Instructional Decision Making, Objectives, and Activities

Overview

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

Teachers' Perceptions of Their Decision-Making Autonomy

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 curricular and instructional decisions for their classes.

As can be seen in Table 5.1, in science classes across all grade levels, teachers tend to perceive themselves as having strong control over pedagogical decisions such as determining the amount of homework to be assigned (59–74 percent), selecting teaching techniques (48–68 percent), and choosing criteria for grading student performance (41–59 percent). In contrast, especially in the elementary grades, teachers are less likely to feel strong control in determining course goals and objectives (17–36 percent); selecting textbooks/modules/programs (15–36 percent); and selecting content, topics, and skills to be taught (13–34 percent). In fact, in about a third of elementary classes, teachers report having no control over these decisions (see Table 5.2).

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

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determining the amount of homework to be assigned	59 (2.5)	73 (2.2)	74 (1.8)
Selecting teaching techniques	48 (2.3)	67 (2.4)	68 (2.3)
Choosing criteria for grading student performance	41 (2.5)	59 (2.6)	54 (2.2)
Selecting the sequence in which topics are covered	30 (2.6)	41 (2.9)	51 (2.1)
Determining the amount of instructional time to spend on each topic	21 (2.7)	43 (3.2)	48 (2.1)
Determining course goals and objectives	17 (2.7)	33 (3.0)	36 (2.5)
Selecting curriculum materials (e.g., textbooks/modules)	15 (2.5)	28 (2.9)	36 (2.0)
Selecting content, topics, and skills to be taught	13 (2.6)	27 (3.0)	34 (2.2)

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

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determining the amount of homework to be assigned	4 (0.9)	0 (0.2)	1 (0.5)
Selecting teaching techniques	2 (0.5)	0 (0.1)	1 (1.3)
Choosing criteria for grading student performance	5 (0.9)	3 (1.3)	2 (0.5)
Selecting the sequence in which topics are covered	18 (2.1)	13 (2.0)	6 (1.0)
Determining the amount of instructional time to spend on each topic	15 (2.1)	6 (1.6)	4 (1.5)
Determining course goals and objectives	27 (2.2)	20 (2.0)	12 (1.4)
Selecting curriculum materials (e.g., textbooks/modules)	29 (2.3)	17 (2.3)	12 (1.7)
Selecting content, topics, and skills to be taught	34 (2.6)	24 (2.9)	11 (1.3)

A similar pattern appears in mathematics classes (see Tables 5.3 and 5.4). In a majority of mathematics classes, teachers report having strong control over determining the amount of homework to assign (61–75 percent) and selecting teaching techniques (52–71 percent). In relatively few mathematics classes do teachers feel strong control over determining course goals and objectives (16–30 percent); selecting curriculum materials (11–27 percent); and selecting content, topics, and skills to be taught (11–26 percent). In general, teachers of secondary mathematics classes perceive greater control over curriculum and instruction decisions than teachers of elementary mathematics. Further, in a sizeable proportion of classes at each grade band, teachers report having no control over curriculum decisions.

Table 5.3
Mathematics Classes in Which Teachers Report Having Strong Control Over Various Curricular and Instructional Decisions, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determining the amount of homework to be assigned	61 (2.2)	71 (2.4)	75 (1.6)
Selecting teaching techniques	52 (2.2)	68 (2.5)	71 (1.5)
Choosing criteria for grading student performance	34 (2.0)	52 (2.9)	53 (2.0)
Determining the amount of instructional time to spend on each topic	21 (1.8)	37 (2.7)	49 (2.0)
Selecting the sequence in which topics are covered	19 (1.7)	31 (2.6)	45 (1.7)
Determining course goals and objectives	16 (1.7)	28 (2.4)	30 (1.6)
Selecting curriculum materials (e.g., textbooks)	11 (1.5)	18 (2.1)	27 (1.8)
Selecting content, topics, and skills to be taught	11 (1.3)	21 (2.1)	26 (1.6)

Table 5.4
Mathematics Classes in Which Teachers Report Having No Control Over Various Curricular and Instructional Decisions, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determining the amount of homework to be assigned	3 (1.0)	1 (0.4)	2 (0.6)
Selecting teaching techniques	2 (0.6)	0 (0.0)	0 (0.2)
Choosing criteria for grading student performance	6 (1.2)	2 (0.7)	3 (0.6)
Determining the amount of instructional time to spend on each topic	17 (1.7)	6 (0.9)	3 (0.5)
Selecting the sequence in which topics are covered	25 (2.1)	12 (1.4)	8 (1.2)
Determining course goals and objectives	34 (2.3)	26 (2.2)	14 (1.4)
Selecting curriculum materials (e.g., textbooks)	33 (2.3)	27 (2.2)	20 (1.8)
Selecting content, topics, and skills to be taught	40 (2.6)	31 (2.0)	17 (1.8)

In high school computer science classes, teachers also tend to report more control over instruction than curriculum, but in general report having more control over curriculum than their science and mathematics counterparts (see Table 5.5). In very few classes, perhaps because of the largely elective nature of computer science, do teachers feel like they have no control over these decisions (see Table 5.6).

Table 5.5
High School Computer Science Classes in Which Teachers Report Having Strong Control Over Various Curricular and Instructional Decisions

	PERCENT OF CLASSES
Determining the amount of homework to be assigned	77 (3.6)
Choosing criteria for grading student performance	71 (4.1)
Selecting teaching techniques	68 (4.5)
Determining the amount of instructional time to spend on each topic	63 (4.4)
Selecting the sequence in which topics are covered	63 (4.2)
Selecting curriculum materials (e.g., textbooks/online courses)	58 (4.7)
Determining course goals and objectives	57 (4.3)
Selecting content, topics, and skills to be taught	53 (4.2)
Selecting programming languages to use	49 (4.3)

Table 5.6
High School Computer Science Classes in Which Teachers Report Having No Control Over Various Curricular and Instructional Decisions

	PERCENT OF CLASSES
Determining the amount of homework to be assigned	0 (0.3)
Choosing criteria for grading student performance	1 (0.6)
Selecting teaching techniques	0 (0.4)
Determining the amount of instructional time to spend on each topic	1 (0.9)
Selecting the sequence in which topics are covered	2 (1.0)
Selecting curriculum materials (e.g., textbooks/online courses)	4 (1.3)
Determining course goals and objectives	5 (1.5)
Selecting content, topics, and skills to be taught	4 (1.3)
Selecting programming languages to use	13 (2.2)

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

- Determining course goals and objectives;
- Selecting curriculum materials;
- Selecting content, topics, and skills to be taught;
- Selecting the sequence in which topics are covered; and
- Selecting programming languages to use.[17]

For Pedagogy Control, the items are:

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

Table 5.7 displays the mean scores on these composite. These scores indicate that teachers perceive more control over decisions related to pedagogy than curriculum, especially in science and mathematics classes. They also show that perceived control for both composite variables is greater in secondary science and mathematics classes than in elementary classes.

[17] This item was presented only to high school computer science teachers.

Table 5.7
Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM	PEDAGOGY
Science Classes		
Elementary	45 (2.1)	79 (1.2)
Middle	57 (2.2)	87 (1.1)
High	67 (1.4)	87 (1.0)
Mathematics Classes		
Elementary	39 (1.4)	78 (0.9)
Middle	50 (1.5)	86 (0.9)
High	60 (1.2)	87 (0.7)
Computer Science Classes		
High	78 (1.7)	89 (1.4)

When looking at the composite scores by equity factors, a number of differences are apparent by both class and school factors. For example, teachers of science classes composed mostly of low prior achievers report having less control over both curriculum and pedagogy than teachers of classes containing mostly high prior achievers (see Table 5.8). A similar pattern exists in terms of race/ethnicity composition—teachers of classes serving a high proportion of students from race/ethnicity groups historically underrepresented in STEM report lower instructional control than teachers of classes with relatively few students from these groups. Teachers of classes in higher-poverty schools and in large schools tend to report less control than their counterparts in low-poverty and small schools.

