined into two composite variables called Extent Professional Development Aligns with Elements of Effective Professional Development and Extent Professional Development Supports Student-Centered Instruction. As can be seen in Table 5.28, teachers of classes of LPA students experienced professional development that was, on average, more closely aligned with elements of effective professional development and supportive of student-centered instruction than teachers of classes of HPA students. However, the mean scores indicate that most teachers' professional development was only somewhat aligned with elements of effective professional development and somewhat supportive of student-centered instruction.

Table 5.28
Mathematics Class Mean Scores for Teachers' Professional Development Composites, by Prior Achievement

	MEAN SCORE		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Extent Professional Development Aligns With Elements of Effective Professional Development*,a	59 (1.4)	61 (0.7)	64 (1.4)
Extent Professional Development Supports Student-Centered Instruction*	55 (1.4)	59 (0.7)	60 (1.6)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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. There is a significant difference between the two time points for this factor, so the data in this table are based on the recomputed composite definition.

Since 2012, the gap between the mean scores of classes of LPA students and classes of HPA students for the Extent Mathematics Teachers' Professional Development Aligns With Elements of Effective Professional Development Composite has changed (see Figure 5.4). This change appears to be due to a moderate increase in the mean score for classes of LPA students combined with a moderate decrease in mean score for classes of HPA students.38

[38] Too few of the items in the 2018 version of the Extent Professional Development Supports Student-Centered Instruction composite were also asked in 2012 to allow for a comparable composite to be created to examine trend over time.

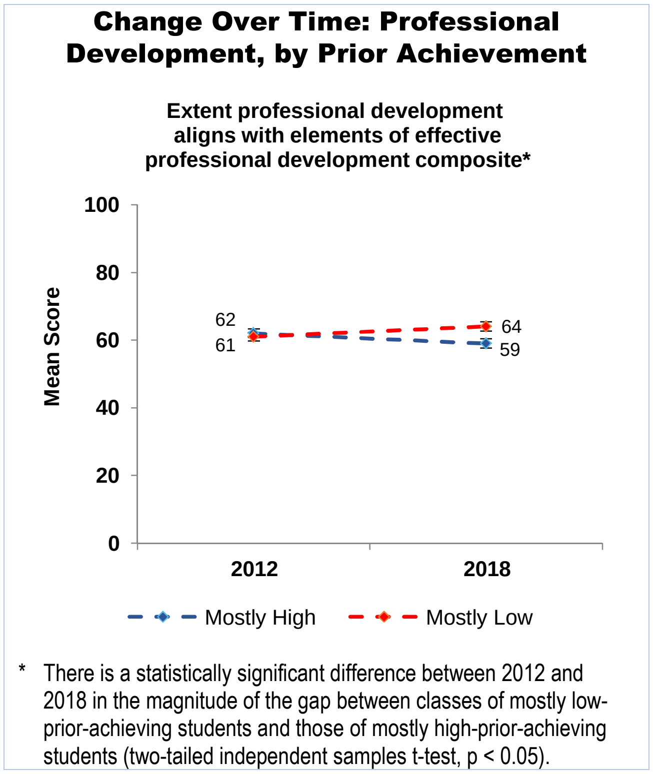


Figure 5.4

Summary

Overall, there were several differences between classes of LPA and HPA students in terms of teachers' backgrounds and experiences. For example, classes of LPA students were more likely than classes of HPA students to be taught by teachers with five or fewer years of experience teaching mathematics. In addition, classes of LPA students were less likely to be taught by teachers who had completed a substantial college-level mathematics coursework related to NCTM preparation standards, and, at the secondary level, with a degree in mathematics or mathematics education and those.

Teachers of mathematics classes across prior achievement levels held similar reform-oriented and traditional beliefs about teaching and learning, and they reported similar levels of pedagogical preparedness (e.g., differentiating mathematics instruction for diverse learners). However, classes of LPA students were somewhat less likely than classes of HPA students to be taught by teachers who had strong feelings of content preparedness and preparedness to monitor and address student thinking during instruction.

