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2018 NSSME+: Status of Middle School Science

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Additional Information

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

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Introduction

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

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

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

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

This report describes the status of middle school (grades 6–8) science instruction based on the responses of 958 middle school teachers.[1] For comparison purposes, some tables disaggregate

[1] A middle school science teacher is defined as someone whose randomly selected class was a grades 6–8 science course.

the data by the subject (i.e., Earth/space science, general science, life science, and physical science).

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

This status report of middle school science teaching is organized into major topical areas:

- Characteristics of the middle school science teaching force;
- Professional development of middle school science teachers;
- Middle school science instruction;
- Resources available for middle school science instruction; and
- Factors affecting middle school science instruction.

Middle School Science Teachers' Backgrounds and Beliefs

A well-prepared teaching force is essential for an effective education system. This section provides data about the nation's middle school science teachers, including their course backgrounds, perceptions of preparedness, and beliefs about teaching and learning.

Teacher Characteristics

Middle school science teachers are much more likely to be female than male, and the overwhelming majority are white (see Table 1). Over a third have five or fewer years of experience teaching science. A quarter of middle school science had a full-time job in a science- or engineering-related field prior to teaching. Nearly 7 out of 10 middle school science teachers teach a single course type (e.g., general science, life science, physical science) within science.

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

[3] Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc.

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

Table 1
Characteristics of the Middle School Science Teaching Force

	PERCENT OF TEACHERS
Sex	
Female	71 (1.8)
Male	28 (1.8)
Other	0 (0.2)
Hispanic or Latino	
Yes	7 (1.2)
No	93 (1.2)
Race	
White	91 (1.5)
Black or African American	8 (1.5)
American Indian or Alaskan Native	2 (0.6)
Asian	2 (0.5)
Native Hawaiian or Other Pacific Islander	0 (0.2)
Age	
≤ 30	17 (2.1)
31–40	29 (2.5)
41–50	26 (1.9)
51–60	20 (2.0)
61 +	8 (1.4)
Experience Teaching Science at the K–12 Level	
0–2 years	21 (2.0)
3–5 years	15 (1.7)
6–10 years	18 (1.3)
11–20 years	34 (2.2)
≥ 21 years	12 (1.5)
Number of Science Subjects Taught	
1	68 (2.3)
2	17 (1.9)
3 or more	15 (2.0)
Full-Time Job in Science Prior to Teaching	
Yes	23 (2.8)
No	77 (2.8)

The vast majority of middle school science teachers have had formal preparation for teaching leading to a teacher credential, with roughly half receiving their teaching credential as part of their undergraduate degree and the other half through a master's or post-baccalaureate program (see Table 2). Only 4 percent of middle school science teachers have not earned a teaching credential.

Table 2
Middle School Science Teachers' Paths to Certification

	PERCENT OF TEACHERS
An undergraduate program leading to a bachelor's degree and a teaching credential	53 (2.8)
A master's program that also led to a teaching credential	24 (2.7)
A post-baccalaureate credentialing program (no master's degree awarded)	20 (2.3)
Has not earned a teaching credential	4 (1.3)

Content Preparedness

Slightly more than half of middle school science teachers earned a college degree in science/ engineering or science education (see Table 3). That 42 percent have a degree related to science or engineering and 36 percent have a degree in science education indicates that many have degrees in both areas.

Table 3
Middle School Science Teacher Degrees

	PERCENT OF TEACHERS
Science/Engineering	42 (2.2)
Science Education	36 (2.8)
Science/Engineering or Science Education	54 (2.9)

As can be seen in Table 4, the majority of middle school science teachers have had introductory coursework in each major science discipline. For example, nearly 90 percent have taken an introductory biology course, 65 percent an advanced biology course, and over half one or more courses related to teaching biology. Only 1 in 10 middle school science teachers have had any coursework in engineering.

Table 4
Middle School Science Teachers Completing Various College Courses

	PERCENT OF TEACHERS
Biology	
Introductory	88 (2.0)
Advanced	65 (2.3)
Teaching Methods	52 (2.2)
Earth/Space Science	
Introductory	68 (2.6)
Advanced	29 (2.1)
Teaching Methods	22 (1.8)
Chemistry	
Introductory	79 (2.2)
Advanced	41 (2.3)
Teaching Methods	15 (1.9)
Physics	
Introductory	67 (2.4)
Advanced	19 (1.8)
Teaching Methods	16 (1.9)
Environmental Science	
Introductory	55 (2.4)
Advanced	19 (1.7)
Teaching Methods	14 (1.9)
Engineering	
Any Engineering	10 (1.7)

Some middle school science teachers teach classes focused on a single discipline (e.g., physical science). Others teach general or integrated science classes. Clearly, the two types of classes place different demands on teachers' content knowledge. Among those who teach discipline-specific courses, the vast majority of middle school science teachers do not have a science degree in the science discipline they teach (see Table 5). However, the majority of those who teach life science either hold a degree in the field or have taken three or more advanced courses in that field. In contrast, more than half of those teaching Earth/space science have not completed any college coursework in the discipline beyond the introductory level. Only one-quarter of physical science teachers have taken college physical science courses beyond the introductory level.

Table 5
Middle School Science Teachers With Varying Levels of Background in Subject

	PERCENT OF TEACHERS		
	LIFE SCIENCE	PHYSICAL SCIENCES†	EARTH/SPACE SCIENCE
Degree in field	40 (4.5)	7 (3.3)	5 (1.3)
No degree in field, but 3+ courses beyond introductory	26 (3.9)	10 (3.3)	22 (6.0)
No degree in field, but 1–2 courses beyond introductory	10 (2.3)	9 (3.3)	17 (4.0)
No degree in field or courses beyond introductory	18 (3.1)	64 (5.4)	31 (5.5)
No coursework in field	6 (2.0)	9 (2.2)	26 (5.3)

† Physical sciences teacher data is based on coursework in chemistry and/or physics.

Teachers of general/integrated science are typically responsible for instruction across science disciplines. Accordingly, the National Science Teachers Association (NSTA) has recommended coursework in chemistry, Earth science, life science, and physics for these teachers.[5] As can be seen in Table 6, 49 percent of middle grades teachers assigned to general and/or integrated science meet that standard, and another 29 percent have had coursework in 3 of the 4 areas.

