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2018 NSSME+: Status of Elementary School Science

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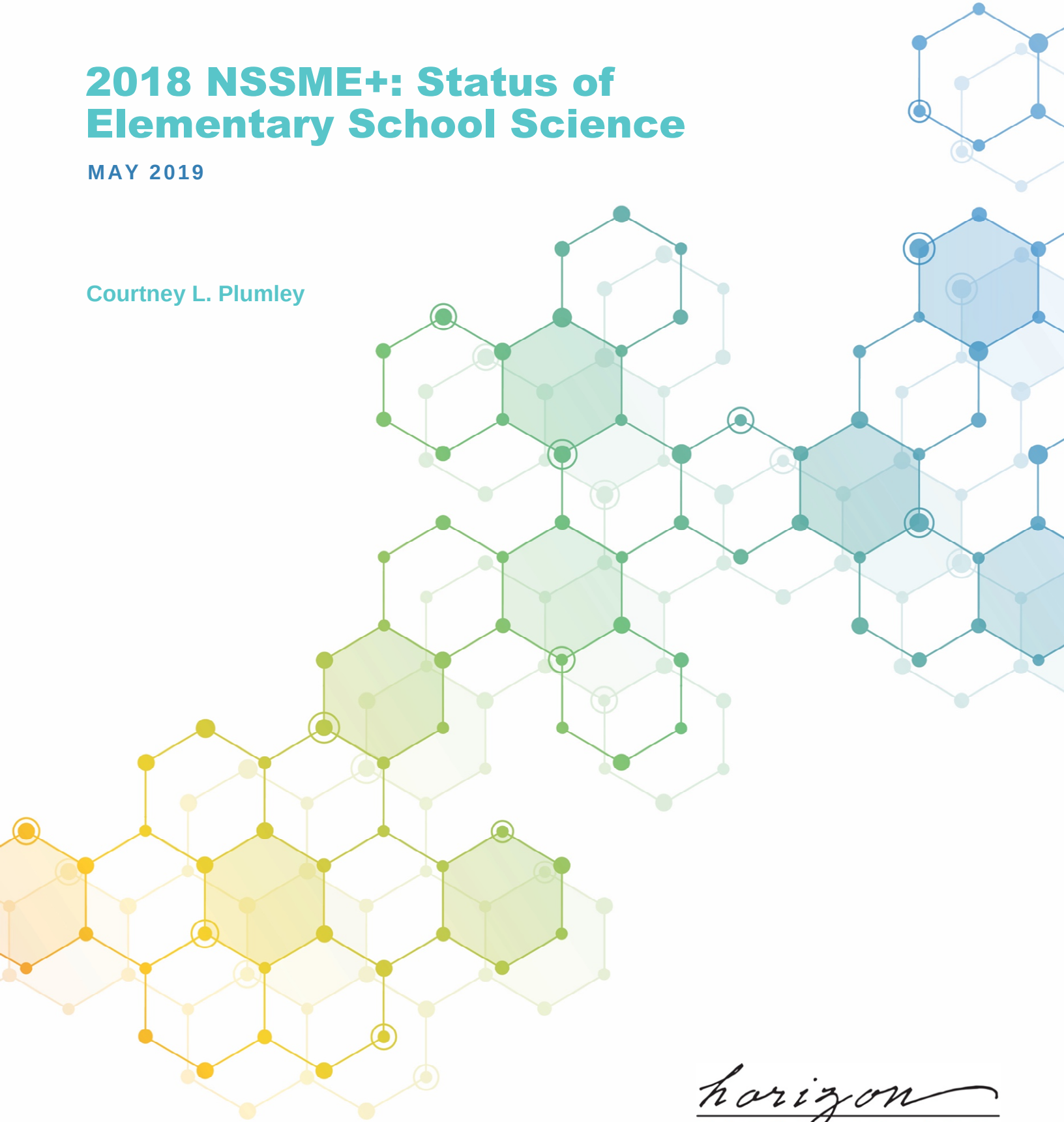
Courtney L. Plumley



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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 elementary (K–5 and 6th grade self-contained) science education based on the responses of 919 teachers, 435 of whom teach grades K–2 (called "primary" grades in this report) and 484 of whom teach grades 3–5 and 6th grade self-contained (called "intermediate" grades). Items on the survey asked about teachers themselves (e.g.,

backgrounds and opinions) as well as about their classes. Most elementary teachers were reported to teach in self-contained classrooms; i.e., they were responsible for teaching all academic subjects to a single group of students. Each such sampled teacher was randomly assigned to 1 of 2 groups—science or mathematics—and received a questionnaire specific to that subject. Elementary science teachers who do not teach self-contained classes (e.g., science specialists) were asked to focus on a randomly selected class.

Details on the survey sample design, data collection and analysis procedures, and creation of composite variables[1] are included in the *Report of the 2018 NSSME+*.[2] The standard errors for the estimates presented in this report are included in parentheses in the tables, and narrative sections of the report generally point out only those differences that are substantial as well as statistically significant at the 0.05 level.

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

- Elementary science teachers' backgrounds and beliefs;
- Professional development of elementary science teachers;
- Elementary science instruction;
- Resources available for elementary science instruction; and
- Factors affecting elementary science instruction.

Elementary 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 elementary science teachers, including their course backgrounds, beliefs about teaching and learning, and perceptions of preparedness.

Teacher Characteristics

Elementary science teachers are predominately female, and about 9 in 10 characterize themselves as white (see Table 1). Although a majority of elementary science teachers are over 40 years old, one-third have five or fewer years of experience teaching science. Very few have had a full-time job in a science- or engineering-related field before becoming a teacher.

[1] 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.

[2] 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.

Table 1
Characteristics of the Elementary Science Teaching Force

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Sex			
Female	94 (0.7)	96 (0.9)	91 (1.1)
Male	6 (0.7)	4 (0.9)	9 (1.2)
Other	0 (0.1)	0 ---†	0 (0.2)
Hispanic or Latino			
Yes	9 (1.6)	8 (1.6)	10 (2.2)
No	91 (1.6)	92 (1.6)	90 (2.2)
Race			
White	88 (1.5)	89 (1.7)	87 (2.1)
Black or African American	8 (1.2)	9 (1.5)	8 (1.5)
Asian	2 (0.6)	1 (0.6)	3 (1.0)
American Indian or Alaska Native	1 (0.6)	0 (0.2)	3 (1.3)
Native Hawaiian or Other Pacific Islander	1 (0.4)	1 (0.5)	1 (0.6)
Age			
≤ 30	19 (1.6)	16 (1.9)	21 (2.3)
31–40	28 (1.6)	28 (2.0)	28 (2.4)
41–50	29 (1.8)	31 (2.5)	26 (2.3)
51–60	20 (1.4)	19 (1.8)	21 (2.3)
61+	5 (0.8)	5 (1.3)	4 (1.1)
Experience Teaching Science at the K–12 Level			
0–2 years	15 (1.3)	12 (1.8)	18 (2.0)
3–5 years	19 (1.4)	18 (1.9)	19 (1.9)
6–10 years	19 (1.6)	17 (2.1)	22 (2.1)
11–20 years	31 (2.0)	34 (2.7)	27 (2.5)
≥ 21 years	16 (1.2)	19 (1.8)	14 (1.8)
Full-Time Job in Science Prior to Teaching			
Yes	3 (0.7)	2 (0.6)	5 (1.2)
No	97 (0.7)	98 (0.6)	95 (1.2)

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

The vast majority of elementary science teachers have had formal preparation for teaching leading to a teacher credential (see Table 2). About two-thirds received their teaching credential as part of their undergraduate program; about a fifth received their credential through a master's program.

Table 2
Elementary Science Teachers' Paths to Certification

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
An undergraduate program leading to a bachelor's degree and a teaching credential	65 (1.9)	65 (2.9)	65 (2.5)
A master's program that also led to a teaching credential	22 (1.8)	23 (2.8)	21 (2.2)
A post-baccalaureate credentialing program (no master's degree awarded)	11 (1.5)	10 (1.8)	13 (2.0)
Has not earned a teaching credential	1 (0.5)	1 (0.7)	1 (0.6)

Content Preparedness

If teachers are to help students learn science, they must themselves have a good understanding of the content and the discipline as a way of knowing. As can be seen in Table 3, very few elementary science teachers have college or graduate degrees in science, engineering, or science education. However, nearly 90 percent of elementary science teachers have taken college coursework in life science, and approximately two-thirds have had coursework in Earth science (see Table 4). In contrast, fewer than half have had at least one college course in chemistry, environmental science, or physics, and almost none have had coursework in engineering.