There were also a number of similarities among classes with regard to teachers' professional development experiences. For example, a large majority of classes across prior achievement levels were taught by teachers who participated in mathematics-focused professional development in the last three years and who generally reported similar characteristics and emphases of those experiences. However, teachers of classes of LPA students were somewhat more likely than their counterparts to examine classroom artifacts and rehearse instructional practices during professional development. In addition, their professional development experiences were more likely to heavily emphasize finding out what students think or already know prior to instruction on a topic and incorporating students' cultural backgrounds into mathematics instruction.

Since 2012, the distribution of well-prepared teachers between classes with low and high levels of prior achievement has remained largely consistent. One notable difference is teachers' feelings of preparedness to teach functions. Over time, the gap between classes of LPA and HPA students taught by teachers who felt well prepared to teach this area has become more pronounced, disadvantaging classes of LPA students.

Supportive Context for Learning

The 2018 NSSME+ collected information about factors that could promote and inhibit mathematics instruction in the school, including school policies and stakeholder support. This section presents these data, highlighting the similarities and differences between classes of LPA students and classes of HPA students.

Factors Affecting Student Opportunity to Learn

Table 5.29 displays the percentages of classes taught by teachers who rated various factors as promoters of effective instruction. A large majority of classes, regardless of prior achievement level, were taught by teachers who considered the amount of instructional time devoted to mathematics as promoting effective instruction. Principal support, the amount of time for teachers to plan, and current state standards were also viewed as promoting effective mathematics instruction by teachers of more than 60 percent of mathematics classes, regardless of the prior achievement level of the class.

Although there were some similarities, there were also significant differences between classes of LPA students and classes of HPA students on four items. First, teachers of classes of LPA students were less likely than teachers of classes of HPA students to rate students' prior knowledge and skills as promoting effective instruction (49 vs. 70 percent). In addition, student motivation, interest, and effort in mathematics, as well as college entrance requirements were less likely to be seen as promoting effective mathematics instruction in classes of LPA students than in classes of HPA students (48 vs. 71 percent and 46 vs. 69 percent, respectively). Finally, only 40 percent of classes of LPA students compared to 56 percent of classes of HPA students were taught by teachers who rated parent/guardian expectations and involvement as promoting effective instruction.

Table 5.29
Factors Promoting[a] Effective Instruction in Mathematics Classes, by Prior Achievement

	PERCENT OF CLASSES		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
Amount of instructional time devoted to mathematics[b]	91 (4.6)	84 (1.9)	75 (5.6)
(t) Principal support	77 (2.9)	76 (1.6)	70 (3.0)
(t) Amount of time for you to plan, individually and with colleagues	76 (2.7)	70 (1.6)	67 (3.7)
(t) Current state standards	69 (2.9)	75 (1.7)	63 (3.0)
(t) District/Diocese/School pacing guides	62 (3.6)	65 (1.6)	53 (3.4)
(t) Amount of time available for your professional development	60 (3.0)	57 (1.8)	53 (3.8)
Students' prior knowledge and skills*	70 (2.8)	66 (1.9)	49 (3.5)
(t) Students' motivation, interest, and effort in mathematics*	71 (3.2)	64 (1.8)	48 (3.6)
(t) College entrance requirements*,[c]	69 (3.6)	60 (3.0)	46 (6.0)
(t) Teacher evaluation policies	49 (3.4)	48 (1.9)	44 (3.5)
(t) Parent/guardian expectations and involvement*	56 (3.3)	48 (1.6)	40 (3.4)
(t) State/district/diocese testing/accountability policies[d]	42 (3.5)	43 (1.8)	37 (3.0)
(t) Textbook selection policies	43 (3.0)	41 (1.8)	34 (3.8)

(t) Trend item

* There is a statistically significant difference between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