Table 6
Middle School Teachers of General/Integrated Science Coursework Related to NSTA Preparation Standards

	PERCENT OF TEACHERS
Courses in chemistry, Earth science, life science, and physics	49 (2.8)
Courses in 3 of the 4 areas	29 (3.0)
Courses in 2 of the 4 areas	12 (1.9)
Course in 1 of the 4 areas	4 (0.9)
Courses in 0 of the 4 areas	6 (2.3)

The survey also asked middle school science teachers to rate how well prepared they feel to teach each of a number of topics related to their randomly selected class. Roughly half of middle school teachers whose randomly selected class includes life science feel very well prepared to teach about structures and functions of organisms, ecology and ecosystems, cell biology, and genetics (see Table 7). Approximately half of the middle school science teachers whose class includes chemistry feel very well prepared to teach about states, classes, and properties of matter; the periodic table; atomic structure; and elements, compounds, and mixtures. In contrast, only about a quarter feel very well prepared to teach about chemical bonding, equations, nomenclature, and reactions. Only about 4 in 10 teachers of Earth/space science feel very well prepared to teach about Earth's features and physical processes, and only 44 percent of those whose class includes physics feel very well prepared to teach about forces and motion. Similarly, only 31 percent of middle school science teachers responsible for teaching about environmental issues feel very well prepared to teach that topic.

5 National Science Teachers Association. (2012). *NSTA science content analysis form: Elementary science specialists or middle school science teachers.* Arlington, VA: NSTA.

Table 7
Middle School Science Teachers Considering Themselves Very Well Prepared to Teach Each of a Number of Topics

	PERCENT OF TEACHERS†
Biology/Life Science	
Structures and functions of organisms	55 (2.7)
Ecology/ecosystems	52 (3.0)
Cell biology	50 (2.6)
Genetics	46 (3.0)
Evolution	40 (2.8)
Chemistry	
States, classes, and properties of matter	55 (2.6)
The periodic table	47 (3.0)
Atomic structure	46 (3.2)
Elements, compounds, and mixtures	45 (2.6)
Properties of solutions	30 (2.2)
Chemical bonding, equations, nomenclature, and reactions	28 (2.6)
Earth/Space Science	
Earth's features and physical processes	42 (2.2)
The solar system and the universe	32 (2.0)
Climate and weather	31 (2.3)
Environmental Science	
Environmental and resource issues (e.g., land and water use, energy resources and consumption, sources and impacts of pollution)	31 (2.8)
Physics	
Forces and motion	44 (3.5)
Energy transfers, transformations, and conservation	39 (3.0)
Properties and behaviors of waves	21 (2.1)
Electricity and magnetism	19 (2.0)
Modern physics	7 (1.3)

† Each middle school science teacher was asked about one set of science topics based on the discipline of their randomly selected class.

Data from these items were combined into a composite variable called Perceptions of Preparedness to Teach Science Content. As can be seen in Table 8, middle school science teachers of Earth/space and life science classes feel the most prepared to teach their subjects. Though physical science teachers feel less well prepared than Earth/space or life science teachers to teach their subject, they feel better prepared than general or integrated science teachers, perhaps because this latter group is responsible for teaching a broad range of topics.

Table 8
Mean Scores for Middle School Science Teachers' Perceptions of Content Preparedness Composite

	MEAN SCORE
Overall	71 (0.8)
Earth/Space Science	80 (2.3)
General or Integrated Science	63 (1.0)
Life Science	82 (2.0)
Physical Science	71 (2.2)

The survey also asked teachers how well prepared they feel to incorporate engineering into their science instruction. Very few middle school science teachers feel very well prepared to teach engineering concepts, and about a third feel not adequately prepared (see Table 9). This finding is not surprising given that the vast majority of teachers have not had college coursework in engineering, and engineering has not traditionally been part of the school curriculum. As the Next Generation Science Standards include engineering concepts for K–12, there will likely be a need for professional development focused on engineering.

Table 9
Middle School Science Teachers' Perceptions of Preparedness to Teach Engineering

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
Defining engineering problems	29 (2.1)	35 (2.3)	24 (2.0)	12 (1.6)
Developing possible solutions	28 (2.2)	32 (2.2)	26 (1.9)	14 (1.8)
Optimizing a design solution	32 (2.2)	33 (2.2)	24 (1.9)	10 (1.6)

These items were combined into a composite variable titled Perceptions of Preparedness to Teach Engineering; scores are shown in Table 10. The scores show that, in addition to most middle school science teachers not feeling well prepared to teach engineering, those who teach general or integrated science feel the most prepared to integrate it into their curriculum.

Table 10
Mean Scores for Middle School Science Teachers' Perceptions of Preparedness to Teach Engineering Composite

	MEAN SCORE
Overall	43 (1.4)
Earth/Space Science	41 (4.0)
General or Integrated Science	48 (1.4)
Life Science	31 (2.6)
Physical Science	42 (3.9)

Pedagogical Preparedness

The survey asked teachers two series of items focused on their preparedness for a number of tasks associated with instruction. First, they were asked how well prepared they feel to use various student-centered pedagogies. Second, they were asked how well prepared they feel to monitor and address student understanding, focusing on a specific unit in the randomly selected class.

Almost half of middle school science teachers feel very well prepared to use formative assessment to monitor student learning and encourage participation of all students in science and/or engineering (see Table 11). About 40 percent feel very well prepared to develop students' conceptual understanding, encourage students' interest in science and/or engineering, and to develop students' abilities to do science. However, fewer than a quarter feel very well prepared to develop students' awareness of STEM careers, provide science instruction that is based on students' ideas, and incorporate students' cultural backgrounds into science instruction.

