2012 National Survey of Science and Mathematics Education

Status of High School Chemistry

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INTRODUCTION

The 2012 National Survey of Science and Mathematics Education 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. A total of 7,752 science and mathematics teachers in schools across the United States participated in this survey, a response rate of 77 percent. The research questions addressed by the study are:

1. To what extent do science and mathematics instruction and ongoing assessment mirror current understanding of learning?

2. What influences teachers' decisions about content and pedagogy?

3. What are the characteristics of the science/mathematics teaching force in terms of race, gender, age, content background, beliefs about teaching and learning, and perceptions of preparedness?

4. What are the most commonly used textbooks/programs, and how are they used?

5. What formal and informal opportunities do science/mathematics teachers have for ongoing development of their knowledge and skills?

6. How are resources for science/mathematics education, including well-prepared teachers and course offerings, distributed among schools in different types of communities and different socioeconomic levels?

The 2012 National Survey is based on a national probability sample of schools and science and mathematics teachers in grades K–12 in the 50 states and the District of Columbia. The sample was designed to allow national estimates of science and mathematics course offerings and enrollment; teacher background preparation; textbook usage; instructional techniques; and availability and use of science and mathematics facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being drawn into the sample.

Because biology is by far the most common science course at the high school level, selecting a random sample of science teachers would result in a much larger number of biology teachers than chemistry or physics teachers. In order to ensure that the sample would include a sufficient number of chemistry and physics teachers for separate analysis, information on teaching assignments was used to create a separate domain for these teachers, and sampling rates were adjusted by domain. This report describes the status of high school (grades 9–12) chemistry instruction based on the responses of 787 chemistry teachers.[1] For comparison purposes, many of the tables include data from the 931 respondents who do not teach chemistry; i.e., all other

[1] A chemistry teacher is defined as someone who teaches at least one class of non-college prep, 1st year college prep, or 2nd year advanced chemistry.

high school science teachers. These data include responses from high school biology, Earth science, physics, and physical science teachers.

Technical detail on the survey sample design, as well as data collection and analysis procedures, is included in the *Report of the 2012 National Survey of Science and Mathematics Education*.[2] 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.

This status report of high school chemistry teaching is organized into major topical areas:

- Characteristics of the chemistry teaching force;
- Professional development of chemistry teachers;
- Chemistry classes offered;
- Chemistry instruction, in terms of time spent, objectives, and activities;
- Resources available for chemistry instruction; and
- Factors affecting chemistry instruction.

CHARACTERISTICS OF THE HIGH SCHOOL CHEMISTRY TEACHING FORCE

General Demographics

Similar to the other sciences, just over half of chemistry teachers are female, and the overwhelming majority are white (see Table 1). Judging by the age of chemistry teachers, it appears that as many as one-third may be nearing retirement in the next 10 years.

Chemistry teachers are more likely to teach multiple subjects (e.g., biology, chemistry, physics) within science than are other high school science teachers; only 38 percent of chemistry teachers have one preparation, compared to 60 percent of all other high school science teachers.

[2] Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 national survey of science and mathematics education.* Chapel Hill, NC: Horizon Research, Inc.

Table 1
Characteristics of the High School Science Teaching Force

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Sex		
Male	46 (2.0)	46 (2.6)
Female	54 (2.0)	54 (2.6)
Race		
White	94 (0.9)	92 (0.9)
Black or African American	3 (0.7)	3 (0.7)
Hispanic or Latino	3 (0.7)	3 (0.8)
Asian	1 (0.5)	3 (0.7)
American Indian/Alaska Native	1 (0.3)	0 (0.3)
Native Hawaiian/Other Pacific Islander	0 (0.2)	0 (0.3)
Two or more races	1 (0.5)	1 (0.4)
Age		
≤ 30	16 (1.6)	15 (2.1)
31–40	30 (1.6)	32 (2.6)
41–50	25 (1.7)	23 (1.9)
51–60	23 (1.7)	22 (1.9)
61+	6 (1.3)	9 (1.3)
Experience Teaching Science at the K–12 Level		
0–2 years	13 (1.4)	14 (2.2)
3–5 years	16 (1.8)	13 (1.3)
6–10 years	23 (2.1)	21 (2.3)
11–20 years	31 (1.8)	31 (2.4)
≥ 21 years	18 (1.5)	21 (1.8)
Number of Science Subjects Taught		
1	60 (2.0)	38 (2.5)
2	35 (1.7)	42 (2.5)
3 or more	5 (1.0)	20 (2.5)

About 7 in 10 chemistry teachers have a college degree in science or engineering, more than teachers of other sciences; roughly half have a degree in science education, similar to all other teachers (see Table 2). Also similar to other high school science teachers, the vast majority of chemistry teachers have had formal preparation for teaching leading to a teaching credential (see Table 3). Most chemistry teachers received their teaching credential as part of their undergraduate program or a non-master's post-baccalaureate program.

Table 2
High School Science Teacher Degrees

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Science/Engineering	58 (2.1)	69 (2.6)
Science Education	48 (1.8)	48 (2.5)
Science/Engineering or Science Education	80 (1.7)	88 (2.1)

Table 3
High School Science Teachers' Paths to Certification

	Percent of Teachers	
	All Other Sciences	**Chemistry**
An undergraduate program leading to a bachelor's degree and a teaching credential	36 (2.4)	32 (2.9)
A post-baccalaureate credentialing program (no master's degree awarded)	30 (2.1)	31 (3.4)
A master's program that also awarded a teaching credential	29 (2.5)	27 (2.8)
No formal teacher preparation	5 (1.2)	11 (2.1)

Content Preparedness

In terms of the number of college courses they have taken in their subject, chemistry teachers tend not to be quite as well prepared in their subject as are other science teachers. Twenty-nine percent of chemistry teachers have a degree in their subject, compared to 35 percent of other science teachers (see Table 4).

