CHAPTER 3

Science, Mathematics, and Computer Science Professional Development

Overview

Science, mathematics, and computer science teachers, like all professionals, need opportunities to keep up with advances in their field, including both disciplinary content and how to help their students learn important science/mathematics/computer science content. Staying up-to-date is particularly challenging for science and mathematics teachers at the elementary level, since they typically teach multiple subjects. The 2018 NSSME+ collected data on teachers' participation in in-service education and other professional activities, as well as data on study groups, one-on-one coaching, and teacher induction programs provided by schools and districts. These data are discussed in this chapter.

Teacher Professional Development

One important measure of teachers' continuing education is how long it has been since they participated in professional development. As can be seen in Table 3.1, with the exception of elementary science teachers, roughly 80 percent or more of science, mathematics, and computer science teachers have participated in discipline-focused professional development (i.e., focused on science, mathematics, computer science content or the teaching of science, mathematics, computer science) within the last three years. Elementary science teachers stand out for the relative paucity of professional development in science or science teaching, with fewer than about 60 percent having participated in the last three years.

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

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science			
In the last 12 months	36 (2.2)	57 (2.5)	59 (1.8)
1–3 years ago	22 (1.7)	21 (2.2)	24 (1.5)
4–6 years ago	8 (1.2)	6 (1.4)	5 (0.8)
7–10 years ago	5 (0.7)	2 (0.8)	2 (0.4)
More than 10 years ago	6 (1.0)	3 (0.8)	2 (0.6)
Never	24 (1.5)	11 (1.6)	7 (0.9)
Mathematics			
In the last 12 months	59 (2.1)	71 (2.5)	68 (1.7)
1–3 years ago	24 (2.0)	19 (2.0)	21 (1.8)
4–6 years ago	7 (1.1)	5 (1.1)	5 (0.9)
7–10 years ago	1 (0.4)	2 (0.6)	1 (0.3)
More than 10 years ago	2 (0.5)	1 (0.3)	2 (0.7)
Never	5 (1.0)	4 (0.8)	3 (0.5)
Computer Science			
In the last 12 months	n/a	n/a	64 (3.8)
1–3 years ago	n/a	n/a	18 (2.7)
4–6 years ago	n/a	n/a	4 (1.2)
7–10 years ago	n/a	n/a	2 (1.4)
More than 10 years ago	n/a	n/a	1 (0.6)
Never	n/a	n/a	11 (2.7)

Although some involvement in professional development may be better than none, a brief exposure of a few hours over several years is not likely to be sufficient to enhance teachers' knowledge and skills in meaningful ways. Accordingly, teachers across all subject areas were asked about the total amount of time they have spent on discipline-focused professional development in the last three years. As can be seen in Table 3.2, about a quarter of middle school and about a third of high school science teachers have participated in 36 hours or more of science professional development in the last three years; very few elementary teachers have had this amount of professional development in science. A similar pattern exists in mathematics, with about 2 in 5 secondary teachers having participated in at least 36 hours of mathematics-focused professional development in the last three years compared to fewer than 1 in 6 elementary teachers. In contrast, over half of high school computer science teachers have participated in this amount of professional development related to computer science or computer science teaching. This finding most likely reflects the recent national emphasis on computer science in STEM education and the push to develop students' computational thinking skills.

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

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science			
None	43 (2.2)	22 (2.2)	18 (1.3)
Less than 6 hours	20 (1.6)	8 (1.1)	8 (1.3)
6–15 hours	20 (1.5)	23 (2.4)	18 (1.6)
16–35 hours	12 (1.3)	21 (1.6)	22 (1.3)
36–80 hours	3 (0.7)	16 (1.5)	21 (1.4)
More than 80 hours	1 (0.4)	10 (1.2)	14 (1.0)
Mathematics			
None	16 (1.6)	11 (1.7)	11 (1.2)
Less than 6 hours	17 (1.4)	8 (1.6)	7 (0.9)
6–15 hours	31 (1.6)	20 (2.2)	19 (1.5)
16–35 hours	22 (1.6)	24 (1.7)	22 (1.2)
36–80 hours	10 (1.1)	22 (1.9)	24 (1.5)
More than 80 hours	4 (0.6)	15 (1.2)	16 (1.3)
Computer Science			
None	n/a	n/a	18 (2.9)
Less than 6 hours	n/a	n/a	3 (1.1)
6–15 hours	n/a	n/a	8 (2.0)
16–35 hours	n/a	n/a	17 (2.3)
36–80 hours	n/a	n/a	24 (3.2)
More than 80 hours	n/a	n/a	30 (3.0)

The data were also analyzed by a number of class and school equity factors. Table 3.3 suggests some interesting differences in the extent to which science and mathematics classes with different demographic characteristics have access to teachers who have had a substantial amount of professional development. In science, classes composed of mostly low prior achievers and classes with the highest proportion of students from race/ethnicity groups historically underrepresented in STEM are significantly less likely than classes of high prior achievers and few students from these race/ethnicity groups to be taught by teachers who have participated in more than 35 hours of professional development in the last three years. A similar disparity exists by school size. Only about half as many science classes in the smallest schools compared to classes in the largest schools have access to teachers who have participated in a substantial amount of professional development. In contrast, mathematics classes with the highest proportion of students from race/ethnicity groups historically underrepresented in STEM are more likely than their counterparts to be taught by teachers who have participated in more than 35 hours of professional development in the last three years.

Table 3.3
Equity Analyses of Classes Taught by Teachers With More Than 35 Hours of Professional Development in the Last Three Years, by Subject

	PERCENT OF CLASSES	
	SCIENCE	MATHEMATICS
Prior Achievement Level of Class		
Mostly High	36 (2.6)	36 (2.6)
Average/Mixed	15 (0.8)	24 (1.1)
Mostly Low	15 (2.1)	34 (2.5)
Percent of Historically Underrepresented Students in Class		
Lowest Quartile	20 (1.5)	25 (1.9)
Second Quartile	18 (1.7)	26 (2.0)
Third Quartile	19 (1.6)	25 (1.8)
Highest Quartile	15 (1.7)	33 (2.3)
Percent of Students in School Eligible for FRL		
Lowest Quartile	20 (1.6)	26 (2.1)
Second Quartile	20 (2.1)	29 (2.3)
Third Quartile	16 (1.7)	25 (2.1)
Highest Quartile	18 (1.8)	32 (2.2)
School Size		
Smallest Schools	9 (1.4)	26 (2.9)
Second Group	17 (2.2)	27 (2.8)
Third Group	18 (1.4)	29 (2.0)
Largest Schools	21 (1.6)	29 (1.7)

Teachers who had recently participated in professional development were asked about the nature of those activities. Data for science, mathematics, and computer science teachers are shown in Table 3.4. For each subject/grade-range combination, workshops are the most prevalent activity, with roughly 90 percent of teachers indicating they have attended a program/workshop related to their discipline. Participation in professional learning communities is the next most prevalent activity, especially for secondary teachers (ranging from 55–68 percent of teachers). Across grade ranges, mathematics teachers are more likely to have received assistance or feedback from a formally designated coach/mentor than their science and computer science colleagues. Also, computer science teachers are far more likely than high school science and mathematics teachers to have completed an online course/webinar.