Table 11
Middle School Science Teachers Considering Themselves Very Well Prepared for Each of a Number of Tasks

	PERCENT OF TEACHERS
Use formative assessment to monitor student learning	48 (2.2)
Encourage participation of all students in science and/or engineering	44 (2.3)
Develop students' conceptual understanding	42 (2.2)
Encourage students' interest in science and/or engineering	42 (2.2)
Develop students' abilities to do science (e.g., develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	38 (1.9)
Differentiate science instruction to meet the needs of diverse learners	33 (2.0)
Develop students' awareness of STEM careers	21 (1.8)
Provide science instruction that is based on students' ideas	21 (1.8)
Incorporate students' cultural backgrounds into science instruction	15 (1.3)

Table 12 shows the percentage of classes taught by teachers who feel very well prepared for each of a number of tasks related to a specific unit in their instruction. In the majority of middle school science classes, teachers feel very well prepared to assess student understanding at the end of a unit and monitor student understanding during instruction. Teachers feel very well prepared to implement their designated instructional materials, elicit students' initial ideas, or anticipate student difficulties in fewer than half of middle school science classes.

Table 12
Middle School Science Classes in Which Teachers Feel Very Well Prepared for Each of a Number of Tasks in the Most Recent Unit in a Designated Class

	PERCENT OF CLASSES
Assess student understanding at the conclusion of this unit	58 (2.0)
Monitor student understanding during this unit	51 (2.1)
Implement the instructional materials to be used during this unit	45 (2.4)
Find out what students thought or already knew about the key science ideas	39 (2.1)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	37 (2.1)

Data from items asking teachers about their preparedness to provide instruction were combined into composites called Perceptions of Pedagogical Preparedness and Perceptions of Preparedness to Implement Instruction in a Particular Unit. As can be seen in Table 13, teachers feel more prepared to implement instruction in a specific unit than they do regarding general pedagogy.

There are not any differences in either measure of preparedness among teachers of different science courses.

Table 13
Mean Scores for Middle School Science Teachers' Perceptions of General and Unit-Specific Pedagogical Preparedness Composites

	MEAN SCORE	
	PEDAGOGICAL PREPAREDNESS	UNIT-SPECIFIC PREPAREDNESS
Overall	68 (0.9)	77 (0.9)
Earth/Space Science	69 (2.1)	79 (1.8)
General or Integrated Science	68 (0.9)	75 (1.0)
Life Science	70 (1.7)	78 (1.5)
Physical Science	67 (2.1)	76 (1.8)

Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning in science. As can be seen in Table 14, middle school science teachers hold a number of views that are in alignment with what is known about effective science instruction. For example, at least 90 percent agree that: (1) students learn best when instruction is connected to their everyday lives, (2) teachers should ask students to support their conclusions about a science concept with evidence, (3) students should learn science by doing science, (4) most class periods should provide opportunities for students to share their thinking and reasoning, and (5) most class periods should provide opportunities for students to apply scientific ideas to real-world concepts. In addition, about three-quarters agree that it is better for science instruction to focus on ideas in depth, even if it means covering fewer topics.

However, many middle school science teachers also hold views that are inconsistent with effective science instruction. For example, nearly three-quarters agree that students should be provided with definitions for new vocabulary at the beginning of instruction on a science idea. Further, about half believe that hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned and that students learn best in classes with students of similar abilities. Nearly a third believe that teachers should explain an idea to students before having them consider evidence that relates to the idea.

Table 14
Middle School Science Teachers Agreeing† With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS
Reform-Oriented Beliefs	
Students learn best when instruction is connected to their everyday lives.	97 (0.7)
Teachers should ask students to support their conclusions about a science concept with evidence.	97 (0.9)
Students should learn science by doing science (e.g., developing scientific questions; designing and conducting investigations; analyzing data; developing models, explanations, and scientific arguments).	93 (1.7)
Most class periods should provide opportunities for students to share their thinking and reasoning.	92 (1.9)
Most class periods should provide opportunities for students to apply scientific ideas to real-world contexts.	90 (2.0)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	74 (2.9)
Traditional Beliefs	
At the beginning of instruction on a science idea, students should be provided with definitions for new scientific vocabulary that will be used.	72 (2.3)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	57 (2.6)
Students learn science best in classes with students of similar abilities.	48 (3.6)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.	30 (2.6)

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

Data from these items were combined into composites called Traditional Teaching Beliefs and Reform-Oriented Teaching Beliefs. As can be seen in Table 15, although middle school science teachers have strong reform-oriented beliefs, they also have fairly strong traditional beliefs. Overall, teachers’ beliefs are similar across subjects taught.

Table 15
Mean Scores for Middle School Science Teachers’ Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
Overall	57 (1.1)	87 (0.7)
Earth/Space Science	60 (2.3)	85 (2.2)
General or Integrated Science	55 (1.5)	87 (0.7)
Life Science	60 (2.0)	87 (1.5)
Physical Science	61 (1.7)	85 (1.9)

Leadership Roles and Responsibilities

In addition to asking teachers about their content background and preparedness to teach science, the survey asked teachers whether they had served in various leadership roles in the profession in the last three years. Nearly half of middle school science teachers have observed another teacher’s science lesson for the purpose of providing feedback and served on a school or district science committee (see Table 16). Fewer than 1 in 4 have led a teacher study group or workshop, supervised a student teacher in their classroom, or served as a formal mentor or coach.

Table 16
Middle School Science Teachers Having Various Leadership Responsibilities Within the Last Three Years

	PERCENT OF TEACHERS
Observed another teacher's science lesson for the purpose of giving them feedback	44 (3.1)
Served on a school or district/diocese-wide science committee	44 (3.1)
Served as a lead teacher or department chair in science	37 (2.7)
Taught a science lesson for other teachers in their school to observe	37 (2.9)
Led or co-led a workshop or professional learning community for other teachers focused on science or science teaching	22 (2.3)
Supervised a student teacher in their classroom	22 (2.2)
Served as a formal mentor or coach for a science teacher	21 (2.1)

Professional Development of Middle School Science Teachers

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 content. The 2018 NSSME+ collected data on teachers' participation in professional development, as well as characteristics of the professional development.