Table 5.8
Equity Analyses of Science Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM	PEDAGOGY
Prior Achievement Level of Class		
Mostly High	65 (1.9)	90 (1.0)
Average/Mixed	53 (1.4)	82 (0.9)
Mostly Low	46 (2.7)	79 (2.2)
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	63 (1.8)	87 (1.1)
Second Quartile	56 (1.8)	83 (1.3)
Third Quartile	47 (1.7)	82 (1.1)
Highest Quartile	49 (4.1)	79 (2.3)
Percent of Students in School Eligible for FRL		
Lowest Quartile	56 (1.8)	84 (1.4)
Second Quartile	56 (2.2)	85 (1.3)
Third Quartile	55 (3.1)	84 (1.4)
Highest Quartile	47 (1.8)	79 (1.5)
School Size		
Smallest Schools	64 (3.5)	89 (1.8)
Second Group	60 (3.3)	81 (2.0)
Third Group	52 (1.6)	81 (1.4)
Largest Schools	49 (1.4)	83 (0.9)
Community Type		
Rural	61 (1.6)	87 (1.0)
Suburban	52 (1.0)	81 (0.8)
Urban	52 (3.4)	82 (1.8)
Region		
Midwest	59 (1.9)	82 (1.4)
Northeast	58 (3.7)	82 (2.2)
South	46 (1.6)	82 (1.0)
West	58 (1.7)	84 (1.2)

Similar patterns are evident in mathematics classes, though differences tend to be limited to curriculum control (see Table 5.9). Computer science results are shown in Table 5.10. Although there appear to be differences in curriculum control by school size and community type, they are not statistically significant.

Table 5.9
Equity Analyses of Mathematics Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM	PEDAGOGY
Prior Achievement Level of Class		
Mostly High	59 (1.7)	88 (1.1)
Average/Mixed	45 (1.1)	81 (0.6)
Mostly Low	45 (1.8)	81 (1.0)
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	56 (1.5)	85 (1.0)
Second Quartile	50 (1.8)	83 (0.9)
Third Quartile	41 (1.7)	81 (1.3)
Highest Quartile	42 (1.8)	79 (1.3)
Percent of Students in School Eligible for FRL		
Lowest Quartile	51 (1.9)	82 (0.8)
Second Quartile	49 (1.9)	84 (1.1)
Third Quartile	47 (1.6)	82 (1.2)
Highest Quartile	43 (2.0)	80 (1.3)
School Size		
Smallest Schools	61 (3.0)	84 (1.4)
Second Group	53 (2.3)	83 (1.0)
Third Group	46 (1.5)	81 (1.2)
Largest Schools	43 (1.4)	82 (0.7)
Community Type		
Rural	57 (1.7)	85 (1.0)
Suburban	45 (1.2)	81 (0.8)
Urban	45 (1.8)	81 (1.2)
Region		
Midwest	51 (1.9)	82 (1.2)
Northeast	50 (2.3)	82 (1.1)
South	43 (1.4)	82 (0.9)
West	50 (1.9)	83 (1.2)

Table 5.10
Equity Analyses of High School Computer Science
Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM	PEDAGOGY
Prior Achievement Level of Class		
Mostly High	78 (2.7)	90 (2.2)
Average/Mixed	78 (2.3)	89 (1.8)
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	76 (3.3)	93 (1.6)
Second Quartile	78 (4.0)	87 (3.5)
Third Quartile	75 (4.1)	89 (2.7)
Highest Quartile	83 (2.9)	89 (3.1)
Percent of Students in School Eligible for FRL		
Lowest Quartile	78 (2.5)	90 (1.9)
Second Quartile	78 (3.8)	89 (2.8)
Third Quartile	77 (3.8)	88 (3.6)
Highest Quartile	80 (4.1)	90 (2.3)
School Size		
Smallest Schools	88 (5.3)	96 (2.1)
Second Group	79 (4.8)	93 (2.4)
Third Group	77 (2.6)	87 (3.4)
Largest Schools	78 (2.3)	89 (1.7)
Community Type		
Rural	72 (4.3)	85 (4.0)
Suburban	77 (2.1)	92 (1.3)
Urban	82 (3.3)	88 (2.6)
Region		
Midwest	77 (3.2)	89 (3.1)
Northeast	77 (3.5)	90 (2.1)
South	75 (3.5)	89 (2.0)
West	85 (2.9)	89 (2.6)

Instructional Objectives

The survey provided a list of possible objectives of instruction and asked teachers how much emphasis each would receive in an entire course of a particular, randomly selected class. Table 5.11 shows the percentage of science classes by grade range with a heavy emphasis for each objective. Understanding science concepts is the most frequently emphasized objective, although more so in secondary classes (about three-quarters of middle and high school classes) than in elementary (fewer than half of classes). Given the adoption in many states of the NGSS or NGSS-like standards, it is somewhat surprising that fewer than half of secondary classes, and only a quarter of elementary classes have a heavy emphasis on students learning how to do science. In addition, about a third of classes have a heavy emphasis on students learning science vocabulary and/or facts. Objectives least likely to be emphasized are learning about different fields of science and engineering and learning how to do engineering (10 percent or fewer science classes). In fact, 18–31 percent of science classes, depending on grade range, have no emphasis on learning how to do engineering (see Table 5.12)

Table 5.11
Science Classes With Heavy Emphasis on Various Instructional Objectives, by Grade Range

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

Table 5.12
Science Classes With No Emphasis on Learning How To Do Engineering

	PERCENT OF CLASSES
Elementary	22 (1.6)
Middle	18 (1.9)
High	31 (1.5)

The objectives related to reform-oriented instruction (understanding science concepts, learning about different fields of science/engineering, learning how to do science, learning how to do engineering, learning about real-life applications of science/engineering, increasing students' interest in science/engineering, and developing students' confidence that they can successfully pursue careers in science/engineering) were combined into a composite variable. Overall, scores on this composite are not very high (see Table 5.13), indicating that science classes are only somewhat likely to emphasize reform-oriented instructional objectives. In addition, secondary classes are somewhat more likely than elementary classes to emphasize these objectives.

Table 5.13
Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
Elementary	60 (0.9)
Middle	67 (0.8)
High	65 (0.5)

Scores on this composite were also analyzed by a number of equity factors. The only factor that has a clear relationship with this composite is the prior achievement level of the class. As can be seen in Table 5.14, classes containing mostly high-achieving students are more likely to stress reform-oriented instructional objectives than classes with mostly low-achieving students.

Table 5.14
Equity Analysis of Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite by Prior Achievement Level of Class

	MEAN SCORE
Mostly High Achievers	68 (0.9)
Average/Mixed Achievers	63 (0.6)
Mostly Low Achievers	57 (1.3)

In mathematics, about 7 out of 10 elementary, middle, and high school mathematics classes focus heavily on having students understand mathematical ideas (see Table 5.15). Other objectives heavily emphasized by over half of classes across grade levels are learning how to do mathematics and learning mathematical procedures and/or algorithms.