Table 3.4
Teachers Participating in Various Professional Development Activities in Last Three Years, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Science			
Attended a professional development program/workshop	89 (2.0)	94 (1.2)	91 (1.5)
Participated in a professional learning community/lesson study/ teacher study group	42 (2.9)	61 (3.1)	55 (1.7)
Attended a national, state, or regional science teacher association meeting	12 (1.8)	37 (3.2)	40 (2.0)
Received assistance or feedback from a formally designated coach/mentor	28 (2.6)	33 (3.4)	35 (2.1)
Completed an online course/webinar	9 (1.5)	29 (3.0)	34 (2.2)
Took a formal course for college credit	5 (1.3)	9 (1.5)	16 (1.4)
Mathematics			
Attended a professional development program/workshop	94 (1.1)	93 (1.4)	91 (1.4)
Participated in a professional learning community/lesson study/ teacher study group	53 (2.6)	68 (3.1)	64 (2.1)
Attended a national, state, or regional mathematics teacher association meeting	13 (1.7)	26 (2.4)	34 (2.4)
Received assistance or feedback from a formally designated coach/mentor	47 (2.4)	56 (3.2)	44 (2.4)
Completed an online course/webinar	19 (1.5)	35 (2.9)	32 (2.0)
Took a formal course for college credit	5 (1.1)	15 (2.1)	19 (1.7)
Computer Science			
Attended a professional development program/workshop	n/a	n/a	88 (2.4)
Participated in a professional learning community/lesson study/ teacher study group	n/a	n/a	62 (3.8)
Attended a national, state, or regional computer science teacher association meeting	n/a	n/a	35 (3.9)
Received assistance or feedback from a formally designated coach/mentor	n/a	n/a	29 (3.7)
Completed an online course/webinar	n/a	n/a	59 (4.7)
Took a formal course for college credit	n/a	n/a	20 (3.1)

It is widely agreed upon that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include engaging teachers in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; to examine student work and other classroom artifacts for evidence of what students do and do not understand; and to apply what they have learned in their classrooms and subsequently discuss how it went.[14]

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

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

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

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 3.5, 47–62 percent of science teachers, depending on grade range, have worked closely during the professional development with other science colleagues from their school or science teachers in their grade level and/or subject, whether or not they were from the same school. Other relatively common characteristics of their professional development are having opportunities to experience lessons as students would from the textbook/modules used in the classroom (43–45 percent) and engaging in science investigations/engineering design challenges (38–45 percent). Only about a quarter to a third of teachers, depending on grade range, have had substantial opportunities to rehearse instructional practices during professional development.

Table 3.5
Science Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,† by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Worked closely with other teachers from their school	57 (3.3)	62 (3.5)	55 (2.3)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	47 (3.2)	53 (3.0)	54 (2.1)
Had opportunities to engage in science investigations/engineering design challenges	38 (3.0)	46 (3.5)	45 (2.4)
Had opportunities to experience lessons, as their students would, from the textbook/modules they use in their classroom	43 (3.1)	40 (3.0)	45 (2.4)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	30 (2.6)	40 (3.1)	43 (2.4)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	31 (2.9)	38 (3.1)	39 (2.3)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	23 (2.6)	27 (2.6)	35 (2.3)

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

Similar to science, the most prevalent characteristic of mathematics-focused professional development is working closely with other mathematics teachers, whereas having opportunities to rehearse instructional practices during the professional development is a far less likely activity (see Table 3.6). Roughly 40–50 percent of mathematics teachers have had opportunities in their professional development to apply what they learned in their classroom and then come back and talk about it, examine classroom artifacts, engage in mathematics investigations, and experience lessons as their students would from the textbooks/units they use in their classroom.

Table 3.6
Mathematics Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent,† by Grade Range

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

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

Table 3.7 shows the data for high school computer science teachers. About three-fourths have had opportunities to engage in activities to learn computer science in the last three years. Another common characteristic is experiencing lessons as students would from the textbooks/units used in the classroom (62 percent). Further, about half of computer science teachers have had substantial opportunities to work closely with other computer science teachers who taught the same grade and/or subject, whether or not they were from their school, and to examine classroom artifacts. As is the case with science and mathematics teachers, high school computer science teachers rarely have had substantial opportunities to rehearse instructional practices during professional development.

Table 3.7
High School Computer Science Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent†

	PERCENT OF TEACHERS
Had opportunities to engage in activities to learn computer science content	76 (3.6)
Had opportunities to experience lessons, as their students would, from the textbook/units they use in their classroom	62 (3.7)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	51 (4.0)
Had opportunities to examine classroom artifacts (e.g., student work samples, e-portfolios, videos of classroom instruction)	46 (3.9)
Had opportunities to apply what they learned to their classroom and then come back and talk about it as part of the professional development	39 (3.5)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	31 (3.8)
Worked closely with other teachers from their school	26 (3.9)

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

Responses to these seven items describing the characteristics of professional development experiences were combined into a single composite variable called Extent Professional Development Aligns with Elements of Effective Professional Development. As can be seen in Table 3.8, the mean scores on this composite are similar across subject/grade-range categories, except for elementary science, where scores are lower than the other subject/grade-range combinations.

Table 3.8
Teacher Mean Scores for Extent Professional Development Aligns With Elements of Effective Professional Development Composite, by Subject

	MEAN SCORE		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Elementary	49 (1.4)	58 (1.1)	n/a
Middle	55 (1.4)	59 (1.3)	n/a
High	55 (1.1)	57 (0.9)	56 (1.6)

When looking at the composite scores by equity factors, a number of differences are apparent by both class and school factors (see Table 3.9). Science classes consisting mostly of high-achieving students are more likely than classes of mostly low-achieving students to be taught by teachers who attended high-quality professional development (mean scores of 57 and 48, respectively). A similar pattern exists in terms of school size. Science classes in the largest schools have an advantage over those in the smallest schools when it comes to having access to teachers with effective professional learning experiences (mean scores of 54 and 47, respectively).

In contrast, mathematics classes composed of mostly low-achieving students tend to be taught by teachers with more high-quality professional development experiences than classes with mostly high-achieving students (mean score 61 and 56, respectively). Also, high school computer science classes with the largest proportion of students from race/ethnicity groups historically underrepresented in STEM are more likely to be taught by teachers who have experienced aspects of effective professional development than classes with the smallest proportion of students from these groups (mean score of 64 and 51, respectively). However, it is important to note that for computer science, the highest quartile contains relatively few students from these groups.

Table 3.9
Equity Analyses of Class Mean Scores for Extent Professional Development Aligns With Elements of Effective Professional Development Composite, by Subject

	MEAN SCORE		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Prior Achievement Level of Class			
Mostly High	57 (1.3)	56 (1.4)	55 (1.8)
Average/Mixed	52 (0.8)	58 (0.7)	58 (2.4)
Mostly Low	48 (1.6)	61 (1.5)	n/a
Percent of Historically Underrepresented Students in Class			
Lowest Quartile	52 (1.4)	58 (1.2)	51 (3.2)
Second Quartile	50 (1.5)	54 (1.4)	59 (3.8)
Third Quartile	55 (1.4)	60 (1.3)	56 (2.6)
Highest Quartile	52 (1.5)	61 (1.2)	64 (3.3)
Percent of Students in School Eligible for FRL			
Lowest Quartile	53 (1.4)	57 (1.5)	54 (1.8)
Second Quartile	52 (1.5)	56 (1.3)	56 (1.9)
Third Quartile	52 (1.4)	60 (1.3)	60 (4.3)
Highest Quartile	54 (1.5)	60 (1.4)	64 (4.6)
School Size			
Smallest Schools	47 (2.6)	55 (2.2)	55 (5.5)
Second Group	51 (1.6)	59 (1.8)	61 (5.0)
Third Group	53 (1.1)	58 (0.9)	58 (4.0)
Largest Schools	54 (1.1)	59 (0.9)	56 (1.6)

Another series of items asked about the focus of professional development opportunities teachers have had in the last three years. As can be seen in Table 3.10, roughly half of secondary science teachers' recent professional development heavily emphasized deepening understanding of how science is done; monitoring student understanding during science instruction; differentiating science instruction to meet the needs of diverse learners; and deepening science content knowledge. As elementary teachers tend to be less well prepared in science, it is somewhat surprising that they have been less likely to attend professional development that emphasizes deepening their science content knowledge and their understanding of how science is done.