One important measure of teachers' continuing education is how long it has been since they participated in professional development. Nearly 80 percent of middle school science teachers have participated in science/engineering-focused professional development (i.e., focused on science/engineering content or the teaching of science/engineering) in the last three years, with 57 percent having had science/engineering-focused professional development in the last 12 months (see Table 17). However, 1 in 10 middle school science teachers have never participated in science/engineering-focused professional development.

Table 17
Middle School Science Teachers' Most Recent Participation in Science-Focused Professional Development

	PERCENT OF TEACHERS
In the last 12 months	57 (2.5)
1–3 years ago	21 (2.2)
4–6 years ago	6 (1.4)
7–10 years ago	2 (0.8)
More than 10 years ago	3 (0.8)
Never	11 (1.6)

Though a large majority of middle school science teachers have had professional development in the last three years, the quantity varies greatly. About a quarter of middle school science teachers have spent 36 or more hours in science/engineering-related professional development in the last three years, and nearly a third of middle school science teachers have had less than six hours (see Table 18).

Table 18
Time Spent by Middle Science School Teachers on Science-Focused Professional Development in the Last Three Years

	PERCENT OF TEACHERS
None	22 (2.2)
Less than 6 hours	8 (1.1)
6–15 hours	23 (2.4)
16–35 hours	21 (1.6)
36–80 hours	16 (1.5)
More than 80 hours	10 (1.2)

As to how time in professional development is spent, the workshop is the most common form of professional development, with 94 percent of middle school science teachers who have had professional development in the previous three years attending one (see Table 19). Over half have participated in a professional learning community or other type of teacher study group.

Table 19
Middle School Science Teachers Participating in Various Science-Focused Professional Development Activities in the Last Three Years

	PERCENT OF TEACHERS†
Attended a professional development program/workshop	94 (1.2)
Participated in a professional learning community/lesson study/teacher study group	61 (3.1)
Attended a national, state, or regional science teacher association meeting	37 (3.2)
Received assistance or feedback from a formally designated coach/mentor	33 (3.4)
Completed an online course/webinar	29 (3.0)

† Only middle school science teachers indicating that they participated in science-focused professional development in the last three years are included in these analyses.

It is widely agreed upon that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include providing opportunities for teachers to engage in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; examine student work and other classroom artifacts for evidence of what students do and do not understand; and apply what they have learned in their classrooms and subsequently discuss how it went.[6] 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 20, more than half of middle school science teachers attending professional development have had substantial opportunity to work closely with other teachers

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

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

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

from their school or who teach the same subject. Fewer teachers have had opportunities to examine classroom artifacts as part of their professional development or apply what they learned in professional development to their classroom and then go back and talk about it.

Table 20
Middle School Science Teachers Whose Science-Focused Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent†

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

† Includes middle school science teachers indicating 4 or 5 on a five-point scale ranging from 1 “not at all” to 5 “to a great extent.”
‡ Only middle school science teachers indicating that they participated in science-focused professional development in the last three years are included in these analyses.

Another series of items asked about the focus of the opportunities teachers had to learn about content and the teaching of that content in the last three years through professional development. Deepening teachers’ understanding of how science is done and their own science content knowledge was a heavy emphasis for the majority of middle school science teachers who have had professional development in the last three years (see Table 21). In, nearly half have had professional growth opportunities that gave heavy emphasis to differentiating instruction and integrating STEM concepts. Only about a quarter have had professional development with a heavy emphasis on incorporating students’ cultural backgrounds into science instruction.

Table 21
Middle School Science Teachers Reporting That Their Science-Focused Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas

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

† Includes middle school science teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."
‡ Only middle school science teachers indicating that they participated in science-focused professional development in the last three years are included in these analyses.

Data from items asking teachers about their professional development experiences were combined into composites called the Extent Professional Development Aligns with Elements of Effective Professional Development and Extent Professional Development Supports Student-Centered Instruction. As can be seen in Table 22, the mean scores are similar for both composites, regardless of subject taught.

Table 22
Middle School Science Teacher Mean Scores for Professional Development Composites

	MEAN SCORE	
	EXTENT PROFESSIONAL DEVELOPMENT ALIGNS WITH ELEMENTS OF EFFECTIVE PROFESSIONAL DEVELOPMENT	EXTENT PROFESSIONAL DEVELOPMENT SUPPORTS STUDENT-CENTERED INSTRUCTION
Overall	55 (1.4)	55 (1.1)
Earth/Space Science	57 (2.5)	58 (2.2)
General or Integrated Science	55 (1.3)	55 (1.2)
Life Science	54 (2.8)	57 (2.5)
Physical Science	50 (4.3)	52 (3.0)

Middle School Science Instruction

This section draws on teachers' descriptions of what transpires in middle school science classrooms, in terms of teachers' autonomy for making decisions regarding the content and pedagogy of their classes, instructional objectives, and class activities.

Course Offerings

Middle schools were asked whether they offered single-discipline science courses (e.g., life science, physical science), coordinated/integrated science courses, or both in each grade 6–8 contained in the school. As can be seen in Table 23, single-discipline courses are slightly less common than coordinated/integrated science courses in 6th grade; in 7th and 8th grade, single-discipline courses are just as common as multi-discipline courses. At each grade level, about a fifth of schools offer both types of courses.

Table 23
Type of Middle School Science Courses Offered, by Grade

	PERCENT OF SCHOOLS		
	GRADE 6	GRADE 7	GRADE 8
Multi-Discipline Science Courses Only	45 (3.5)	41 (3.5)	42 (3.4)
Single-Discipline Science Courses Only	35 (3.5)	40 (3.8)	40 (3.7)
Both	19 (3.2)	18 (3.0)	18 (2.9)

Class Characteristics

The typical middle school science class has approximately 23 students; two-thirds of the classes have between 18 and 28 students. Demographic data for middle school science students are shown Table 24.

Table 24
Demographics of Students in Middle School Science Classes

	PERCENT OF STUDENTS
Sex	
Male	52 (0.7)
Female	48 (0.7)
Race/Ethnicity	
White	52 (1.6)
Hispanic or Latino	24 (1.7)
Black or African American	16 (1.3)
Asian	4 (0.5)
American Indian or Alaskan Native	1 (0.3)
Native Hawaiian or Other Pacific Islander	0 (0.1)
Two or more races	4 (0.4)

Over 40 percent of middle school science classes are heterogeneously grouped, containing students with a mixture of prior achievement levels (see Table 25). A quarter of classes are composed of most average prior achieving students, with the remainder about evenly split between mostly low and mostly high prior achieving students.