The data also reveal two notable differences in emphasis by grade range. One is that 41 percent of elementary mathematics classes focus heavily on increasing students' interest in mathematics, compared to 34 percent and 26 percent of middle and high school classes, respectively. The other is that learning to perform computations with speed and accuracy is more likely to be heavily emphasized in elementary classes than in middle and high school classes (33, 20, and 21 percent, respectively).

Table 5.15
Mathematics Classes With Heavy Emphasis on Various Instructional Objectives, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Understanding mathematical ideas	67 (1.7)	71 (1.9)	69 (1.7)
Learning how to do mathematics (e.g., consider how to approach a problem, explain and justify solutions, create and use mathematical models)	62 (1.9)	61 (2.1)	63 (1.6)
Learning mathematical procedures and/or algorithms	52 (1.7)	53 (2.6)	55 (1.8)
Developing students' confidence that they can successfully pursue careers in mathematics	37 (1.7)	41 (2.0)	37 (1.5)
Learning about real-life applications of mathematics	34 (1.9)	37 (1.9)	32 (1.4)
Learning mathematics vocabulary	36 (1.7)	27 (1.9)	29 (1.5)
Increasing students' interest in mathematics	41 (1.9)	34 (2.0)	26 (1.3)
Learning test-taking skills/strategies	30 (1.8)	23 (1.5)	25 (1.3)
Learning to perform computations with speed and accuracy	33 (2.1)	20 (1.6)	21 (1.3)

Table 5.16 presents mean scores on the reform-oriented instructional objectives in mathematics composite by grade range. Mathematics classes are, on average, likely to emphasize reform-oriented instructional objectives at all grade levels—more so than science classes do.

Table 5.16
Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
Elementary	79 (0.6)
Middle	79 (0.6)
High	77 (0.4)

Similar to science, there are differences in composite scores by the prior achievement level of the class in mathematics. Reform-oriented instructional objectives are more heavily emphasized in mathematics classes with mostly high-prior-achieving students than in classes with mostly average/mixed or low-prior-achieving students (see Table 5.17).

Table 5.17
Equity Analysis of Mathematics Class Mean Scores for the Reform-Oriented Instructional Objectives Composite by Prior Achievement Level of Class

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

In high school computer science classes, learning how to do computer science, understanding computer science concepts, developing students' confidence that they can successfully pursue computer science careers, and increasing student interest receive a heavy emphasis in a majority of classes (see Table 5.18). Learning vocabulary and/or the syntax of a particular language receives a heavy emphasis in only a third of classes.

Table 5.18
High School Computer Science Classes With Heavy Emphasis on Various Instructional Objectives

	PERCENT OF CLASSES
Learning how to do computer science (e.g., breaking problems into smaller parts, considering the needs of a user, creating computational artifacts)	60 (3.5)
Understanding computer science concepts	55 (3.6)
Developing students' confidence that they can successfully pursue careers in computer science	52 (3.9)
Increasing students' interest in computer science	50 (3.6)
Learning how to develop computational solutions	43 (4.1)
Learning about real-life applications of computer science	39 (4.3)
Learning computer science vocabulary and/or program syntax	33 (3.9)

Table 5.19 shows scores on the reform-oriented instructional objectives composite for high school computer science classes overall and by two equity factors. Interestingly, classes with a higher proportion of students from race/ethnicity groups historically underrepresented in STEM fields are more likely to emphasize reform-oriented objectives, as are classes in schools with a higher proportion of students eligible for free/reduced-price lunch.

Table 5.19
Equity Analyses of High School Computer Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
Overall	**81 (1.0)**
Percent of Historically Underrepresented Students in Class	
Lowest Quartile	75 (1.9)
Second Quartile	80 (2.1)
Third Quartile	81 (1.7)
Highest Quartile	86 (2.2)
Percent of Students in School Eligible for FRL	
Lowest Quartile	78 (1.4)
Second Quartile	80 (1.8)
Third Quartile	82 (2.7)
Highest Quartile	85 (2.9)

Class Activities

Teachers were asked several items about their instruction in the randomly selected class. One item asked how often they use different pedagogies (e.g., explaining ideas to students, small group work). Another asked how often they engage students in practices associated with the discipline. Response options for both of these sets of items were: never, rarely (e.g., a few times a year), sometimes (e.g., once or twice a month), often (e.g., once or twice a week), and all or almost all science/mathematics/computer science lessons. Teachers were also asked two questions about their most recent lesson in this class: (1) how instructional time was apportioned and (2) what instructional activities took place. Results for science instruction are presented first, followed by mathematics and then computer science instruction.

Science Instruction

Depending on grade range, 42–48 percent of classes include the teacher explaining science ideas in all or almost all lessons (see Table 5.20). The majority of elementary science classes engage in whole-class discussions in nearly every lesson, though this activity becomes less frequent as the grade level increases. Approximately a third of K–12 science classes have students work in small groups in all or almost all science lessons.

Table 5.20
Science Classes in Which Teachers Report Using Various Activities in All or Almost All Lessons, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Explain science ideas to the whole class	48 (1.8)	46 (2.1)	42 (1.7)
Engage the whole class in discussions	55 (1.5)	42 (2.1)	31 (1.6)
Have students work in small groups	30 (2.0)	33 (2.1)	30 (1.5)
Have students do hands-on/laboratory activities	16 (1.9)	11 (1.4)	12 (1.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	14 (1.3)	17 (1.9)	8 (0.9)
Focus on literacy skills (e.g., informational reading or writing strategies)	20 (1.5)	11 (1.4)	6 (0.9)
Engage the class in project-based learning (PBL) activities	8 (2.0)	8 (1.4)	6 (0.7)
Have students practice for standardized tests	5 (0.9)	4 (0.8)	5 (0.8)
Have students read from a textbook, module, or other material in class, either aloud or to themselves	11 (1.4)	8 (1.7)	4 (0.7)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	3 (0.5)	2 (0.5)	4 (0.7)

As can be seen in Table 5.21, three instructional activities occur at least once a week in a large majority of science classes across grade levels: explaining science ideas to the whole class (85–92 percent), engaging the whole class in discussions (78–90 percent), and having students work in small groups (75–87 percent). Over half of elementary and about two-thirds of secondary science classes include hands-on/laboratory activities on a weekly basis. In addition, roughly 30 percent of classes engage students in project-based learning activities weekly.

Elementary and middle school science classes are much more likely than high school classes to include literacy activities at least once a week. For example, students read from a science textbook, module, or other material on a weekly basis in approximately 4 out of 10 elementary and middle grades classes, compared to a quarter of high school classes. Having students write reflections at least once a week is also more common in elementary and middle school classes than high school classes. In addition, 60 percent of elementary classes focus on literacy skills at least once a week, compared to only one-third of high school classes.

Table 5.21
Science Classes in Which Teachers Report Using Various Activities at Least Once a Week, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Explain science ideas to the whole class	85 (1.9)	92 (1.0)	92 (0.9)
Engage the whole class in discussions	90 (1.0)	89 (1.2)	78 (1.3)
Have students work in small groups	75 (1.6)	87 (1.5)	84 (1.5)
Have students do hands-on/laboratory activities	53 (1.9)	63 (2.0)	68 (1.6)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	43 (2.0)	47 (2.1)	28 (1.4)
Focus on literacy skills (e.g., informational reading or writing strategies)	60 (1.6)	46 (2.3)	33 (1.6)
Engage the class in project-based learning (PBL) activities	29 (2.2)	31 (2.3)	28 (1.7)
Have students practice for standardized tests	17 (1.3)	19 (1.7)	20 (1.5)
Have students read from a textbook, module, or other material in class, either aloud or to themselves	37 (1.7)	39 (2.6)	26 (1.7)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	10 (1.1)	10 (1.2)	15 (1.3)

The survey also asked how often students in science classes are engaged in doing science as described in documents like *A Framework for K–12 Science Education*[18]—i.e., the practices of science such as formulating scientific questions, designing and implementing investigations, developing models and explanations, and engaging in argumentation. As can be seen in Table 5.22, students often engage in aspects of science related to conducting investigations and analyzing data. For example, about half of middle and high school classes have students organize and represent data, make and support claims with evidence, conduct scientific investigations, and analyze data at least once a week. At the elementary level, about a third of classes engage students in these activities weekly.