Table 3
Elementary Science Teacher Degrees

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Science/Engineering	3 (0.5)	2 (0.6)	4 (0.9)
Science Education	1 (0.3)	0 (0.3)	1 (0.6)
Science/Engineering or Science Education	3 (0.7)	1 (0.6)	6 (1.3)

Table 4
Elementary Science Teachers With College Coursework in Various Disciplines

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Biology/Life Sciences	89 (1.2)	89 (1.6)	88 (1.7)
Earth/Space Science	66 (1.5)	68 (2.3)	65 (2.4)
Chemistry	45 (1.8)	44 (2.4)	46 (2.8)
Environmental Science	40 (1.8)	38 (2.5)	42 (2.4)
Physics	31 (1.7)	28 (2.3)	35 (2.4)
Engineering	3 (0.5)	3 (0.9)	2 (0.6)

Because elementary science teachers are typically responsible for instruction across science disciplines, the National Science Teachers Association (NSTA) has recommended that they demonstrate competency in life science, Earth science, and physical science.[3] As a proxy for the

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

competencies outlined by NSTA in these different areas, teachers were asked about their coursework in each. As can be seen in Table 5, about one-third of elementary science teachers have had courses in all of those areas, and another 37 percent have had coursework in 2 of the 3 areas. At the other end of the spectrum, 7 percent of elementary teachers have not had courses in any of these areas.

Table 5
Elementary Science Teachers' Coursework Related to NSTA Preparation Standards

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Courses in Earth, life, and physical science†	34 (1.5)	35 (2.1)	32 (2.7)
Courses in 2 of the 3 areas	37 (1.6)	34 (2.4)	39 (2.6)
Course in 1 of the 3 areas	23 (1.4)	24 (2.2)	21 (2.4)
Courses in 0 of the 3 areas	7 (1.0)	7 (1.2)	7 (1.5)

† Physical science is defined as a course in either chemistry or physics.

Elementary teachers are typically responsible for teaching not only science, but also mathematics, reading/language arts, and other academic subjects to one group of students. Consequently, the 2018 NSSME+ asked those teachers in self-contained classes to rate their content preparedness in each of those subjects. It is clear that elementary school teachers do not feel equally well prepared to teach all academic subjects, with perceptions of preparedness to teach science paling in comparison to reading/language arts and mathematics (see Table 6). However, it is somewhat surprising that elementary teachers feel as well prepared as they do to teach science considering their lack of college coursework in the subject.

Table 6
Self-Contained Elementary Teachers' Perceptions of Their Preparedness to Teach Each Subject

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
All Elementary				
Reading/Language Arts	0 (0.1)	3 (0.5)	19 (1.0)	77 (1.2)
Mathematics	0 (0.1)	4 (0.7)	23 (1.6)	73 (1.6)
Social Studies	3 (0.5)	15 (1.0)	39 (1.4)	42 (1.3)
Science	4 (0.8)	23 (1.8)	42 (1.9)	31 (1.9)
Computer Science/Programming	45 (1.8)	35 (1.5)	14 (1.1)	6 (0.7)
Primary Grades				
Reading/Language Arts	0 (0.2)	2 (0.5)	16 (1.3)	82 (1.4)
Mathematics	0 ---†	4 (0.9)	22 (1.9)	74 (1.9)
Social Studies	2 (0.5)	15 (1.5)	39 (1.8)	43 (1.8)
Science	3 (0.9)	22 (2.2)	44 (2.3)	31 (2.5)
Computer Science/Programming	44 (1.9)	34 (1.6)	15 (1.3)	7 (0.9)
Intermediate Grades				
Reading/Language Arts	0 (0.2)	4 (0.9)	24 (1.7)	71 (1.9)
Mathematics	0 (0.3)	4 (1.1)	24 (2.7)	72 (2.9)
Social Studies	4 (0.8)	15 (1.5)	40 (2.2)	41 (2.3)
Science	7 (1.4)	24 (2.6)	39 (2.6)	31 (2.6)
Computer Science/Programming	47 (2.8)	35 (2.4)	14 (1.4)	4 (1.0)

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

All elementary science teachers were asked about their preparedness to teach various disciplines within science, as well as engineering. As can be seen in Table 7, approximately one-quarter of elementary science teachers feel very well prepared to teach life science, and one-fifth feel very well prepared to teach Earth science. Only 13 percent feel very well prepared to teach physical science. Engineering stands out as the area where elementary teachers feel least prepared.

Table 7
Elementary Teachers' Perceptions of Their Preparedness to Teach Various Science Disciplines

	PERCENT OF TEACHERS			
	NOT ADEQUATELY PREPARED	SOMEWHAT PREPARED	FAIRLY WELL PREPARED	VERY WELL PREPARED
All Elementary				
Life Science	3 (0.7)	24 (1.8)	49 (1.8)	24 (1.5)
Earth/Space Science	6 (0.8)	27 (1.5)	47 (1.7)	20 (1.5)
Physical Science	11 (1.3)	35 (1.6)	41 (2.1)	13 (1.1)
Engineering	51 (2.2)	33 (1.8)	14 (1.2)	3 (0.6)
Primary Grades				
Life Science	3 (0.8)	24 (2.4)	51 (2.5)	22 (2.0)
Earth/Space Science	6 (1.2)	29 (2.3)	49 (2.4)	16 (1.7)
Physical Science	13 (1.8)	34 (2.2)	43 (2.5)	10 (1.3)
Engineering	52 (3.0)	32 (2.6)	13 (1.8)	3 (0.9)
Intermediate Grades				
Life Science	4 (1.0)	24 (2.3)	46 (2.4)	26 (2.2)
Earth/Space Science	6 (1.3)	25 (2.2)	44 (2.5)	24 (2.2)
Physical Science	10 (1.6)	35 (2.2)	38 (2.9)	17 (1.8)
Engineering	49 (2.9)	34 (2.5)	14 (1.8)	3 (0.9)

These items were combined to form a composite variable called Perceptions of Content Preparedness. The mean composite scores shown in Table 8 indicate that elementary teachers generally do not feel well prepared to teach science. The scores also suggest that teachers in the primary grades and intermediate grades have similar perceptions of preparedness to teach science.

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

	MEAN SCORE
All Elementary	50 (0.8)
Primary Grades	49 (1.1)
Intermediate Grades	51 (1.0)

Pedagogical Preparedness

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

Overall, the large majority of elementary science teachers do not feel very well prepared pedagogically to teach science (see Table 9). For example, only 31 percent feel very well

prepared to encourage participation of all students in science and/or engineering, and only 23 percent feel very well prepared to develop students' conceptual understanding. Fewer than 1 in 10 feel very well prepared to develop students' awareness of STEM careers.

Table 9
Elementary Science Teachers Considering Themselves Very Well Prepared for Each of a Number of Tasks

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Encourage participation of all students in science and/or engineering	31 (1.6)	32 (2.3)	29 (2.2)
Use formative assessment to monitor student learning	28 (1.7)	28 (2.3)	28 (2.5)
Encourage students' interest in science and/or engineering	26 (1.3)	26 (1.9)	26 (2.1)
Develop students' conceptual understanding	23 (1.5)	22 (1.8)	23 (2.2)
Differentiate science instruction to meet the needs of diverse learners	19 (1.3)	19 (1.7)	18 (2.1)
Develop students' abilities to do science (e.g., develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	17 (1.5)	16 (2.0)	17 (2.0)
Provide science instruction that is based on students' ideas	12 (1.1)	12 (1.6)	12 (1.6)
Incorporate students' cultural backgrounds into science instruction	11 (1.1)	11 (1.6)	11 (1.7)
Develop students' awareness of STEM careers	9 (0.9)	8 (1.3)	10 (1.5)

Table 10 shows the percentage of classes taught by teachers who feel very well prepared for each of a number of tasks related to monitoring and addressing student understanding in a specific science unit. Teachers in only about a third of elementary classes feel very well prepared to monitor students' understanding, implement the designated instructional materials, assess students' understanding at the end of instruction, and uncover ideas students have prior to instruction. In addition, fewer than one-quarter of teachers in elementary classes feel very well prepared to anticipate difficulties students may have with the unit.

Table 10
Elementary 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		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Monitor student understanding during this unit	33 (1.9)	37 (2.9)	30 (2.5)
Assess student understanding at the conclusion of this unit	32 (1.8)	35 (2.8)	29 (2.5)
Implement the instructional materials to be used during this unit	32 (2.0)	33 (2.8)	31 (2.7)
Find out what students thought or already knew about the key science ideas	31 (2.2)	36 (2.7)	27 (3.4)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	22 (1.9)	26 (2.9)	19 (2.2)

The items in Table 9 were combined into a composite variable to examine science teachers' overall perceptions of pedagogical preparedness, and the items in Table 10 were combined to create a composite variable related to teachers' perceptions of pedagogical preparedness in a specific unit. As can be seen in Table 11, elementary science teachers feel more prepared to do the unit-related tasks than they do to teach science more generally.