Table 25
Prior Achievement Grouping in Middle School Science Courses

	PERCENT OF CLASSES
Mostly low achievers	17 (1.8)
Mostly average achievers	26 (1.8)
Mostly high achievers	15 (1.6)
A mixture of levels	43 (2.3)

Teachers' Perceptions of Their Decision-Making Autonomy

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

Table 26
Middle School 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	73 (2.2)
Selecting teaching techniques	67 (2.4)
Choosing criteria for grading student performance	59 (2.6)
Determining the amount of instructional time to spend on each topic	43 (3.2)
Selecting the sequence in which topics are covered	41 (2.9)
Determining course goals and objectives	33 (3.0)
Selecting curriculum materials (e.g., textbooks/modules)	28 (2.9)
Selecting content, topics, and skills to be taught	27 (3.0)

These items related to classroom control were combined into two composite variables: Curriculum Control and Pedagogical Control. The scores on the composites show that teachers of middle school science classes have much more control over how they teach their class compared to their control over what curriculum is used in their classroom (see Table 27). There are no significant differences on these composites by the subject of the class.

Table 27
Middle School Science Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM CONTROL	PEDAGOGICAL CONTROL
Overall	57 (2.2)	87 (1.1)
Earth/Space Science	53 (5.8)	81 (4.7)
General or Integrated Science	54 (2.5)	87 (1.7)
Life Science	59 (4.0)	86 (1.8)
Physical Science	63 (4.1)	90 (2.0)

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate how much emphasis each receives in the randomly selected class. As can be seen in Table 28, although a large majority of middle school science classes have a heavy emphasis on deepening students' conceptual understanding of science, fewer than half have a heavy emphasis on students learning how to do science. Only about a third of middle school science classes have a heavy emphasis on increasing students' interest in science and developing students' confidence that they can successfully pursue science/engineering careers.

Table 28
Middle School Science Classes With Heavy Emphasis on Various Instructional Objectives

	PERCENT OF CLASSES
Understanding science concepts	77 (1.8)
Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	46 (2.1)
Learning science vocabulary and/or facts	37 (2.2)
Increasing students' interest in science/engineering	35 (2.1)
Developing students' confidence that they can successfully pursue careers in science/engineering	30 (1.9)
Learning about real-life applications of science/engineering	28 (2.0)
Learning test-taking skills/strategies	23 (1.8)
Learning how to do engineering (e.g., identify criteria and constraints, design solutions, optimize solutions)	10 (1.2)
Learning about different fields of science/engineering	7 (1.2)

Data from these items were used to create a composite variable measuring how much emphasis teachers put on reform-oriented instructional objectives. The mean score of 67 indicates moderate emphasis on these objectives (see Table 29). Scores are similar across all middle school science course types.

Table 29
Middle School Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
Overall	67 (0.8)
Earth/Space Science	67 (2.4)
General or Integrated Science	67 (0.9)
Life Science	67 (2.0)
Physical Science	65 (1.8)

Class Activities

The 2018 NSSME+ included several items that provide information about how science is taught at the middle school level. One series of items listed various instructional strategies and asked teachers to indicate the frequency with which they used each in a randomly selected class. As can be seen in Table 30, the vast majority of middle school science classes include the teacher explaining science ideas, whole class discussions, and students working in small groups on a weekly basis. About 3 in 5 classes engage students in hands-on/laboratory activities at least once a week. It is interesting that fewer than half of middle school science classes have students write reflections on what they are learning once or more a week, given what is known from research on learning about the importance of reflection.

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

	PERCENT OF CLASSES
Explain science ideas to the whole class	92 (1.0)
Engage the whole class in discussions	89 (1.2)
Have students work in small groups	87 (1.5)
Have students do hands-on/laboratory activities	63 (2.0)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	47 (2.1)
Focus on literacy skills (e.g., informational reading or writing strategies)	46 (2.3)
Have students read from a textbook, module, or other material in class, either aloud or to themselves	39 (2.6)
Engage the class in project-based learning (PBL) activities	31 (2.3)
Have students practice for standardized tests	19 (1.7)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	10 (1.2)

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*[7]—i.e., the practices of science such as formulating scientific questions, designing and implementing investigations, developing models and explanations, and engaging in argumentation. Two findings are evident in the results (see Table 31). One is that, overall, middle school classes tend not to be engaged in the practices very often. The second is that they are more often engaged in aspects of science related to conducting investigations and analyzing data than aspects related to evaluating the strengths/limitations of evidence and the practice of argumentation. For example, about half of middle school science classes have students organize and represent data, conduct scientific investigations, and make and support claims with evidence at least once a week. In contrast, fewer than a quarter of middle school science classes have students, at least once a week, identify the strengths and limitations of a model or competing scientific explanations, evaluate the credibility of scientific information, pose questions about scientific arguments, determine what details about an investigation might persuade a targeted audience about a scientific claim, or construct a persuasive case.

[7] 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 31
Middle School Science Classes in Which Teachers Report Students Engaging in Various Aspects of Science Practices at Least Once a Week

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

These items were combined into a composite; mean scores, overall and by course type, are shown in Table 32. Across all middle school courses, the scores are fairly low.

Table 32
Middle School Science Class Mean Scores for Engaging Students in the Practices of Science Composite

	MEAN SCORE
Overall	50 (0.8)
Earth/Space Science	51 (2.4)
General or Integrated Science	50 (1.0)
Life Science	50 (2.4)
Physical Science	48 (2.2)

Given recent trends to incorporate engineering and computer science into science instruction, the 2018 NSSME+ asked teachers how frequently they do so. As can be seen in Table 33, 90 percent of middle school science classes incorporate engineering at least a few times a year, with about 4 in 10 doing so at least once a month. In contrast, only about 2 in 10 middle school science classes ever incorporate coding into science instruction, and typically just a few times year in the classes that do.