Given the inclusion of engineering in the NGSS and many states' standards, as well as teachers' self-report of lack of preparation to teach engineering, it is somewhat surprising that fewer than a third of K–12 science teachers have attended professional development that focused heavily on deepening their understanding of how engineering is done. Further, only about a quarter of science teachers across the grade-range categories have attended professional development with a heavy emphasis on incorporating students' cultural backgrounds into science instruction despite the push for culturally responsive teaching.

Table 3.10
Science Teachers Reporting That Their Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas, by Grade Range

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

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

Data for mathematics teachers are shown in Table 3.11. Similar to science, about half of mathematics teachers across the grade ranges have had professional growth opportunities in the last three years that heavily emphasized deepening understanding of how mathematics is done (49–58 percent), monitoring student understanding during mathematics instruction (53–56 percent), and differentiating mathematics instruction to meet the needs of diverse learners (53–56 percent). Another area emphasized, was learning about difficulties students may have with particular mathematics ideas and procedures (46–51 percent). Learning how to use hands-on activities/manipulatives for mathematics instruction was also a common focus of professional development, though more so at the elementary level than the secondary level. Only about 20 percent of teachers' recent professional development emphasized learning how to provide mathematics instruction that integrates engineering, science, and/or computer science, and incorporating students' cultural backgrounds into mathematics instruction.

Table 3.11
Mathematics Teachers Reporting That Their Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas, by Grade Range

	PERCENT OF TEACHERS		
	ELEMENTARY	MIDDLE	HIGH
Differentiating mathematics instruction to meet the needs of diverse learners	56 (2.7)	55 (3.2)	53 (2.0)
Monitoring student understanding during mathematics instruction	56 (2.1)	55 (2.7)	53 (1.8)
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)	58 (2.4)	55 (3.1)	49 (2.4)
Learning about difficulties that students may have with particular mathematical ideas and procedures	47 (2.2)	51 (3.1)	46 (2.0)
Learning how to use hands-on activities/manipulatives for mathematics instruction	59 (2.5)	45 (3.4)	40 (2.2)
Deepening their own mathematics content knowledge	51 (2.5)	44 (3.4)	39 (2.1)
Finding out what students think or already know prior to instruction on a topic	46 (2.4)	39 (3.4)	38 (2.2)
Implementing the mathematics textbook to be used in their classroom	40 (2.6)	38 (3.1)	25 (2.1)
Incorporating students' cultural backgrounds into mathematics instruction	20 (1.9)	19 (3.0)	25 (2.3)
Learning how to provide mathematics instruction that integrates engineering, science, and/or computer science	22 (2.4)	20 (2.5)	21 (1.8)

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

High school computer science teacher data are shown in Table 3.12. The most common emphases related to understanding and doing computer science: deepening their computer science content knowledge, including programming (70 percent); learning how to use programming activities that require a computer (64 percent); and deepening understanding of how computer science is done (63 percent). Half of computer science teachers' professional development has had a substantial focus on implementing the computer science textbook/online course to be used in their classroom. Only about a quarter have attended professional development that emphasized differentiating computer science instruction to meet the needs of diverse learners or incorporating students' cultural backgrounds into computer science instruction, two areas that likely will need greater emphasis to help ensure students from all backgrounds have opportunities in this field.

Table 3.12
High School Computer Science Teachers Reporting That Their Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas

	PERCENT OF TEACHERS
Deepening their own computer science content knowledge, including programming	70 (3.6)
Learning how to use programming activities that require a computer	64 (4.1)
Deepening their understanding of how computer science is done (e.g., breaking problems into smaller parts, considering the needs of a user, creating computational artifacts)	63 (3.6)
Implementing the computer science textbook/online course to be used in their classroom	50 (4.0)
Learning about difficulties that students may have with particular computer science ideas and/or practices	48 (4.2)
Monitoring student understanding during computer science instruction	40 (3.6)
Learning how to provide computer science instruction that integrates engineering, mathematics, and/or science	36 (3.7)
Differentiating computer science instruction to meet the needs of diverse learners	29 (3.4)
Incorporating students' cultural backgrounds into computer science instruction	25 (3.4)

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

Several items related to a focus on student-centered instruction in recent teacher professional development were combined into a composite variable. As can be seen in Table 3.13, professional development for elementary mathematics is more likely than professional development for elementary science to support student-centered instruction (mean scores of 61 and 48, respectively). Interestingly, in science, professional development for middle and high school teachers gives more emphasis to student-centered instruction than elementary teachers, but in mathematics, professional development for elementary teachers is more likely to have this focus compared to what high school mathematics teachers experience. Lastly, the mean score for high school computer science teachers is significantly higher than the mean scores for both science and mathematics high school teachers.

Table 3.13
Teacher Mean Scores for Extent Professional Development Supports Student-Centered Instruction Composite, by Subject

	MEAN SCORE		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Elementary	48 (1.6)	61 (1.1)	n/a
Middle	55 (1.1)	58 (1.2)	n/a
High	52 (0.8)	54 (0.9)	58 (1.8)

Table 3.14 provides information about the extent to which science, mathematics, and computer science classes with different demographic characteristics have access to teachers who have had recent opportunities to learn about student-centered instruction. Science classes in suburban schools and those consisting of mostly high prior achievers are more likely to be taught by teachers with higher scores on this composite than classes in rural schools or those consisting of mostly low prior achievers. In mathematics, the opposite pattern is evident for prior achievement level of the class. The mean score for mathematics classes with mostly low-achieving students is 60, compared to 55 for classes with mostly high-achieving students. Surprisingly, disparities in science, mathematics, or computer science classes do not exist when the data are examined by school size, poverty level, and the percentage of students in the class from race/ethnicity groups historically underrepresented in STEM.

Table 3.14
Equity Analyses of Class Mean Scores for Extent Professional Development Supports Student-Centered Instruction Composite, by Subject

	MEAN SCORE		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Prior Achievement Level of Class			
Mostly High	54 (1.4)	55 (1.4)	56 (3.0)
Average/Mixed	51 (1.0)	59 (0.7)	59 (2.6)
Mostly Low	49 (1.8)	60 (1.6)	n/a
Percent of Historically Underrepresented Students in Class			
Lowest Quartile	51 (1.4)	59 (1.1)	54 (3.5)
Second Quartile	50 (1.4)	53 (1.2)	62 (5.5)
Third Quartile	52 (1.5)	59 (1.1)	60 (3.4)
Highest Quartile	51 (1.9)	62 (1.5)	61 (4.2)
Percent of Students in School Eligible for FRL			
Lowest Quartile	51 (1.5)	58 (1.3)	54 (2.3)
Second Quartile	52 (1.3)	55 (1.1)	58 (3.5)
Third Quartile	50 (1.5)	59 (1.1)	63 (4.7)
Highest Quartile	53 (2.0)	62 (1.7)	62 (6.3)
School Size			
Smallest Schools	47 (2.9)	61 (1.8)	59 (8.2)
Second Group	51 (1.7)	60 (1.6)	65 (5.2)
Third Group	52 (1.4)	59 (1.1)	59 (4.9)
Largest Schools	52 (1.1)	57 (1.0)	56 (2.4)
Community Type			
Rural	48 (1.4)	58 (1.2)	65 (4.3)
Suburban	53 (1.0)	58 (1.0)	57 (2.1)
Urban	51 (1.5)	59 (1.4)	57 (4.8)

Professional Development Offerings at the School Level

The data presented in this chapter thus far are drawn from the teacher questionnaires. The 2018 NSSME+ also included School Program Questionnaires for science and mathematics and a School Coordinator Questionnaire for computer science,[15] each completed by a person knowledgeable about school programs, policies, and practices in the designated subject.