Table 11
Mean Scores for Elementary Science Teachers' Perceptions of General and Unit-Specific Pedagogical Preparedness Composites

	MEAN SCORE	
	PEDAGOGICAL PREPAREDNESS	PREPAREDNESS TO IMPLEMENT INSTRUCTION IN PARTICULAR UNIT
All Elementary	57 (0.8)	68 (0.8)
Primary Grades	56 (1.1)	70 (1.3)
Intermediate Grades	57 (1.1)	66 (1.0)

Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning in science. As can be seen in Table 12, elementary science teachers hold a number of views that align with what is known about effective science instruction. For example, more than 90 percent of elementary teachers agree that: (1) most class periods should provide opportunities for students to share their thinking and reasoning, (2) teachers should ask students to support their conclusions about a science concept with evidence, (3) students should learn science by doing science, (4) students learn best when instruction is connected to their everyday lives, and (5) most class periods should provide opportunities for students to apply scientific ideas to real-world contexts. In addition, three-quarters of elementary teachers agree that it is better to focus on ideas in depth even if it means covering fewer topics, which is one of the central tenets of calls for reform in science education.

Inconsistent with what the field knows about effective teaching, 33 percent of elementary teachers agree that teachers should explain an idea to students before having them consider evidence for that idea, and more than half think that hands-on/laboratory activities should be used primarily to reinforce ideas that the students have already learned. And despite recommendations that students develop understanding of concepts first and learn the scientific language later, 77 percent agree that students should be given definitions for new vocabulary at the beginning of instruction on an idea.

Table 12
Elementary Science Teachers Agreeing† With Various Statements About Teaching and Learning

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Reform-Oriented Beliefs			
Most class periods should provide opportunities for students to share their thinking and reasoning.	96 (0.9)	96 (1.2)	96 (1.2)
Students learn best when instruction is connected to their everyday lives.	95 (1.0)	97 (1.1)	94 (1.6)
Students should learn science by doing science (e.g., developing scientific questions; designing and conducting investigations; analyzing data; developing models, explanations, and scientific arguments).	95 (1.0)	95 (1.3)	96 (1.4)
Teachers should ask students to support their conclusions about a science concept with evidence.	95 (1.1)	93 (1.6)	96 (1.2)
Most class periods should provide opportunities for students to apply scientific ideas to real-world contexts.	93 (1.2)	94 (1.6)	92 (1.8)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics.	75 (2.1)	74 (2.8)	76 (2.5)
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.	77 (2.1)	80 (2.7)	74 (3.0)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned.	56 (2.4)	53 (3.5)	58 (3.0)
Teachers should explain an idea to students before having them consider evidence that relates to the idea.	33 (2.1)	35 (3.0)	31 (3.0)
Students learn science best in classes with students of similar abilities.	25 (1.9)	23 (2.7)	28 (3.0)

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

These items were combined into two composite variables: Traditional Teaching Beliefs and Reform-Oriented Teaching Beliefs. The composite scores shown in Table 13 suggest that elementary science teachers have relatively strong reform-oriented beliefs. However, traditional beliefs are also fairly prevalent across all elementary grades.

Table 13
Mean Scores for Elementary Science Teachers' Beliefs About Teaching and Learning Composites

	MEAN SCORE	
	TRADITIONAL BELIEFS	REFORM-ORIENTED BELIEFS
All Elementary	55 (0.9)	86 (0.6)
Primary Grades	55 (1.2)	86 (0.7)
Intermediate Grades	56 (1.1)	87 (0.9)

Leadership Roles and Responsibilities

In addition to asking teachers about their educational background, beliefs, and preparedness, the survey asked teachers whether they have served in various leadership roles in the profession in the last three years. As can be seen in Table 14, the majority of elementary science teachers have not served in leadership roles in the last three years. Only about a third of elementary science

teachers supervised a student teacher in their classroom, and only about a fifth served on a school or district-wide science committee.

Table 14
Elementary Science Teachers Having Various Leadership Responsibilities Within the Last Three Years

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Supervised a student teacher in their classroom	30 (2.2)	30 (2.7)	30 (3.2)
Served on a school or district/diocese-wide science committee	22 (1.9)	21 (2.4)	24 (2.5)
Served as a lead teacher or department chair in science	14 (1.6)	12 (2.1)	18 (2.5)
Observed another teacher's science lesson for the purpose of giving them feedback	11 (1.6)	10 (1.9)	13 (2.6)
Led or co-led a workshop or professional learning community for other teachers focused on science or science teaching	8 (1.4)	8 (1.9)	9 (1.8)
Taught a science lesson for other teachers in their school to observe	8 (1.1)	6 (1.3)	10 (1.9)
Served as a formal mentor or coach for a science teacher	4 (0.7)	3 (0.9)	5 (1.3)

Professional Development of Elementary 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. However, staying up-to-date is particularly challenging for teachers at the elementary level, as they typically teach multiple subjects. About 60 percent of elementary 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 (see Table 15). At the other end of the spectrum, almost 1 in 4 elementary science teachers have never participated in science/engineering-focused professional development.

Table 15
Elementary Teachers' Most Recent Participation in Science-Focused Professional Development

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
In the last 12 months	36 (2.2)	31 (2.6)	41 (2.9)
1–3 years ago	22 (1.7)	24 (2.3)	19 (2.4)
4–6 years ago	8 (1.2)	9 (1.6)	7 (1.4)
7–10 years ago	5 (0.7)	5 (1.2)	4 (0.9)
More than 10 years ago	6 (1.0)	7 (1.4)	5 (1.2)
Never	24 (1.5)	24 (1.8)	24 (2.2)

Although some involvement in professional development is better than none, brief exposure of a few hours over several years is not likely to enhance teachers' knowledge and skills in meaningful ways. Accordingly, teachers were asked about the total amount of time they have spent on professional development related to science/engineering in the last three years. Nearly

two-thirds of elementary teachers have spent less than 6 hours in science/engineering-focused professional development in the last three years; only a small percentage have had more than 35 hours (see Table 16).

Table 16
Time Spent by Elementary Teachers on Science-Focused Professional Development in the Last Three Years

	PERCENT OF TEACHERS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
None	43 (2.2)	46 (2.7)	40 (2.8)
Less than 6 hours	20 (1.6)	22 (2.2)	18 (1.9)
6–15 hours	20 (1.5)	17 (2.0)	24 (2.4)
16–35 hours	12 (1.3)	11 (1.8)	14 (2.1)
36–80 hours	3 (0.7)	3 (0.9)	4 (0.9)
More than 80 hours	1 (0.4)	1 (0.5)	1 (0.6)

Teachers who participated in professional development were asked about the nature of those activities. Workshops on science or science teaching were the most prevalent activity, with about 9 in 10 elementary teachers indicating they have attended one in the last three years (see Table 17). In addition, 42 percent have participated in science/engineering-related professional learning communities or other types of teacher study groups.

Table 17
Elementary Teachers Participating in Various Science-Focused Professional Development Activities in the Last Three Years

	PERCENT OF TEACHERS†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Attended a professional development program/workshop	89 (2.0)	88 (2.8)	89 (2.5)
Participated in a professional learning community/lesson study/teacher study group	42 (2.9)	40 (4.0)	43 (3.6)
Received assistance or feedback from a formally designated coach/mentor	28 (2.6)	27 (3.5)	30 (4.0)
Attended a national, state, or regional science teacher association meeting	12 (1.8)	12 (2.4)	12 (2.7)
Completed an online course/webinar	9 (1.5)	7 (1.8)	12 (2.4)
Took a formal course for college credit	5 (1.3)	5 (1.8)	5 (2.3)

† Only elementary 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.[4] Accordingly, teachers who participated in professional development in the last three years were asked a series of additional questions about the nature of those experiences.

As can be seen in Table 18, 57 percent of elementary science teachers have had substantial opportunities to work closely with other teachers from their school in their professional development. Forty-three percent have had substantial opportunities to experience science lessons as their students would, though primary grades teachers are more likely than intermediate grades teachers to have had this opportunity (48 vs. 37 percent). Only about a third of elementary teachers have had substantial opportunities to engage in science investigations/ engineering design challenges, examine classroom artifacts, and try out what they learned and then come back to talk about it in their professional development.