Table 33
Middle School Science Classes in Which Teachers Report Incorporating Engineering and Coding Into Science Instruction

	PERCENT OF CLASSES
Engineering	
Never	10 (1.8)
Rarely (e.g., a few times per year)	51 (2.4)
Sometimes (e.g., once or twice a month)	32 (2.2)
Often (e.g., once or twice a week)	5 (1.0)
All or almost all science lessons	1 (0.6)
Coding	
Never	81 (1.9)
Rarely (e.g., a few times per year)	14 (1.8)
Sometimes (e.g., once or twice a month)	3 (0.8)
Often (e.g., once or twice a week)	1 (0.5)
All or almost all science lessons	0 (0.3)

In addition to asking about class activities in the course as a whole, the 2018 National Survey asked teachers about activities that took place during their most recent science lesson in the randomly selected class. Students working in small groups and the teacher explaining a science idea to the whole class are the most common activities occurring in 85 and 74 percent of lessons, respectively (see Table 34). Whole class discussion occurs in about two-thirds of lessons, and students reading about science, students doing hands-on/laboratory activities, and students writing about science occur in about half of middle school science lessons.

Table 34
Middle School Science Classes Participating in Various Activities in Most Recent Lesson

	PERCENT OF CLASSES
Students working in small groups	85 (1.3)
Teacher explaining a science idea to the whole class	74 (2.2)
Whole class discussion	67 (2.3)
Students reading about science	48 (2.6)
Students doing hands-on/laboratory activities	46 (2.0)
Students writing about science	46 (2.6)
Students completing textbook/worksheet problems	39 (2.2)
Teacher conducting a demonstration while students watched	30 (2.1)
Test or quiz	14 (1.5)
Practicing for standardized tests	8 (1.0)

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. An average of 35 percent of class time is spent on small group work, 32 percent on whole class activities, and 22 percent on students working individually (see Table 35). Non-instructional activities, including attendance taking and interruptions, account for 12 percent of science class time.

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

	AVERAGE PERCENT OF CLASS TIME
Small group work	35 (1.1)
Whole class activities (e.g., lectures, explanations, discussions)	32 (0.8)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	22 (0.8)
Non-instructional activities (e.g., attendance taking, interruptions)	12 (0.3)

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class; results are shown in Table 36. The vast majority of middle school science classes assign 60 minutes or fewer of homework per week.

Table 36
Amount of Homework Assigned in Middle School Science Classes Per Week

	PERCENT OF CLASSES
None	8 (1.8)
1–15 minutes per week	15 (1.9)
16–30 minutes per week	33 (2.8)
31–60 minutes per week	31 (2.7)
61–90 minutes per week	8 (1.4)
91–120 minutes per week	3 (1.0)
More than 2 hours per week	2 (1.2)

The survey asked how often students in the randomly selected class were required to take assessments the teachers did not develop, such as state or district benchmark assessments. More than 8 in 10 classes are required to take such an assessment at least once a year, with nearly 4 in 10 required to do so three or more times a year (see Table 37).

Table 37
Frequency of Required External Testing in Middle School Science Classes

	PERCENT OF CLASSES
Never	17 (1.8)
Once a year	33 (2.7)
Twice a year	11 (1.8)
Three or four times a year	28 (2.8)
Five or more times a year	11 (1.9)

Resources Available for Middle School Science

The quality and availability of instructional resources are a major factors affecting science teaching. The 2018 NSSME+ included a series of items on instructional materials—which ones teachers use and how teachers use them—as well as the adequacy of other resources for their science instruction.

Instructional Materials

The survey collected data on the use of instructional materials in science classes. As can be seen in Table 38, two-thirds of middle school science classes have materials designated for use by the school or district. If materials were designated for their class, the survey presented them with a list of possible types of materials. Of the middle school science classes with designated materials, the vast majority had a commercially published textbook designated. About one-third of middle school science classes have commercially published kits/modules and units or lessons developed by their state, counts, district, or diocese designated. The data also indicate that for many classes, multiple types of materials are being designated.

Table 38
Middle School Science Classes for Which Various Types of Instructional Materials Are Designated

	PERCENT OF CLASSES
District Designates Instructional Materials	
No	34 (2.8)
Yes	66 (2.8)
Types of Designated Instructional Materials†	
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks	87 (1.8)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	39 (2.8)
Commercially published kits/modules (printed or electronic)	36 (3.1)
State, county, district, or diocese-developed units or lessons	32 (2.3)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	26 (2.2)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	15 (2.0)

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

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction is based on various types of materials. As can be seen in Table 39, the most commonly used materials in middle school science classes are units/lessons created by teachers; these types of materials are used at least once a week in over three-quarters of classes. Fewer than half of middle school science classes base instruction on commercially published textbooks at least once a week. Units/lessons collected by teachers from other sources (e.g., conferences, colleagues) as well as lessons from both free and fee-based websites are used weekly in 31–43 percent of middle school science classes.

Table 39
Middle School Science Classes Basing Instruction on Various Instructional Resources at Least Once a Week

	PERCENT OF CLASSES
Units or lessons you created (either by yourself or with others)	76 (2.0)
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks	45 (2.6)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	43 (2.4)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	34 (1.9)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	31 (1.8)
Commercially published kits/modules (printed or electronic)	21 (2.4)
State, county, district, or diocese-developed units or lessons	21 (1.9)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	9 (1.0)

Teachers who indicated that the randomly selected class used commercially published materials were asked to record the title, author, year, and ISBN of the material used most often in the class. Using this information, the publisher of the material was identified. The most commonly used materials in middle school science classes are shown in Table 40.

Table 40
Most Commonly Used Middle School Science Instructional Materials, by Course

COURSE	PUBLISHER	TITLE
Earth/Space Science	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
General/Integrated Science	Pearson	*Interactive Science*
	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
	McGraw-Hill Education	*Glencoe Science*
	Houghton Mifflin Harcourt	*Holt Science & Technology*
Life Science	Pearson	*Interactive Science*
	Houghton Mifflin Harcourt	*Science Fusion*
	McGraw-Hill Education	*Glencoe iScience*
	Houghton Mifflin Harcourt	*Life Science*
	Houghton Mifflin Harcourt	*Holt Science & Technology*
Physical Science	McGraw-Hill Education	*Glencoe iScience*
	Houghton Mifflin Harcourt	*Physical Science*

Table 41 shows the publication year of commercially published instructional materials used. More than half of middle school science classes use materials published prior to 2009.