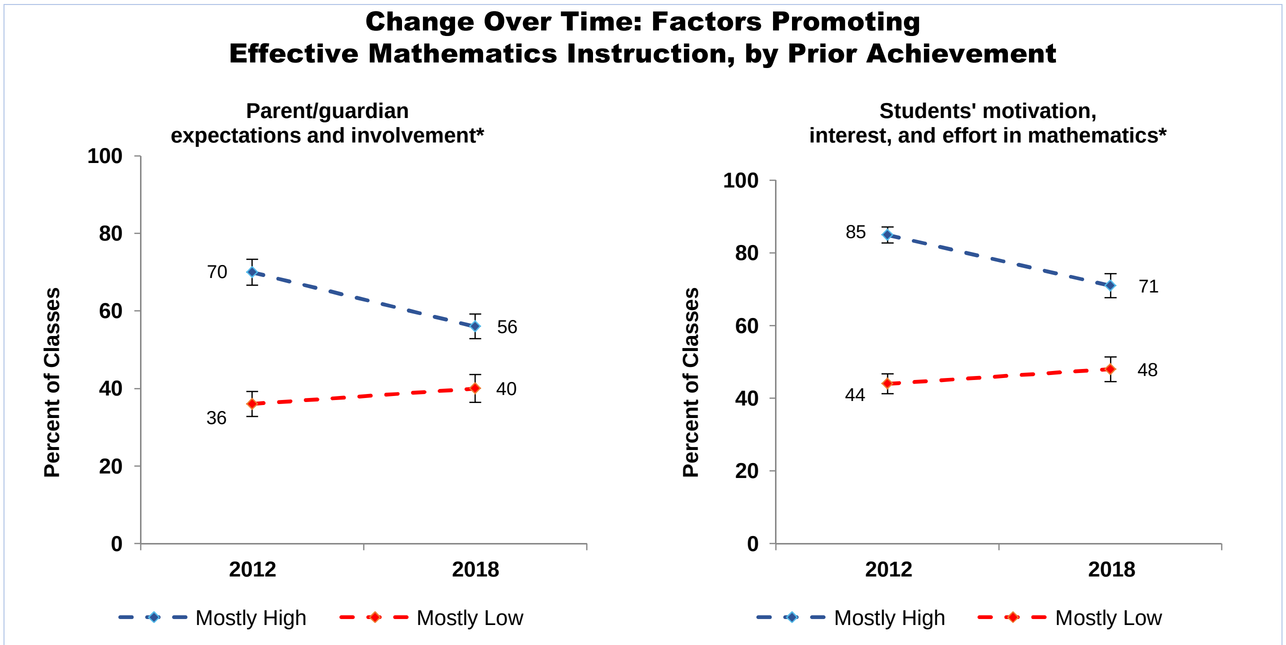
[a] Includes mathematics teachers indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

[b] This item was presented only to elementary school teachers.

[c] This item was presented only to high school teachers.

[d] This item was presented only to teachers in public and Catholic schools.

Figure 5.5 shows two items with significant changes over time between classes of LPA and HPA students: (1) parent/guardian expectations and involvement and (2) students' motivation, interest, and effort in mathematics. In both cases, there is a narrowing of the gap, with fewer teachers of classes of HPA students rating these factors as promoting effective instructive in 2018 than in 2012.



* There is a statistically significant difference between 2012 and 2018 in the magnitude of the gap between classes of mostly low-prior-achieving students and those of mostly high-prior-achieving students (two-tailed independent samples t-test, $p < 0.05$).

Figure 5.5

Three composites were created from these items to summarize the extent to which various factors support effective instruction: (1) Extent to Which School Support Promotes Effective Instruction, (2) Extent to Which the Policy Environment Promotes Effective Instruction, and (3) Extent to Which Stakeholders Promote Effective Instruction. As can be seen in Table 5.30, there was a significant gap for the stakeholder composite with regard to prior achievement level. Specifically, classes of LPA students had lower mean scores than classes of HPA students (mean scores of 55 vs. 71). When looking at trends, the 2018 data for the Extent to Which School Support Promotes Effective Instruction and Extent to Which the Policy Environment Promotes Effective Instruction composites are not significantly different than in 2012.[39]

[39] Too few items in the 2018 version of the Extent to Which Stakeholders Promote Effective Instruction composite were also asked in 2012; thus, trend data are not available to report.