Across all grade bands, students tend to not be engaged very often in aspects of science related to evaluating the strengths/limitations of evidence and the practice of argumentation. For example, fewer than a quarter of secondary science classes have students, at least once a week, pose questions about scientific arguments, evaluate the credibility of scientific information, identify strengths and limitations of a scientific model, evaluate the strengths and weaknesses of competing scientific explanations, determine what details about an investigation might persuade a targeted audience about a scientific claim, or construct a persuasive case. Even fewer elementary classes engage students in these activities weekly, and about a third never do so (see Table 5.23).

[18] National Research Council. 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.

Table 5.22
Science Classes in Which Teachers Report Students Engaging in Various Aspects of Science Practices at Least Once a Week, by Grade Range

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

Table 5.23
Science Classes in Which Teachers Report Students Never Engaging in Various Aspects of Science Practices, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Organize and/or represent data using tables, charts, or graphs in order to facilitate analysis of the data	6 (0.7)	1 (0.3)	1 (0.3)
Make and support claims with evidence	10 (1.1)	1 (0.3)	2 (0.5)
Conduct a scientific investigation	4 (0.6)	2 (0.6)	2 (0.4)
Analyze data using grade-appropriate methods in order to identify patterns, trends, or relationships	12 (1.1)	3 (1.0)	3 (0.6)
Determine what data would need to be collected in order to answer a scientific question	8 (0.9)	2 (0.5)	3 (0.5)
Generate scientific questions	6 (0.8)	2 (0.4)	3 (0.5)
Compare data from multiple trials or across student groups for consistency in order to identify potential sources of error or inconsistencies in the data	22 (1.4)	4 (0.8)	4 (0.6)
Develop scientific models—physical, graphical, or mathematical representations of real-world phenomena	19 (1.1)	3 (0.6)	5 (0.7)
Use multiple sources of evidence to develop an explanation	15 (1.2)	3 (0.6)	5 (0.6)
Develop procedures for a scientific investigation to answer a scientific question	9 (1.0)	3 (0.6)	4 (0.8)
Select and use grade-appropriate mathematical and/or statistical techniques to analyze data	27 (1.5)	12 (1.6)	8 (0.9)
Determine whether or not a question is scientific	20 (1.4)	5 (0.8)	8 (0.7)
Revise their explanations based on additional evidence	17 (1.2)	4 (0.7)	5 (0.8)
Summarize patterns, similarities, and differences in scientific information obtained from multiple sources	24 (1.2)	9 (1.5)	10 (1.1)
Use data and reasoning to defend, verbally or in writing, a claim or refute alternative scientific claims	27 (1.5)	8 (1.6)	9 (0.8)
Consider how missing data or measurement error can affect the interpretation of data	24 (1.5)	4 (1.0)	4 (0.7)
Use mathematical and/or computational models to generate data to support a scientific claim	28 (1.6)	10 (1.5)	9 (1.0)
Pose questions that elicit relevant details about the important aspects of a scientific argument	31 (1.4)	12 (1.5)	13 (1.3)
Evaluate the credibility of scientific information—e.g., its reliability, validity, consistency, logical coherence, lack of bias, or methodological strengths and weaknesses	38 (1.6)	13 (1.5)	11 (0.9)
Identify the strengths and limitations of a scientific model—in terms of accuracy, clarity, generalizability, accessibility to others, strength of evidence supporting it	31 (1.4)	8 (1.3)	6 (0.9)
Evaluate the strengths and weaknesses of competing scientific explanations	33 (1.4)	10 (1.5)	11 (1.2)
Determine what details about an investigation might persuade a targeted audience about a scientific claim	33 (1.7)	15 (1.8)	16 (1.3)
Construct a persuasive case, verbally or in writing, for the best scientific model or explanation for a real-world phenomenon	35 (1.6)	16 (1.7)	17 (1.4)

These items were combined into a composite variable titled Engaging Students in the Practices of Science. The scores on this composite indicate that students are more likely to be engaged in doing science in middle and high school classes than they are in elementary classes (see Table 5.24). In addition, the scores indicate that students engage in this set of practices, on average, just once or twice a month or less.

Table 5.24
Science Class Mean Scores for Engaging Students in the Practices of Science Composite

	MEAN SCORE
Elementary	39 (0.8)
Middle	50 (0.8)
High	50 (0.6)

Table 5.25 displays scores on this composite by the two class-level equity factors. Students in classes of mostly high prior achievers are more likely to be engaged in these practices than classes of average or low prior achievers. In addition, when considering the percentage of students in classes from race/ethnicity groups historically underrepresented in STEM, classes in the highest quartile are more likely to be engaged in these practices than classes in the other three quartiles.

Table 5.25
Equity Analyses of Science Class Mean Scores for Engaging Students in the Practices of Science Composite

	MEAN SCORE
Prior Achievement Level of Class	
Mostly High	51 (1.1)
Average/Mixed	43 (0.5)
Mostly Low	42 (1.5)
Percent of Historically Underrepresented Students in Class	
Lowest Quartile	43 (0.9)
Second Quartile	42 (0.9)
Third Quartile	43 (1.0)
Highest Quartile	47 (1.3)

Given recent trends to incorporate engineering and computer science into science education, the 2018 NSSME+ asked teachers how frequently they do so. As can be seen in Table 5.26, the typical science class experiences engineering a few times per year (48–51 percent of classes depending on grade level). About a third of science classes incorporate engineering at least monthly. In terms of coding, a large majority (71–89 percent) of classes never include coding as part of their science instruction. Interestingly, coding occurs somewhat more often in elementary classes than in middle or high school classes.

Table 5.26
Science Classes in Which Teachers Report Incorporating Engineering and Coding Into Science Instruction, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Engineering			
Never	16 (1.8)	10 (1.8)	20 (1.8)
Rarely (e.g., a few times per year)	48 (2.5)	51 (2.4)	50 (1.9)
Sometimes (e.g., once or twice a month)	26 (2.2)	32 (2.2)	24 (1.5)
Often (e.g., once or twice a week)	8 (2.7)	5 (1.0)	6 (1.1)
All or almost all science lessons	1 (0.5)	1 (0.6)	1 (0.2)
Coding			
Never	71 (3.4)	81 (1.9)	89 (1.2)
Rarely (e.g., a few times per year)	16 (2.0)	14 (1.8)	6 (0.9)
Sometimes (e.g., once or twice a month)	11 (2.8)	3 (0.8)	4 (0.8)
Often (e.g., once or twice a week)	3 (0.7)	1 (0.5)	0 (0.1)
All or almost all science lessons	0 ---†	0 (0.3)	0 (0.0)

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

In addition to asking about class activities in the course as a whole, teachers were asked about activities that took place during their most recent science lesson in the randomly selected class. As can be seen in Table 5.27, small group work and the teacher explaining science ideas to the whole class are the most common activities, occurring in three-quarters or more of classes. Whole class discussions are also relatively common, though more so in elementary classes than middle or high school classes (86, 67, and 59 percent of classes, respectively). Almost half of elementary and middle school classes include students doing hands-on/laboratory activities and students writing about science in the most recent lesson, compared to 4 in 10 or fewer high school classes.