Table 41
Publication Year of Textbooks Used in Middle School Science Classes

	PERCENT OF CLASSES†
2009 and earlier	51 (3.7)
2010–2012	27 (2.9)
2013–2015	12 (1.8)
2016–2018	11 (2.4)

† Only middle school science classes using commercially published textbooks/modules are included in these analyses.

Teachers were also asked whether the most recent unit in their randomly selected class was based primarily on either a commercially published textbook or materials developed by the state or district. Most recent units in over half of middle school science classes are based on such materials (see Table 42). Further, in 78 percent of these classes teachers incorporate activities from other materials, in 69 percent teachers modify activities, and in 54 percent teachers "pick and choose" from the materials.

Table 42
Middle School Science Teachers' Use of Instructional Materials in Most Recent Unit

	PERCENT OF CLASSES
Most Recent Unit Based on Commercially Published or State/District-Developed Material	
No	46 (2.3)
Yes	54 (2.3)
Ways Textbook is Substantially† Used‡	
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	78 (2.8)
I used these materials to guide the structure and content emphasis of the unit.	72 (2.8)
I modified activities from these materials.	69 (3.0)
I picked what is important from these materials and skipped the rest.	54 (3.4)

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

Teachers were asked why they skip parts of their textbook/module. As can be seen in Table 43, teachers in the large majority of these classes skip parts because (1) they have a different activity for the science ideas that work better, (2) the science ideas addressed in the skipped activities are not included in their pacing guides/standards, and (3) the teacher did not have enough instructional time to include the activities. Other common reasons for skipping activities include a lack of needed materials, students already knowing science ideas, and activities being too difficult for students.

Table 43
Reasons Why Parts of Middle School Science Materials Are Skipped

	PERCENT OF CLASSES†
I have different activities for those science ideas that work better than the ones I skipped.	83 (3.4)
The science ideas addressed in the activities I skipped are not included in my pacing guide/standards.	76 (3.4)
I did not have enough instructional time for the activities I skipped.	73 (3.6)
I did not have the materials needed to implement the activities I skipped.	56 (4.1)
My students already knew the science ideas or were able to learn them without the activities I skipped.	52 (4.4)
The activities I skipped were too difficult for my students.	43 (3.9)
I did not have the knowledge needed to implement the activities I skipped.	25 (4.4)

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

Given that teachers often skip activities in their materials because they know of better ones, it is perhaps not surprising that many supplement their materials. Helping students at different levels of achievement learn the targeted ideas, providing students with additional practice, and having additional activities that the teacher likes are the most common reasons for supplementing (see Table 44). In nearly half of middle school science classes, teachers supplement because their pacing guide indicates they should.

Table 44
Reasons Why Middle School Science Materials Are Supplemented

	PERCENT OF CLASSES†
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	90 (2.6)
Supplemental activities were needed to provide students with additional practice.	90 (2.3)
I had additional activities that I liked.	86 (2.6)
Supplemental activities were needed to prepare students for standardized tests.	60 (3.9)
My pacing guide indicated that I should use supplemental activities.	49 (3.9)

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

Finally, when teachers reported that they modified their published material, they rated each of several factors that may have contributed to their decision. The most common reasons for modifying materials are: (1) not having enough instructional time to implement activities as originally designed, (2) not having the necessary materials for the original activities, and (3) the original activities were too difficult conceptually for students (see Table 45).

Table 45
Reasons Why Middle School Science Materials Are Modified

	PERCENT OF CLASSES†
I did not have enough instructional time to implement the activities as designed.	70 (3.5)
I did not have the necessary materials/supplies for the original activities.	62 (3.6)
The original activities were too difficult conceptually for my students.	54 (3.9)
The original activities were too easy conceptually for my students.	46 (4.0)
The original activities were not structured enough for my students.	41 (3.8)
The original activities were too structured for my students.	33 (4.0)

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

Other Middle School Science Instructional Resources

Teachers were presented with a list of instructional technologies and asked about their availability (either always in the classroom or upon request) in the randomly selected class. As can be seen in Table 46, the vast majority of middle school science classes have access to projection devices, balances, and microscopes. In contrast, only about two-thirds have access to probes for collecting data.

Table 46
Availability† of Instructional Resources in Middle School Science Classes

	PERCENT OF CLASSES
Projection devices (e.g., Smartboard, document camera, LCD projector)	99 (1.1)
Balances (e.g., pan, triple beam, digital scale)	96 (1.0)
Microscopes	93 (1.3)
Probes for collecting data (e.g., motion sensors, temperature probes)	68 (2.4)

† Includes middle school science teachers indicating the resource is always available in their classroom or available upon request.

Teachers were also asked about the availability, either in their classroom or in another room, of laboratory facilities. Nearly all middle school science classes have electric outlets, 9 in 10 access to faucets and sinks, and 8 in 10 lab tables.

Table 47
Availability† of Laboratory Facilities in Middle School Science Classes

	PERCENT OF CLASSES
Electric outlets	98 (0.7)
Faucets and sinks	89 (1.5)
Lab tables	81 (2.0)

† Includes middle school science teachers indicating the resource is located in the classroom or available in another room.

When asked about the adequacy of resources for instruction, teachers in the majority of middle school science classes consider their facilities, equipment, and instructional technology adequate (see Table 48). However, teachers in fewer than half of middle school science classes consider their access to consumable supplies adequate.

Table 48

Adequacy† of Resources for Middle School Science Instruction

	PERCENT OF CLASSES
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	62 (2.7)
Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners)	58 (2.9)
Instructional technology (e.g., calculators, computers, probes/sensors)	57 (2.5)
Consumable supplies (e.g., chemicals, living organisms, batteries)	45 (2.7)

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

Table 49 shows mean scores on a composite based on these items. The scores indicate that teachers think their resources for instruction are somewhat, but not very, adequate. Interestingly, the mean score for physical science classes is much higher than that of any other science course.