Table 18

Elementary 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‡		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Worked closely with other teachers from their school	57 (3.3)	58 (4.7)	56 (4.2)
Worked closely with other teachers who taught the same grade and/or subject whether or not they were from their school	47 (3.2)	48 (4.2)	47 (4.2)
Had opportunities to experience lessons, as their students would, from the textbook/modules they use in their classroom	43 (3.1)	48 (3.9)	37 (4.0)
Had opportunities to engage in science investigations/engineering design challenges	38 (3.0)	40 (4.7)	35 (3.8)
Had opportunities to examine classroom artifacts (e.g., student work samples, videos of classroom instruction)	31 (2.9)	31 (4.0)	30 (4.4)
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)	33 (3.6)	28 (3.2)
Had opportunities to rehearse instructional practices during the professional development (i.e., try out, receive feedback, and reflect on those practices)	23 (2.6)	25 (3.6)	21 (3.3)

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

‡ Only elementary 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 teachers about the focus of their recent professional development/ coursework. For roughly 40 percent of elementary teachers, these experiences heavily emphasized deepening their own science content knowledge, deepening their understanding of how science is done, and monitoring student understanding during instruction (see Table 19). Given the inclusion of engineering in the Next Generation Science Standards and many states' standards, as well as teachers' self-reported lack of preparation to teach engineering, it is somewhat surprising that only a quarter of elementary science teachers have attended professional development that focused heavily on deepening their understanding of how

[4] 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.

engineering is done. Further, only about a fifth of elementary 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 19
Elementary Teachers Reporting That Their Science-Focused Professional Development in the Last Three Years Gave Heavy Emphasis† to Various Areas

	PERCENT OF TEACHERS‡		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Monitoring student understanding during science instruction	40 (3.3)	41 (4.8)	39 (3.7)
Deepening their own science content knowledge	39 (2.6)	37 (3.9)	41 (3.7)
Deepening their understanding of how science is done (e.g., developing scientific questions, developing and using models, engaging in argumentation)	39 (2.9)	43 (4.2)	35 (4.5)
Learning how to provide science instruction that integrates engineering, mathematics, and/or computer science	36 (3.0)	35 (4.6)	37 (4.5)
Finding out what students think or already know prior to instruction on a topic	35 (3.0)	35 (4.6)	34 (3.9)
Implementing the science textbook/modules to be used in their classroom	34 (2.9)	33 (3.9)	35 (4.4)
Differentiating science instruction to meet the needs of diverse learners	33 (2.9)	31 (4.3)	36 (4.5)
Learning about difficulties that students may have with particular science ideas	26 (3.2)	24 (3.8)	28 (4.2)
Deepening their understanding of how engineering is done (e.g., identifying criteria and constraints, designing solutions, optimizing solutions)	25 (2.8)	32 (4.1)	18 (3.1)
Incorporating students' cultural backgrounds into science instruction	19 (2.5)	17 (3.5)	21 (3.3)

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

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

The 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. Similarly, the items about the emphases of professional development were combined into a composite variable called Extent Professional Development Supports Student-Centered Instruction. As can be seen in Table 20, the mean scores on these composites are 50 and below, indicating that elementary science teachers' professional development aligns only somewhat with the elements of effective professional development and does not heavily emphasize student-centered instruction.

Table 20
Elementary 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
All Elementary	49 (1.4)	48 (1.6)
Primary Grades	50 (2.1)	49 (2.3)
Intermediate Grades	47 (1.7)	46 (2.0)

Elementary Science Instruction

The 2018 NSSME+ collected data on elementary science instruction, including time spent on various subjects in the elementary grades and composition of elementary science classes (e.g., gender, race/ethnicity, and prior achievement levels of students). The 2018 NSSME+ also collected data about elementary science teachers' perceptions of their autonomy in making curricular and instructional decisions, as well as their instructional objectives and class activities they use in accomplishing these objectives.

Time Spent

Self-contained elementary teachers were asked how often they teach science. As can be seen in Table 21, only 18 percent of primary grades classes and 26 percent of intermediate grades classes receive science instruction all or most days every week of the school year. The large majority of elementary classes receive science instruction only a few days a week or during some, but not all, weeks of the year.

Table 21
Frequency With Which Self-Contained Elementary Teachers Teach Science

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
All/Most days, every week	21 (1.5)	18 (1.7)	26 (2.1)
Three or fewer days, every week	39 (1.6)	41 (2.0)	38 (2.3)
Some weeks, but not every week	39 (1.8)	42 (2.3)	36 (2.1)

The survey also asked about the approximate number of minutes typically spent on teaching mathematics, reading/language arts, science, and social studies in self-contained classes that cover all four subjects. Primary grades classes spend an average of 17 minutes per day on science, compared to 89 minutes on reading/language arts and 55 minutes on mathematics (see Table 22). A similar pattern is seen in intermediate grades classes, as science is taught an average of 23 minutes per day compared to 85 minutes for reading/language arts and 63 minutes for mathematics.

Table 22
Average Number of Minutes Per Day Spent Teaching Each Subject in Self-Contained Classes†

	NUMBER OF MINUTES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Reading/Language Arts	87 (1.4)	89 (1.8)	85 (2.2)
Mathematics	58 (0.8)	55 (0.9)	63 (1.3)
Science	20 (0.5)	17 (0.5)	23 (0.6)
Social Studies	17 (0.4)	15 (0.5)	19 (0.6)

† Only elementary classes for which teachers indicated they teach reading, mathematics, science, and social studies to one class of students are included in these analyses.

Class Characteristics

The typical elementary science class has 22 students; two-thirds of classes have between 18 and 25 students. Demographic data for elementary science students are shown in Table 23.

Table 23
Demographics of Students in Elementary Science Classes

	PERCENT OF STUDENTS		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Sex			
Male	51 (0.5)	53 (0.7)	50 (0.8)
Female	49 (0.5)	47 (0.7)	50 (0.8)
Race/Ethnicity			
White	50 (1.8)	54 (2.2)	47 (2.7)
Hispanic or Latino	20 (1.6)	16 (1.5)	24 (2.8)
Black or African American	18 (1.4)	18 (1.6)	18 (1.8)
Asian	4 (0.8)	4 (0.9)	4 (1.3)
American Indian or Alaskan Native	3 (0.8)	3 (1.0)	3 (0.9)
Native Hawaiian or Other Pacific Islander	1 (0.2)	1 (0.3)	1 (0.1)
Two or more races	5 (0.4)	5 (0.5)	5 (0.5)

Elementary science teachers were asked to indicate the prior achievement level of students in their class relative to other students in the school. As can be seen in Table 24, the vast majority of classes are composed of students of average prior achievement or a mixture of prior achievement levels.

Table 24
Prior Achievement Grouping in Elementary Science Classes

	PERCENT OF CLASSES			
	MOSTLY LOW ACHIEVERS	MOSTLY AVERAGE ACHIEVERS	MOSTLY HIGH ACHIEVERS	A MIXTURE OF LEVELS
All Elementary	11 (1.3)	43 (1.8)	6 (0.9)	41 (1.9)
Primary Grades	8 (1.5)	42 (2.3)	6 (1.4)	44 (2.4)
Intermediate Grades	13 (1.7)	44 (2.8)	5 (1.3)	38 (2.5)

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 elementary science classes, teachers are most likely to perceive themselves as having strong control over amount of homework, teaching techniques, and criteria for grading student performance (see Table 25). In fewer classes, teachers perceive themselves as having strong control over determining course goals and objectives, selecting curriculum materials, and selecting content, topics, and skills to be taught.

Table 25
Elementary Science Classes in Which Teachers Report Having Strong Control Over Various Curricular and Instructional Decisions

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Determining the amount of homework to be assigned	59 (2.5)	58 (3.1)	61 (3.3)
Selecting teaching techniques	48 (2.3)	43 (3.0)	52 (3.7)
Choosing criteria for grading student performance	41 (2.5)	34 (3.3)	48 (3.6)
Selecting the sequence in which topics are covered	30 (2.6)	25 (3.1)	35 (4.1)
Determining the amount of instructional time to spend on each topic	21 (2.7)	17 (2.6)	25 (4.1)
Determining course goals and objectives	17 (2.7)	13 (1.9)	22 (4.4)
Selecting curriculum materials (e.g., textbooks/modules)	15 (2.5)	12 (2.3)	18 (4.2)
Selecting content, topics, and skills to be taught	13 (2.6)	8 (1.5)	18 (4.4)

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

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

For Pedagogy Control, the items are:

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

As can be seen in Table 26, elementary science teachers perceive much more control over decisions related to pedagogy than curriculum.