Table 5.27
Science Classes Participating in Various Activities in Most Recent Lesson, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Students working in small groups	78 (1.5)	85 (1.3)	81 (1.4)
Teacher explaining a science idea to the whole class	83 (1.5)	74 (2.2)	81 (1.3)
Whole class discussion	86 (1.2)	67 (2.3)	59 (1.6)
Students completing textbook/worksheet problems	35 (1.8)	39 (2.2)	44 (1.6)
Students doing hands-on/laboratory activities	47 (2.1)	46 (2.0)	40 (1.6)
Students writing about science	45 (2.3)	46 (2.6)	34 (1.8)
Teacher conducting a demonstration while students watched	37 (2.1)	30 (2.1)	31 (1.6)
Students reading about science	45 (2.1)	48 (2.6)	29 (1.6)
Test or quiz	9 (1.1)	14 (1.5)	16 (1.2)
Practicing for standardized tests	2 (0.6)	8 (1.0)	8 (0.9)

The survey also asked teachers to estimate the time spent on each of a number of types of activities in this most recent science lesson. Across the grades, about 40 percent of class time is spent on whole class activities, 30 percent on small group work, and 20 percent on students working individually (see Table 5.28). Non-instructional activities, including attendance taking and interruptions, account for about 10 percent or less of science class time.

Table 5.28
Average Percentage of Time Spent on Different Activities in the Most Recent Science Lesson, by Grade Range

	PERCENT OF CLASS TIME		
	ELEMENTARY	MIDDLE	HIGH
Whole class activities (e.g., lectures, explanations, discussions)	41 (0.9)	32 (0.8)	38 (0.8)
Small group work	33 (1.0)	35 (1.1)	34 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	18 (0.8)	22 (0.8)	19 (0.8)
Non-instructional activities (e.g., attendance taking, interruptions)	8 (0.4)	12 (0.3)	10 (0.2)

Mathematics Instruction

Table 5.29 shows the percentage of K–12 mathematics classes in which teachers use various activities in all or almost all mathematics lessons. The teacher explaining mathematical ideas is very common across all grade levels, occurring in all or almost all lessons in 59–73 percent of mathematics classes. As is the case in science, the use of whole class discussion is more common in elementary classes, taking place in nearly all lessons in 71 percent of classes, compared to 54 percent and 50 percent of middle and high school classes, respectively. Another striking difference between the grade ranges is manipulative use in problem-solving/ investigations, with 35 percent of elementary classes providing manipulatives to students in all or almost all lessons, compared to about 5 percent of secondary classes.

Table 5.29
Mathematics Classes in Which Teachers Report Using Various Activities in All or Almost All Lessons, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Explain mathematical ideas to the whole class	73 (2.0)	59 (2.2)	65 (1.7)
Engage the whole class in discussions	71 (1.5)	54 (2.0)	50 (1.7)
Have students work in small groups	51 (2.4)	35 (2.1)	30 (1.7)
Have students practice for standardized tests	8 (0.8)	7 (1.0)	8 (0.8)
Have students read from a textbook or other material in class, either aloud or to themselves	12 (1.1)	7 (1.2)	6 (1.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	13 (1.2)	8 (1.1)	5 (0.9)
Provide manipulatives for students to use in problem-solving/investigations	35 (2.0)	6 (0.9)	4 (0.8)
Focus on literacy skills (e.g., informational reading or writing strategies)	16 (1.5)	4 (0.7)	4 (0.8)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	6 (1.2)	2 (0.5)	4 (1.1)

The percentage of mathematics classes including these same activities at least once a week is displayed in Table 5.30. Not unexpectedly, nearly all classes at each grade level include the teacher explaining mathematical ideas and leading whole class discussions on a weekly basis. Having students work in small groups is also a fairly common weekly occurrence across grade ranges, though its frequency decreases from 88 percent in elementary classes to 71 percent in high school classes. Elementary classes are also much more likely than secondary classes to provide manipulatives for students to use, have students write their reflections, and focus on literacy skills.

Table 5.30
Mathematics Classes in Which Teachers Report Using Various Activities at Least Once a Week, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Explain mathematical ideas to the whole class	95 (0.9)	95 (1.0)	95 (0.7)
Engage the whole class in discussions	95 (0.8)	91 (1.1)	84 (1.2)
Have students work in small groups	88 (1.2)	77 (2.2)	71 (1.7)
Have students practice for standardized tests	26 (1.7)	32 (2.1)	29 (1.5)
Have students read from a textbook or other material in class, either aloud or to themselves	28 (1.7)	24 (2.1)	16 (1.5)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	41 (1.8)	30 (1.8)	19 (1.4)
Provide manipulatives for students to use in problem-solving/investigations	78 (1.4)	29 (2.1)	20 (1.3)
Focus on literacy skills (e.g., informational reading or writing strategies)	41 (2.0)	20 (1.6)	17 (1.2)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	13 (1.6)	10 (1.2)	11 (1.2)

Teachers were also asked how often they engage students in the practices of mathematics described in the *Common Core State Standards—Mathematics*[19] such as making sense of problems, constructing arguments, critiquing the reasoning of others, and modeling with mathematics. Table 5.31 represents the percentage of K–12 mathematics classes that engage students in various aspects of these practices in all or almost all lessons. Across all grade levels, students are unlikely to be engaged in aspects of these practices on a daily basis. For example, in only 39–46 percent of classes, depending on grade level, are students asked to determine whether their answer makes sense in all or almost all lessons. Similarly, only 36–44 percent of classes have students provide mathematical reasoning this regularly. A quarter or fewer of classes have students work on challenging problems, analyze the mathematical reasoning of others, and compare and contrast different solution strategies in all or almost all lessons.

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

Table 5.31
Mathematics Classes in Which Teachers Report Students Engaging in Various Aspects of Mathematical Practices in All or Almost All Lessons, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Determine whether their answer makes sense	46 (2.0)	44 (2.0)	39 (1.3)
Provide mathematical reasoning to explain, justify, or prove their thinking	44 (1.8)	39 (2.3)	36 (1.6)
Represent aspects of a problem using mathematical symbols, pictures, diagrams, tables, or objects in order to solve it	49 (1.8)	33 (1.9)	33 (1.6)
Continue working through a mathematics problem when they reach points of difficulty, challenge, or error	39 (2.2)	32 (1.9)	32 (1.8)
Identify relevant information and relationships that could be used to solve a mathematics problem	30 (1.5)	32 (2.0)	31 (1.7)
Identify patterns or characteristics of numbers, diagrams, or graphs that may be helpful in solving a mathematics problem	33 (1.9)	31 (1.9)	27 (1.5)
Pose questions to clarify, challenge, or improve the mathematical reasoning of others	29 (1.9)	30 (2.0)	27 (1.3)
Determine what units are appropriate for expressing numerical answers, data, and/or measurements	33 (1.9)	29 (1.9)	26 (1.3)
Determine what tools are appropriate for solving a mathematics problem	34 (1.6)	26 (1.7)	26 (1.5)
Work on challenging problems that require thinking beyond just applying rules, algorithms, or procedures	25 (1.5)	22 (1.7)	24 (1.7)
Develop a mathematical model to solve a mathematics problem	36 (1.7)	26 (1.7)	23 (1.5)
Discuss how certain terms or phrases may have specific meanings in mathematics that are different from their meaning in everyday language	22 (1.5)	24 (1.6)	22 (1.3)
Figure out what a challenging problem is asking	32 (1.8)	22 (1.5)	21 (1.6)
Reflect on their solution strategies as they work through a mathematics problem and revise as needed	31 (2.1)	22 (1.6)	20 (1.2)
Work on generating a rule or formula	20 (1.3)	22 (1.9)	20 (1.4)
Analyze the mathematical reasoning of others	23 (1.7)	21 (1.8)	15 (1.1)
Compare and contrast different solution strategies for a mathematics problem in terms of their strengths and limitations	21 (1.6)	15 (1.4)	15 (1.2)

Although students tend not to be engaged in these activities daily, they are relatively likely to engage with them at least once a week (see Table 5.32). For example, in three-quarters or more of classes across the grade bands, students are asked to determine whether their answer makes sense; provide mathematics reasoning to explain, justify, or prove their thinking; develop representations of aspects of problems; and continue working through mathematics problems when they reach points of difficulty, challenge, or error. In addition, given the emphasis in recent years on the importance of students critiquing different approaches to solving mathematics problems, it is somewhat surprising that only two-thirds or fewer classes have students analyze the mathematical thinking of others or compare and contrast different solution strategies on a weekly basis.