School representatives were asked whether professional development workshops in the respective discipline 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 be seen in Table 3.15, both elementary schools and middle schools are more likely to have locally offered workshops in mathematics than in science in the last three years. Schools across the grade levels are least likely to have local workshops in computer science.

[15] Unlike the Computer Science Teacher Questionnaire, which was administered only to high school teachers, the School Coordinator Questionnaire asked schools at all grade levels about computer science practices and programs in the school/district.

Table 3.15
Professional Development Workshops Offered Locally in the Last Three Years, by Subject

	PERCENT OF SCHOOLS		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Elementary	51 (2.8)	69 (2.7)	35 (2.5)
Middle	48 (2.6)	61 (3.3)	28 (2.4)
High	41 (2.9)	46 (3.1)	19 (1.9)

Science and 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. In both science and mathematics, about 60 percent of schools indicated that locally offered workshops have emphasized deepening teachers' understanding of: (1) state standards, (2) how science/mathematics is done, and (3) science/mathematics concepts (see Table 3.16 and Table 3.17). Learning how to engage students in doing science/mathematics, how to use particular instructional materials, and how to use technology in instruction are also relatively common emphases (45–54 percent of schools depending on subject). Relatively few locally offered workshops have focused on how to develop students' confidence that they can successfully pursue careers in the discipline, how to connect instruction to career opportunities, and how to incorporate students' cultural backgrounds into instruction.

Table 3.16
Locally Offered Science Professional Development Workshops in the Last Three Years With a Substantial Emphasis† in Each of a Number of Areas

	PERCENT OF SCHOOLS
Deepening teachers' understanding of the state science/engineering standards	66 (2.9)
Deepening teachers' understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	58 (2.7)
Deepening teachers' understanding of science concepts	57 (3.1)
How to engage students in doing science (e.g., developing scientific questions, developing and using models, engaging in argumentation)	54 (2.8)
How to use technology in science/engineering instruction	48 (3.3)
Deepening teachers' understanding of how students think about various science ideas	46 (3.4)
How to use particular science/engineering instructional materials (e.g., textbooks or modules)	45 (3.2)
Deepening teachers' understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	44 (3.5)
How to monitor student understanding during science instruction	40 (3.1)
How to incorporate real-world issues (e.g., current events, community concerns) into science instruction	38 (2.6)
How to engage students in doing engineering (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	37 (2.9)
How to integrate science, engineering, mathematics, and/or computer science	36 (3.0)
How to adapt science instruction to address student misconceptions	35 (3.2)
How to connect instruction to science/engineering career opportunities	33 (2.9)
How to differentiate science instruction to meet the needs of diverse learners	28 (2.8)
How to develop students' confidence that they can successfully pursue careers in science/engineering	25 (2.7)
How to incorporate students' cultural backgrounds into science instruction	17 (2.1)

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

Table 3.17
Locally Offered Mathematics Professional Development Workshops in the Last Three Years With a Substantial Emphasis† in Each of a Number of Areas

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

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

One concern about professional development workshops is that teachers may not be given adequate assistance in applying what they are learning to their own instruction. Teacher study groups (professional learning communities, lesson study, etc.) have the potential to help teachers focus on instruction. School science, mathematics, and computer science program representatives were asked whether their school has offered teacher study groups where teachers meet on a regular basis to discuss science, mathematics, or computer science teaching and learning in the last three years. As can be seen in Table 3.18, study groups are more likely to be offered in mathematics than in science or computer science. For example, 55 percent of elementary schools offer teacher study groups in mathematics compared to only 28 percent offering them in science.

Table 3.18
Teacher Study Groups Offered at Schools in the Last Three Years, by Subject

	PERCENT OF SCHOOLS		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Elementary	28 (2.4)	55 (3.2)	43 (3.1)
Middle	45 (2.8)	57 (3.3)	41 (3.3)
High	45 (3.1)	53 (2.8)	33 (2.9)

Tables 3.19–3.26 present additional information provided by school program representatives about school-based teacher study groups focused on science and mathematics. As can be seen in Table 3.19, study groups in these two subjects are relatively similar in terms of whether teachers have been required to participate (78 and 81 percent). If schools do have a specified duration for

the science and mathematics study groups, they tend to meet for the entire school year (55 and 72 percent, respectively), but there is considerable variation in the frequency of these study group meetings. About a quarter of schools have science and mathematics teacher study groups that meet more than twice a month.

Table 3.19
Participation, Duration, and Frequency of Teacher Study Groups, by Subject

	PERCENT OF SCHOOLS†	
	SCIENCE	MATHEMATICS
Participation Required		
Yes	78 (2.7)	81 (2.4)
No	22 (2.7)	19 (2.4)
Duration of Study Group		
No specified duration	34 (3.2)	21 (2.4)
Less than one semester	3 (1.1)	2 (1.0)
One semester	8 (2.4)	5 (1.2)
Entire school year	55 (3.3)	72 (2.5)
Frequency of Meetings		
No specified frequency	34 (3.2)	21 (2.4)
Less than once a month	15 (2.4)	15 (2.2)
Once a month	18 (2.5)	23 (2.2)
Twice a month	10 (1.8)	14 (1.8)
More than twice a month	24 (2.3)	27 (2.4)

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

Data about whether schools have had designated leaders for the teacher study groups and where those leaders come from are presented in Table 3.20. Roughly two-thirds of schools have had designated leaders for science and mathematics study groups, who most often come from within the school (50 and 55 percent, respectively.)

Table 3.20
Origin of Designated Leaders of Teacher Study Groups, by Subject

	PERCENT OF SCHOOLS†	
	SCIENCE	MATHEMATICS
No designated leader	37 (3.0)	36 (2.6)
The school	50 (3.1)	55 (2.5)
Elsewhere in the district/diocese‡	17 (2.6)	21 (2.5)
College/University	1 (0.3)	1 (0.5)
External consultants	6 (1.8)	8 (1.7)

† Includes only those schools that offered teacher study groups in the last three years.
‡ This item was presented only to public and Catholic schools.

Information about the composition of teacher study groups is shown in Table 3.21. Most schools organize their science- and mathematics-focused teacher study groups by grade level (51 and 66 percent, respectively), include teachers from multiple grade levels (63 and 59 percent), and limit participation in the study groups to teachers from their school (54 and 58 percent). Many study groups also include school and/or district administrators. It is rare for schools to include higher education faculty or other consultants, parents/guardians or other community members, or teachers from other schools outside the district in the study groups.