Table 26
Elementary Science Class Mean Scores for Curriculum Control and Pedagogy Control Composites

	MEAN SCORE	
	CURRICULUM CONTROL	PEDAGOGY CONTROL
All Elementary	45 (2.1)	79 (1.2)
Primary Grades	44 (1.8)	76 (1.4)
Intermediate Grades	47 (3.1)	81 (1.5)

Instructional Objectives

The survey provided a list of possible objectives of science instruction and asked teachers how much emphasis each would receive over an entire year (or a particular course for elementary teachers who teach science to more than one class of students). As can be seen in Table 27, understanding science concepts and learning how to do science are more likely to be heavily emphasized in intermediate grades classes than primary grades classes (55 vs. 37 percent and 31 vs. 21 percent, respectively). Intermediate grades classes are also more likely than primary

grades classes to focus heavily on learning test-taking skills/strategies (24 vs. 15 percent), likely because most state accountability systems do not test students before 3rd grade. Increasing students' interest in science/engineering, learning science vocabulary and/or facts, and developing students' confidence that they can successfully pursue careers in science/engineering are heavily emphasized in roughly a quarter of elementary science classes.

Table 27
Elementary Science Classes With Heavy Emphasis on Various Instructional Objectives

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Understanding science concepts	47 (1.7)	37 (2.6)	55 (2.8)
Increasing students' interest in science/engineering	27 (2.2)	27 (2.7)	28 (3.2)
Learning science vocabulary and/or facts	27 (1.9)	24 (2.7)	29 (2.5)
Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	26 (2.0)	21 (2.5)	31 (2.9)
Developing students' confidence that they can successfully pursue careers in science/engineering	23 (2.0)	21 (2.4)	24 (3.1)
Learning about real-life applications of science/engineering	20 (2.1)	18 (2.4)	22 (3.6)
Learning test-taking skills/strategies	20 (1.5)	15 (1.7)	24 (2.4)
Learning about different fields of science/engineering	8 (1.9)	6 (1.3)	10 (3.1)
Learning how to do engineering (e.g., identify criteria and constraints, design solutions, optimize solutions)	8 (1.8)	6 (1.7)	10 (3.1)

The objectives related to reform-oriented instruction (understanding science concepts, learning about different fields of science/engineering, learning how to do science, learning how to do engineering, learning about real-life applications of science/engineering, increasing students' interest in science/engineering, and developing students' confidence that they can successfully pursue careers in science/engineering) were combined into a composite variable. Overall, scores on this composite are not very high (see Table 28), indicating that elementary science classes are only somewhat likely to emphasize reform-oriented instructional objectives.

Table 28
Elementary Science Class Mean Scores for the Reform-Oriented Instructional Objectives Composite

	MEAN SCORE
All Elementary	60 (0.9)
Primary Grades	57 (1.1)
Intermediate Grades	63 (1.4)

Class Activities

The 2018 NSSME+ included several items that provide information about how science is taught at the elementary school level. One series of items listed various instructional strategies and asked teachers to indicate the frequency with which they used each in their science class. As can be seen in Table 29, three instructional activities occur at least once a week in at least three-quarters of elementary science classes: engaging the whole class in discussions, explaining science ideas to the whole class, and having students work in small groups. Conversely, several

activities occur weekly in fewer than half of elementary science classes, including having students write their reflections and engaging the class in project-based learning (PBL) activities.

A number of class activities are much more common in intermediate grades than in primary grades, including: having students work in small groups (81 vs. 68 percent), having students write their reflections (49 vs. 37 percent), having students read from curriculum materials in class (44 vs. 29 percent), and having student practice for standardized tests (25 vs. 9 percent).

Table 29
Elementary Science Classes in Which Teachers Report Using Various Activities at Least Once a Week

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Engage the whole class in discussions	90 (1.0)	89 (1.7)	92 (1.2)
Explain science ideas to the whole class	85 (1.9)	83 (1.7)	87 (3.0)
Have students work in small groups	75 (1.6)	68 (2.8)	81 (1.8)
Focus on literacy skills (e.g., informational reading or writing strategies)	60 (1.6)	61 (2.4)	59 (2.9)
Have students do hands-on/laboratory activities	53 (1.9)	51 (2.8)	54 (2.8)
Have students write their reflections (e.g., in their journals, on exit tickets) in class or for homework	43 (2.0)	37 (2.8)	49 (2.9)
Have students read from a textbook, module, or other material in class, either aloud or to themselves	37 (1.7)	29 (2.4)	44 (2.8)
Engage the class in project-based learning (PBL) activities	29 (2.2)	28 (2.4)	30 (3.4)
Have students practice for standardized tests	17 (1.3)	9 (1.4)	25 (2.3)
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	10 (1.1)	9 (1.5)	10 (1.6)

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*[5]—i.e., the practices of science such as formulating scientific questions, designing and implementing investigations, developing models and explanations, and engaging in argumentation. As can be seen in Table 30, the majority of elementary science classes do not engage in aspects of science practices on a weekly basis. Of those that do, the most common practices are generating scientific questions (38 percent of classes), conducting scientific investigations (36 percent), organizing and/or representing data (34 percent), and making and supporting claims with evidence (32 percent).

More intermediate grades classes than primary grades classes engage with the majority of the science practices on a weekly basis, including:

- Conducting scientific investigations (41 vs. 31 percent);
- Making and supporting claims with evidence (39 vs. 24 percent);
- Developing procedures for a scientific investigation (34 vs. 23 percent);
- Using multiple sources of evidence (35 vs. 17 percent); and
- Developing scientific models (23 vs. 13 percent).

[5] 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 30
Elementary Science Classes in Which Teachers Report Students Engaging in Various Aspects of Science Practices at Least Once a Week

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Generate scientific questions	38 (2.2)	35 (2.5)	40 (3.3)
Conduct a scientific investigation	36 (2.2)	31 (2.6)	41 (3.0)
Organize and/or represent data using tables, charts, or graphs in order to facilitate analysis of the data	34 (2.1)	29 (2.8)	38 (2.7)
Make and support claims with evidence	32 (2.0)	24 (2.5)	39 (3.3)
Determine what data would need to be collected in order to answer a scientific question	29 (2.1)	23 (2.5)	36 (3.6)
Develop procedures for a scientific investigation to answer a scientific question	29 (2.2)	23 (2.8)	34 (3.0)
Analyze data using grade-appropriate methods in order to identify patterns, trends, or relationships	27 (1.9)	25 (2.6)	28 (3.0)
Use multiple sources of evidence to develop an explanation	26 (2.0)	17 (1.8)	35 (3.1)
Revise their explanations based on additional evidence	22 (2.0)	13 (1.8)	29 (3.0)
Compare data from multiple trials or across student groups for consistency in order to identify potential sources of error or inconsistencies in the data	19 (2.2)	14 (2.6)	22 (3.2)
Determine whether or not a question is scientific	19 (1.6)	13 (2.0)	24 (2.4)
Develop scientific models—physical, graphical, or mathematical representations of real-world phenomena	19 (1.7)	13 (1.7)	23 (2.7)
Summarize patterns, similarities, and differences in scientific information obtained from multiple sources	18 (2.2)	14 (1.8)	22 (3.4)
Use data and reasoning to defend, verbally or in writing, a claim or refute alternative scientific claims	17 (1.6)	12 (1.9)	22 (2.5)
Select and use grade-appropriate mathematical and/or statistical techniques to analyze data	15 (1.4)	16 (1.8)	14 (2.1)
Consider how missing data or measurement error can affect the interpretation of data	14 (1.5)	11 (2.1)	16 (2.3)
Pose questions that elicit relevant details about the important aspects of a scientific argument	14 (1.4)	9 (1.5)	18 (2.1)
Evaluate the strengths and weaknesses of competing scientific explanations	12 (1.3)	9 (1.5)	14 (2.1)
Identify the strengths and limitations of a scientific model—in terms of accuracy, clarity, generalizability, accessibility to others, strength of evidence supporting it	12 (1.8)	9 (1.6)	15 (3.0)
Use mathematical and/or computational models to generate data to support a scientific claim	12 (1.2)	10 (1.5)	13 (2.0)
Determine what details about an investigation might persuade a targeted audience about a scientific claim	11 (1.2)	7 (1.4)	14 (1.9)
Construct a persuasive case, verbally or in writing, for the best scientific model or explanation for a real-world phenomenon	10 (1.1)	8 (1.4)	11 (1.9)
Evaluate the credibility of scientific information—e.g., its reliability, validity, consistency, logical coherence, lack of bias, or methodological strengths and weaknesses	8 (1.1)	6 (1.2)	11 (1.8)

These items were combined into a composite variable titled Engaging Students in the Practices of Science. The scores on this composite, displayed in Table 31, indicate that students in elementary science classes are not very likely to be engaged in the science practices, though students in intermediate grades classes are more likely than students in primary grades classes to do so.