Table 5.32
Mathematics Classes in Which Teachers Report Students Engaging in Various Aspects of Mathematical Practices at Least Once a Week, by Grade Range

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

Table 5.33 shows the means for the Engaging Students in the Practices of Mathematics composite by grade band, and Table 5.34 shows scores by the prior achievement level of students and percentage of students in the class from race/ethnicity groups historically underrepresented in STEM. Overall, scores are similar across grade bands, though a little higher for elementary classes than high school classes. Scores are also slightly higher for classes composed of mostly high prior achievers than for classes of mostly low prior achievers.

Table 5.33
Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite

	MEAN SCORE
Elementary	74 (0.7)
Middle	73 (0.6)
High	71 (0.5)

Table 5.34
Equity Analyses of Mathematics Class Mean Scores for Engaging Students in Practices of Mathematics Composite

	MEAN SCORE
Prior Achievement Level of Class	
Mostly High	75 (0.8)
Average/Mixed	73 (0.5)
Mostly Low	72 (0.9)
Percent of Historically Underrepresented Students in Class	
Lowest Quartile	73 (0.5)
Second Quartile	72 (0.9)
Third Quartile	73 (0.8)
Highest Quartile	74 (0.9)

Similar to science, very few mathematics classes incorporate coding into instruction (see Table 5.35). The practice is somewhat more common in the elementary grades than secondary grades, but even at the elementary level tends to be done only a few times a year if at all.

Table 5.35
Mathematics Classes in Which Teachers Report Incorporating Coding Into Mathematics Instruction, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Never	74 (2.0)	86 (2.1)	89 (1.0)
Rarely (e.g., a few times per year)	15 (1.7)	11 (1.6)	9 (0.9)
Sometimes (e.g., once or twice a month)	7 (1.1)	3 (1.3)	2 (0.4)
Often (e.g., once or twice a week)	3 (0.8)	0 (0.3)	1 (0.2)
All or almost all mathematics lessons	0 (0.3)	0 (0.1)	0 (0.1)

Table 5.36 presents the percentage of most recent lessons in K–12 mathematics classes that include various activities. With only a few exceptions, the frequency of activities in each grade range is fairly similar. For example, most elementary, middle, and high school lessons include the explanation of mathematical ideas (88–91 percent) and students working in small groups (78–87 percent). Having students complete textbook/worksheet problems is also prevalent, occurring in roughly 3 out of 4 K–12 mathematics lessons. Lessons vary across the grade ranges in the use of hands-on/manipulatives and whole class discussion. At the elementary level, 65 percent of lessons include students doing hands-on/manipulative activities compared to only 24 and 17 percent of middle and high school mathematics lessons, respectively. In addition, 87 percent of elementary lessons include whole class discussion compared to 78 and 70 percent of middle and high school mathematics lessons.

Table 5.36
Mathematics Classes Participating in Various Activities in Most Recent Lesson, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Teacher explaining a mathematical idea to the whole class	89 (1.3)	88 (1.6)	91 (1.0)
Students working in small groups	87 (1.4)	83 (1.7)	78 (1.2)
Students completing textbook/worksheet problems	77 (1.6)	76 (1.7)	78 (1.4)
Whole class discussion	87 (1.5)	78 (1.5)	70 (1.4)
Teacher conducting a demonstration while students watched	78 (1.9)	65 (2.1)	64 (1.3)
Test or quiz	18 (1.8)	15 (1.5)	19 (1.2)
Students doing hands-on/manipulative activities	65 (2.1)	24 (1.8)	17 (1.5)
Practicing for standardized tests	13 (1.7)	17 (1.5)	15 (1.0)
Students reading about mathematics	17 (1.4)	15 (1.5)	15 (1.3)
Students writing about mathematics	27 (1.6)	19 (1.6)	14 (1.1)

The proportion of time spent on various instructional arrangements in mathematics lessons is relatively similar across the grade levels (see Table 5.37), though there is some variation. On average, more time is spent in whole class activities in high school mathematics classes than in elementary classes, ranging from 35–42 percent of class time. In contrast, the time spent in small group work decreases with increasing grade range, from 33 percent of time in elementary classes to 26 percent of time in high school mathematics classes.

Table 5.37
Average Percentage of Time Spent on Different Activities in the Most Recent Mathematics Lesson, by Grade Range

	AVERAGE PERCENT OF CLASS TIME		
	ELEMENTARY	MIDDLE	HIGH
Whole class activities (e.g., lectures, explanations, discussions)	35 (0.7)	39 (0.8)	42 (0.7)
Small group work	33 (0.8)	28 (1.0)	26 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	24 (0.6)	22 (0.7)	22 (0.7)
Non-instructional activities (e.g., attendance taking, interruptions)	8 (0.3)	11 (0.3)	10 (0.2)

Computer Science Instruction

Table 5.38 shows the percentage of high school computer science classes in which teachers use various activities in all or almost all lessons. Having students work on programming activities using a computer is by far the most common mode of instruction in high school computer science classes (69 percent). Students working in small groups, the teacher explaining ideas to the class, and whole class discussions occur daily in about a quarter to a third of high school computer science classes.

Table 5.38
High School Computer Science Classes in Which Teachers Report Using Various Activities in All or Almost All Lessons

	PERCENT OF CLASSES
Have students work on programming activities using a computer	69 (3.7)
Have students work in small groups	30 (2.8)
Engage the whole class in discussions	27 (3.4)
Explain computer science ideas to the whole class	27 (3.4)
Have students explain and justify their method for solving a problem	19 (4.2)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	13 (3.4)
Have students compare and contrast different methods for solving a problem	8 (2.4)
Have students do hands-on/manipulative programming activities that do not require a computer	8 (2.3)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	8 (2.4)
Have students present their solution strategies to the rest of the class	6 (2.2)
Have students read from a textbook/online course in class, either aloud or to themselves	6 (2.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	4 (2.0)

On a weekly basis, the same activities are the most common (see Table 5.39). For example, 97 percent of classes have students work on programming activities using a computer, 84 percent include lecture, 71 percent whole class discussions, and 66 percent small group work at least once a week. Although it does not occur daily in many classes, having students explain and justify their method for solving a problem occurs weekly in nearly two-thirds of high school computer science classes.