Table 3.21
Composition of Teacher Study Groups, by Subject

	PERCENT OF SCHOOLS†	
	SCIENCE	MATHEMATICS
Organized by grade level	51 (3.2)	66 (2.6)
Include teachers from multiple grade levels	63 (2.9)	59 (2.5)
Limited to teachers from this school	54 (3.5)	58 (3.2)
Include school and/or district/diocese administrators	46 (3.1)	55 (2.8)
Include teachers who teach different science/engineering/mathematics subjects	44 (3.2)	39 (2.8)
Include teachers from other schools in the district/diocese‡	27 (2.8)	24 (2.7)
Include higher education faculty or other "consultants"	11 (2.2)	18 (2.2)
Include teachers from other schools outside of your district/diocese	5 (1.8)	4 (1.4)
Include parents/guardians or other community members	0 (0.2)	1 (0.6)

† Includes only those schools that offered teacher study groups in the last three years.
‡ This item was presented only to public and Catholic schools.

School science and mathematics program representatives were also asked about the activities typically included in teacher study groups focused on their subject. As can be seen in Table 3.22 and Table 3.23, 65 percent of study groups in science and 81 percent in mathematics have involved teachers in analyzing student assessment results. Roughly one-half to two-thirds of study groups in each subject have had teachers plan lessons together and analyze student instructional materials. Considerably fewer study groups have had teachers provide feedback on each other's instruction, rehearse instructional practices, and observe each other's instruction.

Table 3.22
Description of Activities in Typical Science Teacher Study Groups

	PERCENT OF SCHOOLS†
Analyze student science assessment results	65 (3.1)
Plan science/engineering lessons together	67 (2.8)
Analyze science/engineering instructional materials (e.g., textbooks or modules)	51 (2.9)
Examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	38 (3.2)
Engage in science investigations	30 (3.4)
Rehearse instructional practices (i.e., try out, receive, feedback, and reflect on those practices)	24 (2.6)
Provide feedback on each other's science/engineering instruction	22 (2.4)
Observe each other's science/engineering instruction (either in-person or through video recording)	17 (2.3)
Engage in engineering design challenges	18 (2.9)

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

Table 3.23
Description of Activities in Typical Mathematics Teacher Study Groups

	PERCENT OF SCHOOLS†
Analyze student mathematics assessment results	81 (2.5)
Plan mathematics lessons together	63 (2.5)
Analyze mathematics instructional materials (e.g., textbooks)	60 (3.3)
Examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	42 (2.7)
Engage in mathematics investigations	36 (2.7)
Provide feedback on each other's mathematics instruction	30 (3.0)
Rehearse instructional practices (i.e., try out, receive feedback, and reflect on those practices)	28 (2.5)
Observe each other's mathematics instruction (either in-person or through video recording)	26 (2.7)

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

Further, school program representatives were asked about the extent to which the teacher study groups have addressed each of a number of topics. These data are presented in Table 3.24 and Table 3.25. Similar to the pattern seen with locally offered professional development workshops, in many schools, both science and mathematics teacher study groups in the last three years have focused heavily on deepening teachers' understanding of the state standards (66 and 61 percent, respectively). Other areas with a substantial emphasis are learning how to engage students in doing science/mathematics (56 and 59 percent); deepening teachers' understanding of how science/mathematics is done (46 and 53 percent); deepening teachers' understanding of how students think about various ideas (44 and 53 percent); and monitoring student understanding during instruction (44 and 52 percent). Only about a third of schools indicated that science-focused study groups have had a large emphasis on how to engage students in doing engineering and deepening teachers' understanding of how engineering is done.

In addition, study groups in mathematics are more likely than those in science to focus on how to differentiate instruction to meet the needs of diverse learners and how to adapt instruction to address student misconceptions. In contrast, science study groups are more likely than mathematics study groups to emphasize how to incorporate real-world issues into instruction.

Table 3.24
Science Teacher Study Groups Offered in the Last Three Years With a Substantial Emphasis† in Each of a Number of Areas

	PERCENT OF SCHOOLS
Deepening teachers' understanding of the state science/engineering standards	66 (3.2)
How to engage students in doing science (e.g., developing scientific questions, developing and using models, engaging in argumentation)	56 (2.9)
How to use technology in science/engineering instruction	47 (3.5)
Deepening teachers' understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	46 (3.1)
How to use particular science/engineering instructional materials (e.g., textbooks or modules)	46 (3.4)
Deepening teachers' understanding of how students think about various science ideas	44 (3.1)
How to monitor student understanding during science/engineering instruction	44 (3.0)
How to incorporate real-world issues (e.g., current events, community concerns) into science instruction	43 (2.7)
Deepening teachers' understanding of science concepts	41 (3.0)
How to adapt science instruction to address student misconceptions	38 (2.9)
How to differentiate science instruction to meet the needs of diverse learners	38 (3.0)
How to integrate science, engineering, mathematics, and/or computer science	38 (2.9)
How to engage students in doing engineering (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	36 (2.8)
Deepening teachers' understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	33 (3.2)
How to connect instruction to science/engineering career opportunities	27 (2.9)
How to develop students' confidence that they can successfully pursue careers in science/engineering	25 (2.8)
How to incorporate students' cultural backgrounds into science instruction	18 (2.5)

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

Table 3.25
Mathematics Teacher Study Groups Offered in the Last Three Years With a Substantial Emphasis† in Each of a Number of Areas

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

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

Although there is general agreement that teachers can benefit from participating in professional development workshops and study groups, it is often difficult to find time for them to do so. School representatives were given a list of ways in which time might be provided for teachers to participate in professional development, regardless of whether it is offered by the school, and asked to indicate which are used in their school. As can be seen in Table 3.26, roughly half of schools use teacher work days during the school year for science-related professional development; over two-thirds do so for mathematics-related professional development. It is less common for schools to use substitute teachers or early dismissal/late start for students as a means to provide time for professional development in science and mathematics. In mathematics, more schools at the elementary and middle level provide common planning time for professional development than schools at the high school level (58, 48, and 36 percent, respectively).

Table 3.26
How Schools Provide Time for Professional Development, by Grade Range

	PERCENT OF SCHOOLS		
	ELEMENTARY	MIDDLE	HIGH
Science			
Professional days/teacher work days during the students' school year	43 (3.2)	54 (3.5)	54 (3.2)
Professional days/teacher work days before and/or after the students' school year	37 (3.3)	44 (3.3)	46 (3.2)
Substitute teachers to cover teachers' classes while they attend professional development	26 (2.8)	36 (3.1)	38 (3.0)
Early dismissal and/or late start for students	19 (2.2)	27 (2.5)	36 (2.9)
Common planning time for teachers	41 (3.1)	40 (3.4)	33 (2.9)
Mathematics			
Professional days/teacher work days during the students' school year	70 (2.8)	69 (3.3)	67 (3.3)
Professional days/teacher work days before and/or after the students' school year	53 (3.0)	54 (3.0)	57 (3.1)
Substitute teachers to cover teachers' classes while they attend professional development	36 (3.0)	36 (3.2)	39 (3.1)
Early dismissal and/or late start for students	35 (2.9)	36 (3.3)	39 (3.0)
Common planning time for teachers	58 (2.8)	48 (3.2)	36 (3.2)

As noted earlier, professional development workshops and teacher study groups can provide important opportunities for teachers to deepen their disciplinary and pedagogical content knowledge, and to develop skill in using that knowledge for key tasks of teaching, such as analyzing student work to determine what a student does and does not understand. When resources allow, one-on-one coaching to help teachers improve their practice can be a powerful tool.