Table 31
Elementary Science Class Mean Scores for Engaging Students in the Practices of Science Composite

	MEAN SCORE
All Elementary	39 (0.8)
Primary Grades	34 (1.1)
Intermediate Grades	43 (1.2)

Given recent trends to incorporate engineering and computer science into science instruction, the 2018 NSSME+ asked teachers how frequently they do so. The vast majority of elementary science classes experience engineering one or two times per month or less, and 16 percent never engage in engineering activities (see Table 32). A large majority (71 percent) of elementary classes never include coding as part of their science instruction.

Table 32
Elementary Science Classes in Which Teachers Report Incorporating Engineering and Coding Into Science Instruction

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Engineering			
Never	16 (1.8)	17 (2.9)	15 (2.2)
Rarely (e.g., a few times per year)	48 (2.5)	53 (2.8)	44 (3.8)
Sometimes (e.g., once or twice a month)	26 (2.2)	24 (2.9)	28 (2.7)
Often (e.g., once or twice a week)	8 (2.7)	4 (1.4)	12 (4.4)
All or almost all science lessons	1 (0.5)	1 (0.5)	2 (0.9)
Coding			
Never	71 (3.4)	72 (3.4)	70 (4.8)
Rarely (e.g., a few times per year)	16 (2.0)	17 (2.6)	15 (2.6)
Sometimes (e.g., once or twice a month)	11 (2.8)	9 (2.0)	12 (4.6)
Often (e.g., once or twice a week)	3 (0.7)	3 (1.1)	3 (1.0)
All or almost all science lessons	0 ---†	0 ---†	0 ---†

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

In addition to asking about class activities in the course as a whole, teachers were asked about activities that took place during their most recent science lesson. As can be seen in Table 33, a large majority of elementary lessons include whole class discussion and the teacher explaining a science idea to the whole class (86 and 83 percent, respectively). In addition, about half of elementary lessons include students doing hands-on/laboratory activities.

There are some notable differences in class activities between the grade bands. Intermediate grades classes are more likely than primary grades classes to work in small groups (84 vs. 70 percent) and read about science (51 vs. 38 percent), while primary grades classes are more likely to have a whole class discussion (89 vs. 83 percent).

Table 33
Elementary Science Classes Participating in Various Activities in Most Recent Lesson

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Whole class discussion	86 (1.2)	89 (1.6)	83 (1.7)
Teacher explaining a science idea to the whole class	83 (1.5)	84 (1.8)	82 (2.3)
Students working in small groups	78 (1.5)	70 (2.4)	84 (1.8)
Students doing hands-on/laboratory activities	47 (2.1)	47 (2.8)	47 (2.8)
Students reading about science	45 (2.1)	38 (2.4)	51 (3.0)
Students writing about science	45 (2.3)	43 (2.8)	46 (3.0)
Teacher conducting a demonstration while students watched	37 (2.1)	40 (2.7)	33 (2.7)
Students completing textbook/worksheet problems	35 (1.8)	34 (2.4)	37 (2.6)
Test or quiz	9 (1.1)	6 (1.5)	12 (1.8)
Practicing for standardized tests	2 (0.6)	0 (0.2)	4 (1.1)

The survey also asked teachers to estimate the time spent on a number of types of activities in their most recent science lesson. As can be seen in Table 34, the majority of class time was spent on whole class activities and small group work. Primary grades classes tend to spend more time than intermediate grades classes on whole class activities (45 vs. 38 percent of class time), while intermediate grades classes tend to spend more time working in small groups (37 vs. 30 percent of class time).

Table 34
Average Percentage of Time Spent on Different Activities in the Most Recent Elementary Science Lesson

	AVERAGE PERCENT OF CLASS TIME		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Whole class activities (e.g., lectures, explanations, discussions)	41 (0.9)	45 (1.3)	38 (1.0)
Small group work	33 (1.0)	30 (1.2)	37 (1.6)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	18 (0.8)	18 (1.0)	17 (1.1)
Non-instructional activities (e.g., attendance taking, interruptions)	8 (0.4)	8 (0.4)	8 (0.6)

Homework and Assessment Practices

Teachers were asked about the amount of science homework assigned per week in their class. More than 90 percent of primary grades classes and nearly 70 percent of intermediate grades classes are given fewer than 15 minutes of science homework per week (see Table 35). These data stand in sharp contrast to mathematics, where about one-third of primary grades classes and about two-thirds of intermediate grades classes are assigned more than 30 minutes of mathematics homework per week.[6]

[6] Data related to the status of elementary mathematics instruction come from: Malzahn, K. A. (2019). *2018 NSSME+: Status of elementary mathematics*. Chapel Hill, NC: Horizon Research, Inc.

Table 35
Amount of Homework Assigned in Elementary Science Classes Per Week

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
None	57 (2.8)	74 (3.6)	41 (3.7)
1–15 minutes per week	21 (2.2)	17 (2.6)	25 (3.1)
15–30 minutes per week	12 (1.4)	5 (1.3)	19 (2.7)
31–60 minutes per week	8 (2.6)	2 (0.9)	13 (4.7)
61–90 minutes per week	2 (1.1)	2 (2.1)	2 (0.9)
91–120 minutes per week	0 (0.1)	0 (0.0)	0 (0.3)
More than 2 hours per week	0 ---†	0 ---†	0 ---†

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

The survey asked how often students are required to take external assessments, such as state or district benchmark assessments. As can be seen in Table 36, 86 percent of primary grades classes and 40 percent of intermediate grades classes never take external assessments in science. In contrast, 73 percent of elementary classes take three or more external assessments in mathematics each year, likely due to state accountability systems, which tend to focus more on mathematics than science.

Table 36
Frequency of Required External Testing in Elementary Science Classes

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Never	62 (2.4)	86 (2.2)	40 (3.5)
Once a year	17 (2.6)	4 (1.2)	31 (4.1)
Twice a year	4 (0.8)	2 (1.0)	5 (1.3)
Three or four times a year	11 (1.5)	5 (1.5)	17 (2.6)
Five or more times a year	6 (1.1)	3 (1.1)	8 (1.6)

Resources Available for Elementary Science

The quality and availability of instructional resources are major factors affecting elementary 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 2018 NSSME+ collected data on the use of various instructional resources, including commercially published textbooks. Of particular interest is how much latitude teachers have in selecting instructional resources. Table 37 shows that instructional materials are designated by the district for most elementary science classes.

Table 37
Elementary Science Classes for Which the District Designates Instructional Materials to Be Used

	PERCENT OF CLASSES
All Elementary	72 (2.4)
Primary Grades	67 (3.2)
Intermediate Grades	76 (3.1)

When teachers responded that their class had a designated instructional material, the survey presented them with a list of possible types of materials. Despite the increasing variety of instructional materials, commercially published textbooks and kits/modules are the most commonly designated materials (see Table 38). In the intermediate grades, textbooks are particularly prevalent (76 percent of intermediate classes vs. 55 percent of primary classes). State- and district-developed resources or fee-based websites are also relatively common in elementary grades. These data indicate that for many classes, multiple types of materials are designated by the district.

Table 38
Elementary Science Classes for Which Various Types of Instructional Resources Are Designated

	PERCENT OF CLASSES†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks	67 (2.9)	55 (3.7)	76 (3.3)
Commercially published kits/modules (printed or electronic)	51 (2.7)	49 (3.1)	53 (3.4)
State, county, district, or diocese-developed units or lessons	43 (2.2)	45 (3.4)	42 (2.7)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	39 (2.7)	43 (2.9)	36 (3.7)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	20 (1.9)	20 (2.7)	21 (2.7)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	9 (1.2)	8 (1.5)	10 (1.8)

† Only elementary 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 was based on various types of materials. As can be seen in Table 39, fee-based websites and teacher-created units and lessons share roughly equal influence on elementary science instruction, followed by commercially published textbooks. Commercially published textbooks and kits/modules are used more often in intermediate grades science classes than primary grades classes (49 vs. 27 percent and 35 vs. 22 percent, respectively).

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

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPOP, Discovery Ed, Teachers Pay Teachers)	49 (2.2)	52 (2.9)	47 (3.2)
Units or lessons you created (either by yourself or with others)	47 (2.4)	47 (2.8)	47 (3.6)
Commercially published textbooks (printed or electronic), including the supplementary materials (e.g., worksheets, laboratory handouts) that accompany the textbooks	38 (1.9)	27 (2.3)	49 (3.1)
State, county, district, or diocese-developed units or lessons	32 (2.4)	32 (2.6)	31 (3.6)
Commercially published kits/modules (printed or electronic)	29 (2.1)	22 (2.2)	35 (3.2)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	28 (2.0)	28 (2.4)	28 (3.1)
Lessons or resources from websites that are free (e.g., Khan Academy, PhET)	23 (2.1)	20 (2.4)	25 (3.3)
Online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity)	7 (1.0)	6 (1.0)	9 (1.7)

Teachers utilizing a published textbook or module were asked to record the title, author, year, and ISBN of the material used most often in the class. Using this information, the publisher of the materials was identified. The four textbook/module series most commonly used in elementary science classes are *Science Fusion* (Houghton Mifflin Harcourt), *FOSS* (Delta Education), *Harcourt Science* (Houghton Mifflin Harcourt), and *Interactive Science* (Pearson).