Table 5.39
High School Computer Science Classes in Which Teachers Report Using Various Activities at Least Once a Week

	PERCENT OF CLASSES
Have students work on programming activities using a computer	97 (1.4)
Have students work in small groups	66 (3.6)
Engage the whole class in discussions	71 (3.3)
Explain computer science ideas to the whole class	84 (2.9)
Have students explain and justify their method for solving a problem	63 (3.4)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	32 (4.4)
Have students compare and contrast different methods for solving a problem	41 (3.8)
Have students do hands-on/manipulative programming activities that do not require a computer	21 (3.6)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	24 (3.2)
Have students present their solution strategies to the rest of the class	35 (4.0)
Have students read from a textbook/online course in class, either aloud or to themselves	31 (4.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	21 (3.3)

Teachers were asked how often they engage students in the practices of computer science described in the Computer Science Teachers Association's K–12 Computer Science Standards.[20]

[20] Computer Science Teachers Association (2017). CSTA K–12 Computer Science Standards. Retrieved from http://www.csteachers.org/standards.

These practices include developing and using abstractions, recognizing and defining computational problems, testing and refining computational artifacts, communicating about computing, and fostering an inclusive computing culture. As can be seen in Table 5.40, activities related to testing and refining computational artifacts occur most frequently. For example, creating computational artifacts, writing comments within code, considering how to break a program into modules/procedures/objects, and adapting existing code to a new problem occur weekly in 60 percent or more of classes. Aspects of computer science related to end users are less often emphasized. For example, only 30 percent of classes have students create instructions for an end-user explaining a computational artifact on a weekly basis. Similarly, fewer than a quarter of high school computer science classes have students create a computational artifact to be used by someone else or get input on computational products from people with different perspectives at least once a week.

Table 5.40
High School Computer Science Classes in Which Teachers Report Students Engaging in Various Aspects of Computer Science Practices at Least Once a Week

	PERCENT OF CLASSES
Create computational artifacts (e.g., programs, simulations, visualizations, digital animations, robotic systems, or apps)	75 (2.8)
Write comments within code to document purposes or features	72 (2.8)
Consider how a program they are creating can be separated into modules/procedures/objects	62 (3.1)
Identify and adapt existing code to solve a new computational problem	60 (3.6)
Provide feedback on other students' computational products or designs	47 (4.1)
Systematically use test cases to verify program performance and/or identify problems	46 (4.2)
Identify real-world problems that might be solved computationally	45 (4.3)
Use computational methods to simulate events or processes (e.g., rolling dice, supply and demand)	45 (3.6)
Explain computational solution strategies verbally or in writing	42 (3.6)
Create instructions for an end-user explaining how to use a computational artifact	30 (3.6)
Compare and contrast the strengths and limitations of different representations such as flow charts, tables, code, or pictures	22 (3.3)
Create a computational artifact designed to be used by someone outside the class or other students	22 (3.6)
Get input on computational products or designs from people with different perspectives	21 (3.2)
Analyze datasets using a computer to detect patterns	20 (3.3)

Table 5.41 shows the percentage of classes that never have students engage in these practices. A quarter of classes never have students analyze datasets to detect patterns, and about a fifth never have students compare and contrast the strengths and limitations of different representations. Roughly 1 in 6 classes never have students consider end-users or get input from other people.

Table 5.41
High School Computer Science Classes in Which Teachers Report Students Never Engaging in Various Aspects of Computer Science Practices

	PERCENT OF CLASSES
Create computational artifacts (e.g., programs, simulations, visualizations, digital animations, robotic systems, or apps)	3 (1.0)
Write comments within code to document purposes or features	0 (0.2)
Consider how a program they are creating can be separated into modules/procedures/objects	2 (0.9)
Identify and adapt existing code to solve a new computational problem	2 (0.9)
Provide feedback on other students' computational products or designs	3 (1.6)
Systematically use test cases to verify program performance and/or identify problems	11 (2.7)
Identify real-world problems that might be solved computationally	1 (0.6)
Use computational methods to simulate events or processes (e.g., rolling dice, supply and demand)	7 (2.0)
Explain computational solution strategies verbally or in writing	4 (1.1)
Create instructions for an end-user explaining how to use a computational artifact	17 (3.2)
Compare and contrast the strengths and limitations of different representations such as flow charts, tables, code, or pictures	19 (2.8)
Create a computational artifact designed to be used by someone outside the class or other students	14 (2.7)
Get input on computational products or designs from people with different perspectives	16 (3.1)
Analyze datasets using a computer to detect patterns	25 (3.7)

These items were combined into a composite variable; mean scores on this composite, overall and by equity factors, are shown in Table 5.42. The overall score of 56 indicates that, on average, students are engaged in this set of activities once or twice a month. There are no statistically significant differences by subgroups.

Table 5.42
Equity Analyses of High School Computer Science Class Mean Scores for Engaging Students in Practices of Computer Science Composite

	MEAN SCORE
Overall	56 (1.3)
Prior Achievement Level of Class	
Mostly High	55 (1.7)
Average/Mixed	56 (1.7)
Percent of Historically Underrepresented Students in Class	
Lowest Quartile	53 (2.0)
Second Quartile	54 (4.1)
Third Quartile	57 (3.0)
Highest Quartile	59 (2.9)
Percent of Students in School Eligible for FRL	
Lowest Quartile	54 (1.9)
Second Quartile	57 (2.4)
Third Quartile	54 (3.4)
Highest Quartile	60 (4.1)

High school computer science teachers were also asked which activities took place in their most recent lesson. As can be seen in Table 5.43, 84 percent of lessons include students working on programming tasks using a computer, and 70 percent include the teacher explaining ideas to the whole class. About half include small group work, whole class discussion, or students watching a demonstration.

Table 5.43
High School Computer Science Classes Participating in Various Activities in Most Recent Lesson

	PERCENT OF CLASSES
Students working on programming tasks using a computer	84 (2.8)
Teacher explaining a computer science idea to the whole class	70 (3.7)
Students working in small groups	57 (4.2)
Whole class discussion	49 (4.1)
Teacher conducting a demonstration while students watched	46 (3.6)
Students reading about computer science	20 (2.8)
Students doing hands-on/manipulative programming activities not using a computer	19 (2.9)
Students completing textbook/worksheet problems	16 (3.0)
Students writing about computer science	13 (3.0)
Test or quiz	9 (1.6)

On average, 40 percent of time in high school computer science classes is spent with students working individually (see Table 5.44). Whole class activities and small group work take up 29 and 22 percent of class time, respectively.

Table 5.44
Average Percentage of Time Spent on Different Activities in the Most Recent High School Computer Science Lesson

	AVERAGE PERCENT OF CLASS TIME
Students working individually (e.g., reading textbooks, programming, taking a test or quiz)	40 (2.1)
Whole class activities (e.g., lectures, explanations, discussions)	29 (2.3)
Small group work	22 (2.1)
Non-instructional activities (e.g., attendance taking, interruptions)	9 (0.5)

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. Across the grade levels, students in mathematics classes are assigned more homework than students in science classes, particularly when looking at the percentage of classes assigned 31 minutes or more per week (see Table 5.45). This pattern is particularly evident in elementary classes, where students in 31 percent of classes are given 31–60 minutes of mathematics homework a week; only 8 percent of elementary classes are assigned this much science homework. Not surprisingly, the amount of time students are asked to spend on science and mathematics homework increases with grade range. For example, over half of high school mathematics classes are assigned one or more hours of homework per week, compared to under one-fifth of elementary classes. Homework expectations in high school computer science classes are similar to those in high school science classes.