Table 5.30
Mathematics Class Mean Scores for Factors Affecting Instruction Composites, by Prior Achievement

	MEAN SCORE		
	MOSTLY HIGH	AVERAGE/MIXED	MOSTLY LOW
(t) Extent to Which School Support Promotes Effecting Instruction	71 (1.9)	71 (1.0)	69 (2.1)
(t) Extent to Which the Policy Environment Promotes Effective Instruction[a]	66 (1.6)	67 (0.8)	62 (1.4)
Extent to Which Stakeholders Promote Effective Instruction*	71 (2.1)	67 (1.0)	55 (2.2)

(t) Trend item

* There is a statistically significant difference between of mostly low-prior-achieving students and those of mostly high-prior-achieving students (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 for 2012 using the 2018 definition. Because there is no significant difference between the two time points on this composite, the data in this table are based on the original 2018 composite definition.

Summary

Overall, teachers of mathematics classes viewed the climate for mathematics instruction as generally supportive, in terms of school support, policies, and stakeholders, regardless of prior achievement level of the class. Factors seen as promoting effective instruction in a majority of mathematics classes included the amount of available instructional time, principal support, planning time, and current state standards. However, there were also significant differences between classes of LPA and HPA students on a number of items, with teachers of classes of LPA students consistently less likely to view these factors (e.g., students' prior knowledge and skills, student motivation, interest, and effort in mathematics, parent/guardian expectations and involvement) as promoting effective instruction.

Since 2012, the context for mathematics learning in classes of LPA students and classes of HPA students has remained largely consistent. However, teachers of each type of mathematics class have become more similar in their views regarding parent/guardian expectations and involvement and students' motivation, interest, and effort as being promoters of effective instruction.

Quartile Cut Points

Quartile cut points are the values that separate one quartile from another such that roughly 25 percent of schools or classes are represented in each quartile. The lowest quartile includes the group that has values below the Quartile 1/Quartile 2 cut point and the highest quartile includes the group with values above the Quartile 3/Quartile 4 cut point.

Each school was classified into one of four categories based on the proportion of students eligible for free/reduced-price lunch (FRL). Defining common categories across grades K–12 would have been misleading, as students tend to select out of the FRL program as they advance in grade due to perceived social stigma. Therefore, the categories were defined as quartiles within groups of schools serving the same grades—e.g., schools with grades K–5, schools with grades 6–8 (see Table A-1).

Table A-1
Cut Points for Percentage of Students in the School Eligible for FRL

		PERCENT FRL USED AS CUTPOINT		
	PERCENT OF SCHOOLS	QUARTILE 1/QUARTILE 2	QUARTILE 2/QUARTILE 3	QUARTILE 3/QUARTILE 4
K–5 Schools	38 (1.6)	33.8	53.6	82.4
6–8 Schools	12 (0.4)	37.6	55.9	80.0
9–12 Schools	15 (0.8)	18.8	40.3	18.8
K–8 Schools	25 (1.7)	17.5	46.2	78.8
6–12 Schools	4 (0.5)	27.0	48.0	66.3
9–12 Schools	6 (0.9)	4.2	34.3	82.5

Each randomly selected class was classified into one of four categories based on the proportion of students in the class identified as being from race/ethnicity groups historically underrepresented in STEM (i.e., American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, multi-racial). As this proportion is similar in schools regardless of grades served, the categories were defined as quartiles across all classes (see Table A-2).

Table A-2
Cut Points for Percentage of Students in the Class From Race/Ethnicity Groups Historically Underrepresented in STEM

	PERCENT HUS USED AS CUTPOINT
Quartile 1/Quartile 2	10.5
Quartile 2/Quartile 3	33.3
Quartile 3/Quartile 4	76.2

Trend Item Wording Differences

The wording of some survey items changed between the 2012 and 2018 iterations of the study. Items with slightly different wording were treated as trend. These items, separated by instrument, are shown in the tables below, along with references to tables in this report that the items appear in.*