Table 40 shows the publication year of science instructional materials. Nearly half of elementary science classes use textbooks or modules published prior to 2010.

Table 40
Publication Year of Textbooks Used in Elementary Science Classes

	PERCENT OF CLASSES†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
2009 or earlier	45 (4.4)	40 (5.0)	48 (5.9)
2010–12	26 (4.7)	23 (4.3)	27 (6.4)
2013–15	21 (3.9)	24 (4.7)	19 (4.3)
2016–18	9 (1.6)	13 (3.1)	7 (1.6)

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

Teachers were also asked whether the most recent unit in their class was based primarily on either a commercially published textbook or materials developed by the state or district. As shown in Table 41, almost two-thirds of elementary science classes are based on such materials. Intermediate grades classes used commercially published materials or state- or district-developed materials more often than primary grades classes (71 vs. 57 percent).

Table 41
Elementary Science Classes in Which the Most Recent Unit Was Based on a Commercially Published Textbook or a Material Developed by the State or District

	PERCENT OF CLASSES†
All Elementary	65 (2.1)
Primary Grades	57 (3.1)
Intermediate Grades	71 (2.5)

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

Teachers were also asked to describe how they used their instructional materials in their most recent unit (see Table 42). Teachers in 77 percent of classes using commercially published or state/district-developed materials base the overall structure and content emphasis of the unit on those materials. However, it is also clear that teachers of elementary science classes deviate from their instructional materials substantially, as many incorporate activities from other sources (65 percent), modify activities (59 percent), or skip activities (51 percent). Teachers in intermediate grades classes are more likely to make all of these types of changes to their instructional materials than teachers in primary grades classes.

Table 42
Ways Elementary Science Teachers Substantially† Used Their Materials in Most Recent Unit

	PERCENT OF CLASSES‡		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
I used these materials to guide the structure and content emphasis of the unit.	77 (3.1)	75 (2.9)	78 (4.9)
I incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what these materials were lacking.	65 (2.7)	56 (3.9)	71 (3.3)
I modified activities from these materials.	59 (2.9)	53 (3.7)	63 (3.9)
I picked what is important from these materials and skipped the rest.	51 (3.1)	44 (4.2)	56 (4.0)

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

‡ Only elementary science classes in which the most recent unit was based on commercially published or state/district-developed materials are included in these analyses.

Teachers who used textbooks/modules or state/district-developed materials in their most recent unit were asked why they skipped parts of these instructional materials. As can be seen in Table 43, activities in textbook/modules are frequently skipped because the teacher did not have enough time to use them (74 percent) or they have other activities that they think work better (69 percent). In the majority of classes, teachers also skip activities because the ideas covered by the activities are not addressed in their pacing guide and/or current state standards (63 percent) or because they do not have the materials needed to implement the activities (62 percent).

Table 43
Reasons Why Parts of Elementary Science Materials Are Skipped

	PERCENT OF CLASSES†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
I did not have enough instructional time for the activities I skipped.	74 (4.5)	81 (4.0)	69 (6.7)
I have different activities for those science ideas that work better than the ones I skipped.	69 (3.9)	67 (4.6)	70 (5.2)
The science ideas addressed in the activities I skipped are not included in my pacing guide/standards.	63 (3.9)	64 (3.3)	63 (5.7)
I did not have the materials needed to implement the activities I skipped.	62 (4.5)	54 (4.5)	66 (5.7)
My students already knew the science ideas or were able to learn them without the activities I skipped.	49 (3.5)	47 (5.1)	51 (5.0)
The activities I skipped were too difficult for my students.	38 (3.7)	37 (4.4)	38 (5.5)
I did not have the knowledge needed to implement the activities I skipped.	24 (3.3)	22 (4.3)	25 (4.0)

† Only elementary 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.

Data about why materials are supplemented are shown in Table 44. In a large majority of elementary science classes when instructional materials are supplemented, teachers do so to help students at different achievement levels (84 percent) or to provide students with additional practice (77 percent). In 82 percent of elementary science classes, teachers supplement their instructional materials because they have other activities that they prefer. In addition, instructional materials are supplemented to prepare students for standardized tests in 47 percent of elementary classes; far more intermediate grades classes use supplemental activities in this way than primary grades classes.

Table 44
Reasons Why Elementary Science Materials Are Supplemented

	PERCENT OF CLASSES†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity.	84 (2.4)	75 (4.2)	90 (2.2)
I had additional activities that I liked.	82 (3.2)	80 (4.4)	83 (3.9)
Supplemental activities were needed to provide students with additional practice.	77 (2.8)	61 (4.8)	86 (2.6)
Supplemental activities were needed to prepare students for standardized tests.	47 (3.7)	25 (4.2)	60 (6.9)
My pacing guide indicated that I should use supplemental activities.	42 (3.6)	42 (4.6)	41 (5.3)

† Only elementary 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 elementary science teachers reported that they modified their published material (which over half did), they rated each of several factors that may have contributed to their decision (see Table 45). Two factors stand out: in 70 percent of classes, teachers do not have enough time to implement the activities as designed, and in 60 percent of classes, they do not have the necessary materials/supplies for the original activities. Looking at differences across elementary grade bands, teachers of intermediate grades classes are more likely than teachers of

primary grades classes to modify their materials because the original activities were not structured enough for their students (48 vs. 33 percent).

Table 45
Reasons Why Elementary Science Materials Are Modified

	PERCENT OF CLASSES†		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
I did not have enough instructional time to implement the activities as designed.	70 (3.9)	67 (3.8)	72 (6.0)
I did not have the necessary materials/supplies for the original activities.	60 (3.8)	56 (3.7)	63 (6.2)
The original activities were too difficult conceptually for my students.	46 (4.1)	46 (4.7)	46 (5.7)
The original activities were not structured enough for my students.	42 (4.3)	33 (4.7)	48 (5.6)
The original activities were too structured for my students.	36 (4.2)	35 (4.4)	37 (6.2)
The original activities were too easy conceptually for my students.	35 (3.5)	38 (4.8)	34 (4.9)

† Only elementary 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 Elementary Science Instructional Resources

Elementary science teachers were presented with a list of general instructional technologies as indicators of whether classes have access to basic resources for science instruction and asked about availability. The percentages of elementary science classes with at least some availability to these instructional technologies (either in the classroom or available upon request) are shown in Table 46. Projection devices and balances are available in the large majority of elementary science classes. Microscopes are available in 56 percent and probes for collecting data in 39 percent of elementary classes.

Table 46
Availability† of Instructional Resources in Elementary Science Classes

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Projection devices (e.g., Smartboard, document camera, LCD projector)	98 (0.7)	98 (0.8)	98 (0.8)
Balances (e.g., pan, triple beam, digital scale)	80 (2.0)	79 (2.8)	82 (2.4)
Microscopes	56 (2.7)	53 (2.7)	59 (4.1)
Probes for collecting data (e.g., motion sensors, temperature probes)	39 (2.7)	36 (3.0)	42 (4.0)

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

Teachers were also asked about the availability of laboratory facilities, either in their classrooms or available upon request. Electrical outlets and running water are widely available in elementary science classes (see Table 47). Fewer than a third of elementary science classes have access to lab tables.

Table 47
Availability† of Laboratory Facilities in Elementary Science Classes

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Electric outlets	93 (1.1)	93 (1.7)	93 (1.3)
Faucets and sinks	83 (2.0)	84 (2.5)	81 (2.8)
Lab tables	29 (3.1)	25 (3.1)	31 (4.5)

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

Teachers were also asked their opinion of the adequacy of different resources for instruction. Teachers in fewer than half of elementary science classes rated their instructional technology, equipment, facilities, and consumable supplies as adequate for science instruction (see Table 48). The availability of instructional technology, equipment, and consumable supplies are more likely to be seen as adequate in intermediate grades classes than primary grades classes.