School program representatives were asked whether any teachers in their school have access to one-on-one coaching focused on improving their science, mathematics, and computer science instruction; these data are shown in Table 3.27. Across subject areas and grade ranges, one-on-one coaching is relatively rare except in elementary school mathematics, where over 4 in 10 schools offer coaching.

Table 3.27
Schools Providing One-on-One Coaching, by Subject

	PERCENT OF SCHOOLS		
	SCIENCE	MATHEMATICS	COMPUTER SCIENCE
Elementary	27 (2.7)	43 (2.8)	28 (2.4)
Middle	23 (2.7)	33 (2.6)	27 (2.3)
High	30 (3.0)	29 (2.8)	21 (2.3)

Not only is one-on-one coaching a somewhat uncommon practice, but the proportion of teachers who are coached is small. In science, roughly 10 percent of teachers in schools are provided with one-on-one coaching (see Table 3.28). The proportion of teachers receiving coaching in mathematics ranges from 13–18 percent depending on grade range.

Table 3.28
Average Percentage of Teachers in Schools Receiving One-on-One Coaching, by Subject

	AVERAGE PERCENT	
	SCIENCE	MATHEMATICS
Elementary	7 (1.1)	18 (1.7)
Middle	9 (1.1)	16 (1.5)
High	11 (1.6)	13 (2.2)

In schools where science/mathematics teachers have access to one-on-one coaching, program representatives were asked who provides the coaching services. Roughly three-quarters of schools that offer coaching use a combination of administrators and teachers/coaches (see Table 3.29).

Table 3.29
Teaching Professionals Providing One-on-One Coaching, by Subject

	PERCENT OF SCHOOLS†	
	SCIENCE	MATHEMATICS
Both administrators and teachers/coaches‡	73 (3.6)	79 (2.8)
Teachers/coaches‡ only	20 (3.3)	17 (2.5)
Administrators only	7 (2.2)	4 (1.3)

† Includes only those schools that provide science-/mathematics-focused coaching.
‡ Includes teachers/coaches of all levels of teaching responsibility: full-time, part-time, and not teaching.

Although most schools have both teachers/coaches and administrators provide coaching, it appears that teachers/coaches are responsible for the bulk of it. Table 3.30 shows the percentage of schools with coaching provided by different professionals to a substantial extent. In science, 40 percent of schools have teachers/coaches who have full-time teaching loads provide one-on-one coaching to a substantial extent; 37 percent use teachers/coaches who do not have classroom teaching responsibilities. Fifty-six percent of schools have one-on-one mathematics coaching provided to a substantial extent by teachers/coaches who do not have classroom teaching responsibilities; 28 percent use teachers/coaches with full class loads to a substantial extent.

Table 3.30
Teaching Professionals Providing One-on-One Coaching to a Substantial Extent,† by Subject

	PERCENT OF SCHOOLS‡	
	SCIENCE	MATHEMATICS
Teachers/coaches who do not have classroom teaching responsibilities	37 (3.5)	56 (3.3)
District/Diocese administrators including science/mathematics supervisors/ coordinators§	36 (4.6)	31 (2.9)
Teachers/coaches who have full-time classroom teaching responsibilities	40 (3.6)	28 (2.9)
The principal of the school	21 (3.2)	25 (2.9)
An assistant principal at the school	18 (2.9)	19 (2.1)
Teachers/coaches who have part-time classroom teaching responsibilities	16 (2.8)	15 (2.8)

† Includes schools indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."
‡ Includes only those schools that provide science-/mathematics-focused coaching.
§ This item was presented only to public and Catholic schools.

In addition, school science and mathematics program representatives were asked about the services provided to teachers in need of special assistance. In science, 33–44 percent of schools, depending on grades served, provide guidance from a formally designated mentor or coach (see Table 3.31). The likelihood of schools providing a higher level of supervision for these teachers increases as grade level increases. In mathematics, about half of the schools at each grade range have mentors or coaches who provide guidance to teachers in particular need of help. Schools that include elementary grades are more likely than schools at the high school level to provide seminars, classes, and/or study groups for these teachers (40 vs. 22 percent, respectively).

Table 3.31
Services Provided to Teachers in Need of Special Assistance in Teaching, by Grade Range

	PERCENT OF SCHOOLS		
	ELEMENTARY	MIDDLE	HIGH
Science			
Guidance from a formally designated mentor or coach	33 (2.5)	35 (2.9)	44 (3.4)
A higher level of supervision than for other teachers	15 (2.2)	22 (2.5)	33 (3.3)
Seminars, classes, and/or study groups	30 (3.1)	28 (3.6)	25 (2.9)
Mathematics			
Guidance from a formally designated mentor or coach	51 (2.8)	46 (3.4)	48 (3.8)
A higher level of supervision than for other teachers	31 (2.8)	27 (2.8)	32 (2.9)
Seminars, classes, and/or study groups	40 (2.9)	35 (3.3)	22 (2.5)

Responses to whether schools/districts provide science, mathematics, and computer science workshops, teacher study groups, and one-on-one coaching were combined to look at the proportion of schools that have not offered any of these types of professional development. As can be seen in Table 3.32, about a third of schools have not offered some form of professional development in science in the last three years; 16–28 percent of schools, depending on grade level, have not offered any type of professional development in mathematics. In contrast, about 40–50 percent of schools have not offered computer science professional development at all in the last three years.

Table 3.32
Schools Not Offering Any Type of Professional Development in the Last Three Years, by Grade Range

	PERCENT OF SCHOOLS		
	ELEMENTARY	MIDDLE	HIGH
Science	33 (2.6)	32 (2.8)	29 (2.9)
Mathematics	16 (2.3)	22 (2.9)	28 (3.1)
Computer Science	40 (2.9)	43 (2.9)	52 (2.8)

Additional analyses were conducted to see if these three types of professional development offerings are equitably distributed across schools. In science, schools with the largest proportion of students eligible for free/reduced-price lunch are more likely to provide workshops than schools with the lowest proportion of students in this category (see Table 3.33). Not surprisingly, the largest schools are significantly more likely than the smallest schools to offer science-focused workshops and teacher study groups. In addition, schools in rural areas are less likely than urban schools to offer workshops and one-on-one coaching.

Table 3.33
Equity Analyses of Locally Offered Science Professional Development Available to Teachers

	PERCENT OF SCHOOLS		
	WORKSHOPS	STUDY GROUPS	ONE-ON-ONE COACHING
Percent of Students in School Eligible for FRL			
Lowest Quartile	44 (3.6)	33 (3.3)	26 (3.4)
Second Quartile	51 (5.0)	38 (4.3)	26 (4.3)
Third Quartile	51 (3.9)	36 (4.0)	26 (3.5)
Highest Quartile	56 (4.6)	38 (3.9)	35 (4.6)
School Size			
Smallest Schools	39 (4.9)	22 (4.3)	22 (4.7)
Second Group	57 (4.4)	36 (4.6)	31 (4.4)
Third Group	46 (4.3)	39 (3.1)	26 (3.4)
Largest Schools	62 (3.3)	49 (3.7)	34 (3.5)
Community Type			
Rural	37 (4.4)	32 (3.9)	20 (3.9)
Suburban	53 (2.8)	40 (2.6)	27 (2.5)
Urban	59 (4.6)	36 (3.5)	38 (4.5)

Table 3.34 shows data for mathematics. The largest schools are substantially more likely than the smallest schools to offer each of these professional development services. Schools with the largest proportion of students eligible for free/reduced-price lunch are more likely than those in the lowest quartile to offer mathematics-focused one-on-one coaching. As is the case in science, schools in rural areas are less likely than urban schools to offer workshops and one-on-one coaching in mathematics.