Table 49

Middle School Science Class Mean Scores for the Adequacy of Resources for Instruction Composite

	MEAN SCORE
Overall	65 (1.4)
Earth/Space Science	60 (3.3)
General or Integrated Science	66 (1.7)
Life Science	59 (4.0)
Physical Science	74 (2.7)

Factors Affecting Middle School Science Instruction

Although the primary focus of the 2018 NSSME+ was on teachers and teaching, the study also collected information on the context of classroom practice. The survey included items asking teachers about the extent various factors promote or inhibit instruction in their randomly selected class.

As can be seen in Table 50, in the majority of middle school science classes, teachers think that many of these factors promote effective instruction. For example, teachers in almost three-quarters of middle school science classes think their principal support promotes effective science instruction. State standards, the amount of time for teacher planning, and student motivation are seen as promoting effective instruction in about two-thirds of classes. Teacher evaluation policies, parent/guardian expectations and involvement, textbook/module selection policies, and state/district testing/accountability policies are seen as promoting effective instruction in fewer than half of classes.

Table 50
Effect† of Various Factors on Instruction in Middle School Science Classes

	PERCENT OF CLASSES		
	INHIBITS	NEUTRAL	PROMOTES
Principal support	10 (2.1)	19 (1.9)	71 (2.5)
Current state standards	8 (1.7)	25 (2.3)	68 (2.5)
Amount of time for you to plan, individually and with colleagues	20 (2.5)	14 (1.5)	66 (2.6)
Students' motivation, interest, and effort in science	24 (1.9)	18 (1.8)	58 (2.4)
Students' prior knowledge and skills	27 (2.4)	19 (1.5)	55 (2.5)
Pacing guides	11 (1.7)	35 (2.9)	54 (2.8)
Amount of time available for your professional development	20 (2.4)	29 (2.6)	51 (2.8)
Teacher evaluation policies	15 (1.7)	44 (2.5)	40 (2.7)
Parent/guardian expectations and involvement	27 (2.4)	33 (2.3)	40 (2.4)
Textbook/module selection policies	20 (2.6)	43 (2.8)	37 (2.8)
State/district/diocese testing/accountability policies‡	27 (2.9)	39 (2.6)	35 (2.8)

† Middle school science teachers rated the effect of each factor on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction." The "inhibits" column includes those indicating 1 or 2. The "promotes" column includes those indicating 4 or 5.
‡ This item was presented only to teachers in public and Catholic schools.

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

Table 51
Middle School Science Class Mean Scores for Factors Affecting Instruction Composites

	MEAN SCORE		
	EXTENT TO WHICH SCHOOL SUPPORT PROMOTES EFFECTIVE INSTRUCTION	EXTENT TO WHICH THE POLICY ENVIRONMENT PROMOTES EFFECTIVE INSTRUCTION	EXTENT TO WHICH STAKEHOLDERS PROMOTE EFFECTIVE INSTRUCTION
Overall	67 (2.0)	63 (1.1)	60 (1.6)
Earth/Space Science	72 (3.5)	61 (3.2)	63 (4.2)
General or Integrated Science	70 (2.5)	63 (1.6)	62 (2.3)
Life Science	64 (4.2)	65 (2.2)	60 (3.5)
Physical Science	58 (5.8)	64 (2.8)	54 (5.7)

Summary

Nearly all middle school science teachers are white, and 7 in 10 are female. More than half have a degree in science and/or science education, and those teaching life science generally have a more in-depth background than those responsible for teaching Earth or physical science. There are a lot of new teachers in the middle school science teaching force where over a third of teachers have less than five years of experience. In addition, although middle school science teachers hold a number of beliefs about teaching and learning that are in alignment with what is known about effective science instruction (e.g., it is better for instruction to focus on ideas in depth, even if that means covering fewer topics), they also hold views that are inconsistent with this research. For example, 72 percent of middle school science teachers believe that students should be provided with definitions for new vocabulary at the beginning of instruction on an idea.

Asked about their professional development experiences, the vast majority of middle school science teachers have participated in science-focused professional development in the last three years. However, only about a quarter have had sustained professional development (more than 35 hours) in that time period. Workshops are the most common form of professional development for teachers as nearly all teachers who participated in professional development in the last three years attended a workshop as part of their professional development. In addition, only about half had opportunities to engage in science investigations in those professional development experiences. For the composites created to show the extent teachers' professional development aligned with effective professional development and supports student-centered instruction, the mean score was only just above half the total points possible.

Data on middle school science courses indicate that most schools offer either single-discipline or coordinated/integrated science courses, but not both types of these courses. The breakdown of schools offering different combinations of science classes is consistent across grades. Middle school science classes are roughly split male and female with males accounting for 52 percent of the students in middle school science classes. In addition, just over half of the students in middle school science classes are white. The prior achievement of these classes is a heterogeneous mix in 4 in 10 classes with the other classes being a homogeneous mix of either low, average, or high prior achieving students.

Instruction in these courses relies heavily on lecture and discussion, with students often participating in whole class discussions or working in small groups. However, the data also indicate that students are engaged in hands-on laboratory activities fairly regularly. Teachers in the vast majority of middle school classes report assigning an hour or less of homework per week. Half of classes are required to take more than one external assessment per year.

Data on classroom resources was also collected and it showed that two-thirds of middle school science classes receive designated materials for instruction. The vast majority of these materials are commercially published textbooks. In addition, three-quarters of classes are based on units that the teacher creates at least once a week. Teachers in almost all middle school science classes that supplement their textbook/module do so because they need activities to provide learning opportunities for students at different levels of achievement or to provide students with additional practice.

When asked about a list of factors affecting instruction, teachers indicated that a majority of them promoted instruction. Some of the most positive factors include principal support, current state standards, and amount of time designated for teachers to plan. Teachers indicated that school support, the policy environment, and stakeholders all generally positively affect instruction.