Table 48
Adequacy† of Resources for Elementary Science Instruction

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Instructional technology (e.g., calculators, computers, probes/sensors)	49 (2.8)	42 (2.9)	56 (4.1)
Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners)	39 (2.5)	33 (3.2)	44 (3.7)
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	38 (2.6)	37 (2.9)	40 (3.9)
Consumable supplies (e.g., chemicals, living organisms, batteries)	30 (2.8)	23 (3.0)	36 (3.8)

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

These items were combined into a composite variable named Adequacy of Resources for Instruction. As can be seen in Table 49, perceptions of the adequacy of resources vary by grade band, with perceived adequacy higher in intermediate grades classes than primary grades classes. However, the data indicate that science instruction in elementary grades is under resourced from the point of view of teachers.

Table 49
Elementary Science Class Mean Scores for the Adequacy of Resources for Instruction Composite

	MEAN SCORE
All Elementary	52 (1.7)
Primary Grades	49 (1.7)
Intermediate Grades	55 (2.5)

Factors Affecting Elementary 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 about the extent various factors promote or inhibit instruction in their class.

As can be seen in Table 50, students' motivation, interest, and effort in science (75 percent), principal support (65 percent), and current state standards (64 percent) are factors commonly seen as promoting effective science instruction by teachers in elementary classes. Students' prior knowledge and skills are more often seen as promoting effective science instruction in primary classes than intermediate classes (65 vs. 55 percent).

Table 50

Factors Promoting† Effective Instruction in Elementary Science Classes

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Students' motivation, interest, and effort in science	75 (2.2)	77 (2.7)	74 (3.2)
Principal support	65 (2.5)	63 (3.8)	66 (3.3)
Current state standards	64 (2.3)	62 (3.4)	66 (2.9)
Students' prior knowledge and skills	60 (2.3)	65 (3.3)	55 (3.4)
Amount of time for you to plan, individually and with colleagues	57 (2.8)	59 (3.7)	56 (3.6)
Pacing guides	55 (2.7)	58 (3.7)	52 (3.5)
Amount of instructional time devoted to science	49 (2.7)	52 (4.0)	46 (3.4)
Amount of time available for your professional development	44 (2.7)	48 (4.2)	41 (3.8)
Teacher evaluation policies	38 (3.1)	37 (4.1)	39 (3.5)
Parent/guardian expectations and involvement	37 (2.3)	40 (2.9)	34 (3.0)
State/district/diocese testing/accountability policies‡	36 (2.5)	35 (3.5)	37 (3.4)
Textbook/module selection policies	32 (2.5)	33 (3.4)	32 (3.2)

† Includes elementary science teachers indicating 4 or 5 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

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

On the other end of the spectrum, elementary science teachers see some factors as inhibiting effective instruction (see Table 51). In particular, the amount of instructional time devoted to science is seen as inhibiting effective science instruction in 28 percent of elementary classes. Several factors are more likely to be seen as inhibiting effective instruction in intermediate grades classes than primary grades classes, including: the amount of time available for professional development (31 vs. 20 percent), textbook selection policies (31 vs. 21 percent), parent/guardian expectations and involvement (25 vs. 11 percent), state/district testing accountability policies (24 vs. 14 percent), and students' prior knowledge and skills (22 vs. 8 percent).

Table 51
Factors Inhibiting† Effective Instruction in Elementary Science Classes

	PERCENT OF CLASSES		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Amount of instructional time devoted to science	28 (2.3)	26 (2.6)	31 (3.6)
Textbook/module selection policies	26 (2.9)	21 (3.1)	31 (4.1)
Amount of time available for your professional development	26 (1.8)	20 (2.4)	31 (3.3)
Amount of time for you to plan, individually and with colleagues	21 (1.8)	19 (2.7)	23 (2.6)
State/district/diocese testing/accountability policies‡	19 (2.0)	14 (2.4)	24 (2.9)
Parent/guardian expectations and involvement	18 (1.8)	11 (2.2)	25 (3.1)
Students' prior knowledge and skills	15 (2.0)	8 (1.8)	22 (3.5)
Teacher evaluation policies	14 (1.7)	15 (2.5)	12 (2.0)
Pacing guides	11 (1.5)	10 (2.2)	13 (2.0)
Students' motivation, interest, and effort in science	9 (1.6)	5 (1.5)	13 (2.7)
Principal support	6 (1.4)	5 (1.6)	7 (2.1)
Current state standards	5 (1.0)	5 (1.5)	5 (1.4)

† Includes elementary science teachers indicating 1 or 2 on a five-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."

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

Three composites from these questionnaire items were created to summarize the extent to which various factors support effective instruction: (1) Extent to Which School Support Promotes Effective Instruction (i.e., amount of time for professional development, and amount of planning time); (2) Extent to Which the Policy Environment Promotes Effective Instruction (i.e., testing/ accountability, textbook selection, pacing guides, teacher evaluation, and current state standards); and (3) Extent to Which Stakeholders Promote Effective Instruction (i.e., students' motivation and interest, students' prior knowledge, parent/guardian expectations and involvement). The means for each composite are shown in Table 52. The mean scores are similar for each composite, ranging from 62 to 68, indicating that stakeholders, policy environment, and school support all somewhat promote effective science instruction. However, stakeholders, such as students and parents, are seen to support science instruction in primary grades classes more than in intermediate grades classes.

Table 52
Elementary Science Class Mean Scores for Factors Affecting Instruction Composites

	MEAN SCORE		
	ALL ELEMENTARY	PRIMARY GRADES	INTERMEDIATE GRADES
Extent to Which Stakeholders Promote Effective Instruction	68 (1.4)	72 (1.6)	64 (2.1)
Extent to Which the Policy Environment Promotes Effective Instruction	62 (1.0)	63 (1.7)	61 (1.3)
Extent to Which School Support Promotes Effective Instruction	62 (1.6)	65 (2.4)	59 (2.1)

Summary

Elementary science teachers are predominately female and white. Although a majority of elementary science teachers are over 40 years old, one-third have five or fewer years of experience teaching science. In general, elementary science teachers have limited college coursework in science, particularly in chemistry, physics, and engineering, and only one-third have had coursework in all of the areas recommended by NSTA. Accordingly, their perceptions of preparedness to teach science pale in comparison to reading/language arts and mathematics.

Elementary science teachers also do not feel very well prepared in terms of science pedagogy, particularly providing science instruction that is based on students' ideas, incorporating students' cultural backgrounds into science instruction, and developing students' awareness of STEM careers. However, when it comes to beliefs, elementary science teachers hold a number of pedagogical beliefs that are well aligned with what is known about effective science teaching (e.g., providing opportunities for students to share their thinking and reasoning, asking students to support their conclusions with evidence). On the other hand, a majority also agree with teaching practices that are inconsistent with what the field knows about effective science teaching, such as providing students with definitions for new vocabulary at the beginning of instruction on an idea and using hands-on/laboratory activities to reinforce ideas that students have already learned.

In addition, elementary teachers have had limited opportunities for professional growth in science. Although the majority have participated in science-focused professional development in the last three years, only a very small percentage have had sustained professional development (more than 35 hours). Furthermore, fewer than a third reported that their professional development in the last three years included characteristics of effective professional development, such as examining classroom artifacts or rehearsing instructional practices during the professional development.

The frequency and duration of elementary science instruction averages only 20 minutes a day, substantially less than the amount of time devoted to reading/language arts and mathematics. Additionally, only 18 percent of primary grades classes and 26 percent of intermediate grades classes receive science instruction all or most days every week of the school year. Teachers in about half of elementary science classes heavily emphasize understanding science concepts, but far fewer give heavy emphasis to other reform-oriented objectives such as learning how to do science or increasing students' interest in science/engineering. Science instruction is based largely on whole class discussion and the teacher explaining ideas to the class. Small group work is also fairly common. Students doing hands-on/laboratory activities and writing reflections occurs weekly in about half of elementary science classes. In addition, the majority of elementary science classes do not engage in aspects of science practices on a weekly basis. Of those that do, the most common practices are generating scientific questions, conducting scientific investigations, organizing and/or representing data, and making and supporting claims with evidence.

Nearly 7 in 10 elementary science classes have district-designated instructional materials. Of these classes, commercially published textbooks or modules are most common. Regardless of whether the classes have designated materials, lessons from fee-based websites and teacher-

created units and lessons influence instruction in roughly half of elementary science classes at least once a week. Additionally, teachers in elementary classes using commercially published materials frequently supplement, modify, and skip parts of their instructional materials.

Students' motivation, interest, and effort in science, principal support, and current state standards are factors commonly seen as promoting effective science instruction in a large majority of elementary classes. Students' prior knowledge and skills are seen by teachers as promoting science instruction in primary grades classes more often than in intermediate grades classes. On the other hand, the amount of instructional time devoted to science is seen as inhibiting effective science instruction in nearly a third of elementary classes. Some factors are seen as inhibiting instruction in more intermediate grades classes than primary grades classes, such as the amount of time available for professional development and state/district testing accountability policies.