Table B-1
School Coordinator Questionnaire Trend Item Differences

2018 ITEM #	2012 ITEM #	FRL TABLE #	COMMUNITY TYPE TABLE #
scq08a	scq08	2.16	3.16
scq08b	scq10a	2.16	3.16

Table B-2
Mathematics Program Questionnaire Trend Item Differences

2018 ITEM #	2012 ITEM #	FRL TABLE #	COMMUNITY TYPE TABLE #
mpq22a	mpq26a	2.33	3.33
mpq22e	mpq26c	2.33	3.33
mpq22i	mpq26h	2.33	3.33
mpq32a	mpq36a	2.34	3.34
mpq32e	mpq36c	2.34	3.34
mpq32i	mpq36h	2.34	3.34
mpq02a	mpq02a	2.38	3.38
mpq02b	mpq02b	2.38	3.38
mpq03a	mpq03a	2.39	3.39
mpq03c	mpq03c	2.39	3.39
mpq03f	mpq03e	2.39	3.39
mpq03g	mpq03d	2.39	3.39
mpq19a	mpq20a	2.41	3.41
mpq19b	mpq20b	2.41	3.41
mpq19d	mpq20e	2.41	3.41
mpq20e	mpq21c	2.43	3.43
mpq20k	mpq21h	2.43	3.43
mpq20p	mpq21o	2.43	3.43

* The 2012 instruments are available at: http://horizon-research.com/NSSME/2012-nssme/instruments and the 2018 instruments are available at: http://horizon-research.com/NSSME/2018-nssme/instruments.

Table B-3
Mathematics Teacher Questionnaire Trend Item Differences

2018 ITEM #	2012 ITEM #	FRL TABLE #	COMMUNITY TYPE TABLE #	HUS TABLE #	PRIOR ACHIEVEMENT TABLE #
mtq32b	mtq32b	2.5	3.5	4.5	5.4
mtq33e	mtq33d	2.7	3.7	4.7	5.6
mtq34f	mtq34e	2.9	3.9	4.9	5.8
mtq34g	mtq34k	2.9	3.9	4.9	5.8
mtq38	mtq38	2.12	3.12	4.12	5.11
mtq26c	mtq27e	2.21	3.21	4.19	5.18
mtq53c	mtq58c	2.26	3.26	4.24	5.23
mtq21c	mtq20b	2.29	3.29	4.27	5.26
mtq21e	mtq20c	2.29	3.29	4.27	5.26
mtq21f	mtq20d	2.29	3.29	4.27	5.26
mtq21g	mtq20e	2.29	3.29	4.27	5.26
mtq22c	mtq22e	2.30	3.30	4.28	5.27
mtq22f	mtq22d	2.30	3.30	4.28	5.27
mtq46c	mtq48d	2.45	3.45	4.30	5.29
mtq46d	mtq48f	2.45	3.45	4.30	5.29
mtq46i	mtq48l	2.45	3.45	4.30	5.29
mtq46k	mtq48n	2.45	3.45	4.30	5.29
mtq46l	mtq48o	2.45	3.45	4.30	5.29

Alternate Composite Definitions Used in Trend Analyses

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. When there is a significant difference between the two time points, the data shown in this report are based on the recomputed composite definition. The definitions for the recomputed composites are shown in the following tables.

Table C-1
Supportive Context for Mathematics Instruction: FRL

	MATHEMATICS PROGRAM QUESTIONNAIRE ITEM
School/district/Diocese mathematics professional development policies and practices†	mpq19a
Amount of time provided for teacher professional development in mathematics	mpq19b
Importance that the school places on mathematics	mpq19c
Other school and/or district and/or diocese initiatives	mpq19d
Number of Items in Composite	**4**
Reliability – Cronbach's Coefficient Alpha	**0.82**
Confirmatory Factor Analysis Fit Index – SRMR	**0.07**

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

Table C-2
Extent Professional Development Aligns With Elements of Effective Professional Development: Prior Achievement

	MATHEMATICS TEACHER QUESTIONNAIRE ITEM†
I had opportunities to engage in mathematics investigations.	mtq21a
I had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction, e-portfolios).	mtq21c
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.	mtq21e
I worked closely with other teachers from my school.	mtq21f
I worked closely with other teachers who taught the same grade and/or subject whether or not they were from my school.	mtq21g
Number of Items in Composite	**5**
Reliability – Cronbach's Coefficient Alpha	**0.67**
Confirmatory Factor Analysis Fit Index – SRMR	**0.06**

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