Table 3.34
Equity Analyses of Locally Offered Mathematics Professional Development Available to Teachers

	PERCENT OF SCHOOLS		
	WORKSHOPS	STUDY GROUPS	ONE-ON-ONE COACHING
Percent of Students in School Eligible for FRL			
Lowest Quartile	61 (4.5)	56 (4.3)	29 (4.1)
Second Quartile	63 (4.6)	63 (4.9)	33 (4.7)
Third Quartile	67 (3.8)	57 (5.0)	49 (4.5)
Highest Quartile	73 (3.7)	56 (4.3)	54 (4.6)
School Size			
Smallest Schools	56 (5.8)	46 (5.0)	26 (4.9)
Second Group	67 (4.9)	61 (4.1)	40 (4.1)
Third Group	69 (3.9)	56 (4.7)	44 (3.3)
Largest Schools	73 (2.9)	69 (3.4)	54 (3.9)
Community Type			
Rural	62 (4.6)	56 (4.1)	25 (3.6)
Suburban	63 (2.9)	62 (3.5)	43 (3.1)
Urban	75 (3.6)	53 (3.9)	51 (4.0)

A somewhat similar pattern is seen in computer science. As can be seen in Table 3.35, the largest schools are significantly more likely than the smallest schools to offer computer science-focused workshops (42 vs. 19 percent, respectively) and teacher study groups (48 vs. 33 percent, respectively). There are also disparities by community type, with rural schools being less likely to provide workshops and study groups than their urban counterparts. The distribution of schools offering one-on-one coaching in computer science is relatively equal when analyzed by each of the different equity factors.

Table 3.35
Equity Analyses of Locally Offered
Computer Science Professional Development Available to Teachers

	PERCENT OF SCHOOLS		
	WORKSHOPS	STUDY GROUPS	ONE-ON-ONE COACHING
Percent of Students in School Eligible for FRL			
Lowest Quartile	33 (4.1)	38 (4.6)	22 (3.5)
Second Quartile	33 (3.8)	50 (4.7)	34 (4.0)
Third Quartile	29 (3.5)	35 (3.5)	18 (2.8)
Highest Quartile	36 (4.4)	49 (4.1)	29 (4.0)
School Size			
Smallest Schools	19 (3.8)	33 (5.1)	22 (3.7)
Second Group	33 (4.0)	46 (5.4)	29 (3.8)
Third Group	35 (3.7)	44 (3.6)	25 (3.1)
Largest Schools	42 (3.4)	48 (3.4)	28 (2.9)
Community Type			
Rural	24 (3.1)	35 (4.7)	22 (3.3)
Suburban	33 (2.7)	43 (3.2)	29 (2.4)
Urban	39 (3.9)	48 (4.2)	25 (3.4)

Teacher Induction Programs

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.[16] 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.

Table 3.36 shows that roughly 70 percent of schools across the grade bands offer formal teacher induction programs. About a third of schools have programs that last one year or less, and about a fourth of schools have programs that last two years. It is rare for schools to have an induction program of three years or more. Of schools that do offer induction programs, a majority of them are developed and implemented by either the district or the school (see Table 3.37).

Table 3.36
Typical Duration of Formal Induction Programs, by Grade Range

	PERCENT OF SCHOOLS		
	ELEMENTARY	MIDDLE	HIGH
No formal induction program	26 (2.4)	31 (2.7)	33 (2.9)
One year or less	32 (2.8)	30 (2.7)	31 (2.3)
Two years	26 (2.6)	28 (2.6)	23 (2.2)
Three or more years	15 (2.0)	12 (1.7)	13 (1.7)

[16] 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
Organization Developing and Implementing Formal Induction Programs, by Grade Range

	PERCENT OF SCHOOLS†		
	ELEMENTARY	MIDDLE	HIGH
School	63 (2.8)	68 (3.4)	78 (2.6)
District/Diocese‡	86 (2.2)	80 (2.6)	74 (2.6)
Regional or county educational service	15 (2.8)	20 (3.4)	21 (3.1)
Local university	3 (1.2)	4 (1.0)	5 (1.4)

† Includes only those schools that provide a formal induction program.
‡ This item was presented only to public and Catholic schools.

The percentages of schools offering a formal teacher induction program are relatively equally distributed when analyzed by various school-based equity factors, including poverty level, community type, and region (see Table 3.38). In contrast, it is not surprising that the largest schools are more likely than the smallest schools to have induction programs for beginning teachers.

Table 3.38
Equity Analyses of Schools Offering Formal Induction Programs

	PERCENT OF SCHOOLS†
Percent of Students in School Eligible for FRL	
Lowest Quartile	70 (3.6)
Second Quartile	79 (3.6)
Third Quartile	77 (4.1)
Highest Quartile	78 (3.8)
School Size	
Smallest Schools	62 (4.9)
Second Group	69 (3.7)
Third Group	84 (3.0)
Largest Schools	89 (1.8)
Community Type	
Rural	71 (4.0)
Suburban	79 (2.4)
Urban	75 (3.7)
Region	
Midwest	73 (3.6)
Northeast	81 (4.6)
South	76 (2.8)
West	74 (4.1)

† Includes only those schools that provide a formal induction program.

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. Other important components of effective induction programs are ongoing communication with administrators, including an orientation meeting; offering common planning time with mentors or other new teachers; providing regular professional development opportunities; allowing new teachers to observe other colleagues, and to be observed; and giving release time and reduced teaching loads.

As can be seen in Table 3.39, many schools at all grade levels have formal induction programs that include a number of these best practices. For example, the most predominant supports provided to beginning teachers include a meeting to orient them to school policies and practices (85–89 percent), formally assigned school-based mentors (81–85 percent), and professional development opportunities on teaching their subject (74–82 percent). In addition, 61–70 percent of schools give release time to observe other teachers in their grade/subject area. Schools at the elementary and middle grades level are more likely than schools at the high school level to offer common planning time with experienced teachers who teach the same subject or grade level (76, 68, and 52 percent, respectively). In contrast, high schools are more likely than their middle or elementary counterparts to provide release time for beginning teachers to attend national, state, or local conferences (51, 38, and 33 percent, respectively).

Table 3.39
Supports Provided as Part of Formal Induction Programs, by Grade Range

	PERCENT OF SCHOOLS†		
	ELEMENTARY	MIDDLE	HIGH
A meeting to orient them to school district/diocese policies and practices	88 (2.2)	85 (2.9)	89 (1.9)
Formally assigned school-based mentor teachers	85 (2.0)	81 (2.8)	84 (2.5)
Professional development opportunities on teaching their subject	80 (2.5)	82 (2.5)	74 (2.7)
Release time to observe other teachers in their grade/subject area	70 (3.1)	67 (3.2)	61 (2.9)
Common planning time with experienced teachers who teach the same subject or grade level	76 (2.6)	68 (3.4)	52 (3.3)
Release time to attend national, state, or local teacher conferences	33 (3.0)	38 (3.1)	51 (3.2)
Professional development opportunities on providing instruction that meets the needs of students from the cultural backgrounds represented in the school	44 (3.1)	43 (3.6)	48 (3.0)
Financial support to attend national, state, or local teacher conferences	22 (2.8)	23 (3.1)	35 (3.1)
District/Diocese-level or university-based mentors	30 (2.5)	30 (3.0)	26 (2.5)
Supplemental funding for classroom supplies	31 (3.2)	29 (3.0)	25 (2.4)
Classroom aides/teaching assistants	14 (2.3)	12 (2.1)	15 (1.9)
Reduced number of teaching preps	1 (0.9)	6 (1.5)	13 (1.6)
Reduced course load	2 (0.9)	3 (1.3)	4 (1.4)
Reduced class size	0 (0.3)	1 (0.4)	3 (1.1)

† Includes only those schools that provide a formal induction program.