Table 5.45
Amount of Homework Assigned in Classes Per Week, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Science			
None	57 (2.8)	8 (1.8)	3 (0.5)
1–15 minutes per week	21 (2.2)	15 (1.9)	9 (1.3)
16–30 minutes per week	12 (1.4)	33 (2.8)	19 (1.3)
31–60 minutes per week	8 (2.6)	31 (2.7)	33 (1.6)
61–90 minutes per week	2 (1.1)	8 (1.4)	22 (1.9)
91–120 minutes per week	0 (0.1)	3 (1.0)	7 (0.9)
More than 2 hours per week	0 ---†	2 (1.2)	7 (0.9)
Mathematics			
None	9 (1.5)	5 (1.5)	4 (0.7)
1–15 minutes per week	17 (1.7)	7 (1.3)	4 (0.7)
16–30 minutes per week	25 (1.9)	16 (2.1)	12 (1.6)
31–60 minutes per week	31 (2.3)	34 (2.4)	29 (1.7)
61–90 minutes per week	11 (1.5)	21 (2.2)	26 (1.6)
91–120 minutes per week	6 (1.0)	13 (2.0)	14 (1.3)
More than 2 hours per week	1 (0.4)	4 (1.3)	12 (1.5)
Computer Science			
None	n/a	n/a	16 (2.6)
1–15 minutes per week	n/a	n/a	13 (2.9)
16–30 minutes per week	n/a	n/a	22 (4.4)
31–60 minutes per week	n/a	n/a	29 (3.9)
61–90 minutes per week	n/a	n/a	12 (2.5)
91–120 minutes per week	n/a	n/a	4 (1.0)
More than 2 hours per week	n/a	n/a	4 (1.2)

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

In science and mathematics, the survey asked how often students in the randomly selected class are required to take assessments the teachers did not develop, such as state or district benchmark assessments. Given that mathematics tends to be included in the high stakes accountability systems of states at more grades than science, it is not surprising that the frequency of external testing is greater in mathematics classes than in science classes, particularly at the elementary and middle grades levels (see Table 5.46). At the elementary level, 62 percent of classes never administer external science assessments; only 9 percent never administer external mathematics assessments.

Table 5.46
Frequency of Required External Testing in Classes, by Grade Range

	PERCENT OF CLASSES		
	ELEMENTARY	MIDDLE	HIGH
Science			
Never	62 (2.4)	17 (1.8)	31 (2.0)
Once a year	17 (2.6)	33 (2.7)	33 (2.0)
Twice a year	4 (0.8)	11 (1.8)	14 (1.7)
Three or four times a year	11 (1.5)	28 (2.8)	16 (1.5)
Five or more times a year	6 (1.1)	11 (1.9)	6 (0.9)
Mathematics			
Never	9 (1.3)	1 (0.4)	20 (1.6)
Once a year	9 (1.3)	12 (2.1)	25 (1.9)
Twice a year	9 (1.4)	11 (1.6)	22 (1.8)
Three or four times a year	48 (2.8)	43 (2.7)	24 (1.7)
Five or more times a year	25 (2.2)	33 (2.7)	10 (1.3)

The prior achievement level of the class, percentage of students in the class from race/ethnicity groups historically underrepresented in STEM, percentage of students in the school eligible for free/reduced-price lunch, and school size are all related to the frequency with which classes are required to take external assessments. As can be seen in Table 5.47, classes with mostly low-achieving students are more likely than classes with mostly high prior achievers to take external mathematics assessments two or more times per year. Similarly, in both science and mathematics, the greater the percentage of students from race/ethnicity groups historically underrepresented in STEM in the class and the greater the percentage of students eligible for free/reduced-price lunch in the school, the more likely students are to be tested this frequently.

Table 5.47
Equity Analyses of Classes Required to Take External Assessments Two or More Times Per Year, by Subject

	PERCENT OF CLASSES	
	SCIENCE	MATHEMATICS
Prior Achievement Level of Class		
Mostly High	35 (3.2)	66 (2.4)
Average/Mixed	29 (1.5)	78 (1.6)
Mostly Low	39 (4.2)	78 (2.7)
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	21 (2.1)	70 (2.2)
Second Quartile	28 (2.6)	73 (2.2)
Third Quartile	36 (3.1)	78 (2.3)
Highest Quartile	38 (4.0)	81 (2.7)
Percent of Students in School Eligible for FRL		
Lowest Quartile	20 (2.3)	68 (2.7)
Second Quartile	32 (3.2)	77 (2.2)
Third Quartile	36 (3.6)	83 (2.2)
Highest Quartile	36 (3.1)	77 (2.8)
School Size		
Smallest Schools	24 (4.4)	69 (4.5)
Second Group	22 (2.8)	73 (2.7)
Third Group	29 (2.9)	79 (2.3)
Largest Schools	37 (2.2)	77 (1.8)

Summary

Data from 2018 NSSME+ indicate that science, mathematics, and computer science teachers perceive more control over decisions related to pedagogy than curriculum. Perceived autonomy over curriculum and pedagogy tends to increase with grade range in both science and mathematics classes, with teachers of elementary classes having less control over what and how they teach than teachers of high school classes.

Teachers of classes at all grade levels, and in all three subjects, are somewhat likely to emphasize reform-oriented instructional objectives, such as developing understanding of science concepts/ mathematics ideas/computer science ideas, and learning how to do science/mathematics/ computer science. However, mathematics and computer science classes are more likely than science classes to emphasize these objectives. There are also some important differences among grade levels. For example, elementary mathematics classes are more likely than middle and high school classes to focus heavily on increasing students' interest in mathematics and learning to perform computations with speed and accuracy.

In terms of instructional activities, teacher explanation of science ideas, whole group discussion, and small group work are very common across the grade levels. Students are engaged in various aspects of science practices (e.g., formulating scientific questions, designing and implementing investigations, engaging in argumentation), on average, once or twice a month or less. Further, students in elementary science classes are less likely than middle and high school students to be engaged in these practices. Across grade levels, there is little incorporation of engineering and almost no coding in science instruction.

Explanation of ideas, whole group discussion, and small group work are also very prominent in mathematics instruction. Students across grade ranges are likely to be engaged in the practices of mathematics at least once per week, with smaller percentages experiencing these practices in all or almost all lessons. Similar to science, very few mathematics classes incorporate coding.

In high school computer science instruction, having students work on programming activities using a computer is by far the most common mode of instruction. Similar to science and mathematics, teacher explanation of ideas, whole group discussion, and small group work are also frequently utilized. Students are engaged in various aspects of computer science practices, on average, once or twice a month. Activities related to testing and refining computational artifacts occur most frequently, including creating computational artifacts, writing comments within code, considering how to break a problem into modules/procedures/objects, and adapting existing code to a new problem.

Across grade levels, students in mathematics classes are assigned more homework than students in science classes. Further, the amount of time students are asked to spend on science and mathematics homework increases with grade range, with homework expectations in high school computer science classes similar to those in high school science classes. Not surprisingly, external testing occurs more frequently in mathematics classes than in science classes. However, in both subjects, the frequency of external testing varies by grade range.

Equity factors, in particular prior achievement level of the class, are related to instruction in science and mathematics. For example, teachers of science classes composed of mostly low prior achievers report having less control over both curriculum and pedagogy than teachers of classes containing mostly high prior achievers. In addition, in both science and mathematics, classes with mostly high-achieving students are more likely to stress reform-oriented objectives than classes consisting of mostly low-achieving students. Classes of mostly low prior-achieving students also are required to take external assessments more frequently than classes of mostly high prior-achieving students. In high school computer science, the percentage of students in the class from race/ethnicity groups historically underrepresented in STEM is often positively correlated with aspects of instruction considered to be high quality, though even the most diverse computer science classes tend to have relatively few students from these groups.