Given that mentoring plays an important role in effective induction programs, the percentage of schools that formally assign school-based mentor teachers was examined by different school characteristics. As can be seen in Table 3.40, urban schools are significantly less likely than their suburban or rural counterparts to assign mentors (78, 87, and 90 percent, respectively). Schools in the West are also less likely to formally assign school-based mentors than schools in the Northeast (75 and 89 percent, respectively). No disparities exist in terms of proportion of students in the school eligible for free/reduced-price lunch or school size.

Table 3.40
Equity Analyses of Schools Providing Formally Assigned School-Based Mentors

	PERCENT OF SCHOOLS†
Percent of Students in School Eligible for FRL	
Lowest Quartile	85 (3.4)
Second Quartile	87 (2.7)
Third Quartile	87 (2.5)
Highest Quartile	83 (3.4)
School Size	
Smallest Schools	87 (3.6)
Second Group	85 (3.1)
Third Group	82 (3.6)
Largest Schools	87 (2.5)
Community Type	
Rural	90 (3.1)
Suburban	87 (1.9)
Urban	78 (3.3)
Region	
Midwest	87 (2.6)
Northeast	89 (4.2)
South	88 (2.2)
West	75 (4.2)

† Includes only those schools that provide a formally assigned school-based mentor in its induction program.

School coordinators who indicated having formally assigned school-based mentors as part of the school induction program were asked to describe the schools' incentives and requirements of these mentors. About 90 percent of schools, when feasible, intentionally assign a school-based mentor who teaches the same subject or grade level as the beginning teacher (see Table 3.41). Also, roughly two-thirds of schools give school-based mentors training on effective mentoring practices, common planning time with their mentees when feasible, and extra compensation for their service. Still, only a quarter of schools intentionally give mentors release time or a reduced course load to work with their mentee.

Table 3.41
Incentives and Requirements of Formally Assigned School-Based Mentors in Induction Programs, by Grade Range

	PERCENT OF SCHOOLS†		
	ELEMENTARY	MIDDLE	HIGH
When feasible, intentionally assigned to beginning teachers who teach the same subject or grade level	88 (2.5)	90 (2.0)	86 (2.4)
Given training on effective mentoring practices	66 (3.3)	61 (3.8)	66 (2.9)
When feasible, intentionally given common planning time with their mentees	71 (3.2)	65 (3.6)	64 (3.5)
Given extra compensation for being a mentor	66 (3.4)	61 (3.3)	63 (2.9)
Required to attend workshops with their mentees	38 (3.4)	38 (3.8)	36 (2.8)
Intentionally given release time or a reduced course load to work with their mentee	25 (3.0)	22 (3.2)	25 (3.1)

† Includes only those schools that provide a formally assigned school-based mentor in its induction program.

Summary

With the exception of elementary science, a large percentage of science, mathematics, and computer science teachers have participated in discipline-focused professional development in the last three years. However, the extent to which professional development experiences incorporate elements of best practice varies. For example, a relatively common professional development opportunity in any subject/grade-range combination is to work closely with other colleagues in the same grade level and/or subject, whether or not they are from the same school. In contrast, very few science, mathematics, and computer science teachers have had a substantial opportunity to engage in rehearsals to try out instructional practices during the professional development. Further, few science and mathematics teachers have had more than 35 hours of professional development in the last three years; slightly more than half of high school computer science teachers have had more than 35 hours of professional development in the last three years.

Workshops are the most prevalent form of professional development teachers experience across all subjects and grade ranges, and participation in teacher study groups is also quite common, especially at the secondary level. Mathematics teachers are more likely to have received assistance or feedback from a formally designated coach/mentor than their science and computer science colleagues. In contrast, high school computer science teachers are far more likely than high school science and mathematics teachers to have completed an online course/webinar in the last three years.

In both science and mathematics, professional development opportunities tend to emphasize deepening understanding of how science/mathematics is done, monitoring student understanding during instruction, and differentiating instruction to meet the needs of diverse learners. Despite the inclusion of engineering in the NGSS and many states' standards, relatively few science teachers across the grade ranges have had professional development that emphasized deepening their understanding of how engineering is done. In mathematics, learning how to use hands-on/manipulatives has also been heavily emphasized in professional development, especially at the elementary level. High school computer science teachers' professional development most often focuses on deepening their computer science content knowledge, such as programming.

School program representatives were asked about locally offered professional development opportunities. Workshops are more common in mathematics than in science at the elementary and middle school. In many schools, these workshops have a substantial focus on state science/mathematics standards, how science/mathematics is done, and science/mathematics content. Relatively few schools offer workshops that emphasize how to develop students' confidence that they can successfully pursue careers in science/engineering/mathematics, how to connect instruction to science/engineering/mathematics career opportunities, and how to incorporate students' cultural backgrounds into science/mathematics instruction.

Teacher study groups also have been fairly common in all three subjects, with the exception of elementary science. Typical activities in study groups involve teachers analyzing student assessment results, planning lessons, and analyzing student instructional materials. Having teachers provide feedback on each other's instruction, rehearse instructional practices, and observe each other's instruction are less common activities. One-on-one coaching is a relatively rare offering across subject areas and grade ranges, although it is somewhat more common for mathematics at the elementary level. In both science and mathematics, one-on-one coaching is more prevalent in urban schools. Also, coaching in science and mathematics is typically provided by both teachers/coaches and administrators; however, teachers/coaches tend to shoulder more of this responsibility.

A relatively large proportion of schools offer formal teacher induction programs, with many of them being developed and implemented by either the district or school. These programs tend to last 1–2 years. Not surprisingly, induction programs are more likely to be offered in the largest schools than their smaller counterparts. The most prominent supports offered as part of these programs include a meeting to orient teachers to school policies and practices, formally assigned school-based mentors, and professional development opportunities for teachers in their subject. However, mentors are less likely to be provided in urban schools. Of schools that provide mentoring as part of their induction program, most assign mentors who teach the same subject or grade as the beginning teachers, and about two-thirds provide mentors with training and extra compensation. Few schools give mentors release time or a reduced course load to work with their mentee.

Equity factors are related to the extent to which science, mathematics, and computer science classes with different demographic characteristics—in particular prior achievement level of the class and proportion of students from race/ethnicity groups historically underrepresented in STEM—have access to teachers with varying teacher professional development experiences. For example, science classes composed of mostly low prior achievers are less likely than classes of high prior achievers to be taught by teachers who have participated in: (1) a substantial amount of professional development, (2) professional learning experiences aligned with characteristics of effective professional development, and (3) professional development that supports student-centered instruction. In mathematics, classes with mostly low prior achievers and students from race/ethnicity groups historically underrepresented in STEM have an advantage over their counterparts when it comes to having access to teachers with a large amount of professional development and experiences aligned with effective practices.

In addition, school science, mathematics, and computer science professional development offerings—workshops, teacher study groups, one-on-one coaching—differ by school factors, such as size and community type. In both science and mathematics, schools in rural areas are less likely to offer workshops and one-on-one coaching than urban schools. The largest schools are also more likely than the smallest schools to provide workshops and teacher study groups in all three subjects.