Table 4
High School Science Teachers with Varying Levels of Background in the Subject of their Randomly Selected Class

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Degree in Field	35 (1.9)	29 (1.8)
No Degree in Field, but 3+ Courses beyond Introductory	38 (2.1)	47 (2.7)
No Degree in Field, but 1–2 Courses beyond Introductory	10 (1.0)	16 (2.0)
No Degree in Field or Courses beyond Introductory	17 (1.5)	8 (3.1)

As can be seen in Table 5, teachers assigned to chemistry classes are similar to the rest of the secondary science teaching force in preparation in science education and having student taught in science. Not surprisingly, chemistry teachers are more likely to have completed college coursework beyond introductory chemistry than are other high school science teachers. Ninety-six percent of chemistry teachers have taken an introductory chemistry course, roughly the same as other science teachers; but 83 percent of chemistry teachers have taken at least one course in organic chemistry, 63 percent have a course in inorganic chemistry, and 45 percent have a course in physical chemistry.

Table 5
High School Science Teachers Completing Various College Courses

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Science Education	86 (2.0)	84 (2.4)
Student teaching in science	73 (2.2)	74 (2.6)
Introductory Chemistry	93 (1.4)	96 (2.2)
Organic Chemistry	56 (2.1)	83 (2.7)
Inorganic Chemistry	37 (1.9)	63 (3.0)
Biochemistry	35 (1.9)	52 (2.8)
Analytical Chemistry	18 (1.8)	50 (2.8)
Physical Chemistry	17 (1.5)	45 (2.7)
Quantum Chemistry	3 (0.6)	17 (1.6)

The survey also asked chemistry teachers to rate how well prepared they feel to teach each of a number of fundamental topics in chemistry. A large majority of chemistry teachers feel very well prepared to teach about elements, compounds, and mixtures; the periodic table; and atomic structure, among others (see Table 6). Few chemistry teachers feel less than fairly well prepared in any of these areas.

Table 6
High School Chemistry Teacher Preparedness to Teach Each of a Number of Topics

	Percent of Chemistry Teachers			
	Not Adequately Prepared	**Somewhat Prepared**	**Fairly Well Prepared**	**Very Well Prepared**
Elements, compounds, and mixtures	0 (0.4)	3 (2.5)	8 (1.8)	89 (2.9)
The periodic table	0 ---†	3 (2.5)	9 (1.8)	88 (2.9)
Chemical bonding, equations, nomenclature, and reactions	0 (0.4)	4 (2.7)	11 (2.0)	85 (3.1)
Atomic structure	0 (0.4)	2 (2.5)	13 (2.0)	84 (2.9)
States, classes, and properties of matter	0 (0.4)	3 (2.5)	12 (2.0)	84 (2.9)
Properties of solutions	0 (0.4)	7 (2.8)	19 (2.1)	73 (3.0)

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

Data from items asking teachers how well prepared they feel to teach the content of a randomly selected course were combined into a composite variable called Perceptions of Preparedness to Teach Science Content.[3] As can be seen in Table 7, chemistry teachers feel better prepared to teach chemistry than teachers of the other sciences feel to teach their specific discipline.

[3] The body of this report includes data on selected composite variables. Data for all composite variables are available in the Appendix.

Table 7
High School Science Teacher Mean Scores for the Perceptions of Preparedness to Teach Science Content Composite

	Mean Score
All Other Sciences[†]	83 (1.0)
Chemistry	93 (1.7)

[†] Composite score is based on the content of each teacher's randomly selected class.

Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning in science. As can be seen in Table 8, chemistry teachers hold a number of views that are in alignment with what is known about effective science instruction. For example, a large majority of chemistry teachers agree that: (1) most class periods should provide opportunities for students to share their thinking and reasoning, (2) most class periods should include some review of previously covered ideas and skills, (3) students should be provided with the purpose for a lesson as it begins, and (4) most class periods should conclude with a summary of the key ideas addressed. In addition, only about a third of chemistry teachers agree that teachers should explain an idea to students before having them consider evidence that relates to the idea.

However, many chemistry teachers also hold views that are inconsistent with effective science instruction. About two-thirds of chemistry teachers believe that students learn best in classes with students of similar abilities, and that students should be provided with definitions for new vocabulary at the beginning of instruction on a science idea. In addition, more than half of chemistry teachers think that hands-on/laboratory activities should be used primarily to reinforce a science idea. Interestingly, chemistry teachers are much more likely than other science teachers to agree that homework should be assigned on most days.

Table 8
High School Science Teachers Agreeing†
with Various Statements about Teaching and Learning

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Most class periods should provide opportunities for students to share their thinking and reasoning	93 (0.8)	89 (2.2)
Most class periods should include some review of previously covered ideas and skills	84 (1.6)	89 (2.0)
Students should be provided with the purpose for a lesson as it begins	89 (1.3)	86 (2.0)
Most class periods should conclude with a summary of the key ideas addressed	89 (1.3)	86 (1.9)
Inadequacies in students' science background can be overcome by effective teaching	83 (1.5)	86 (2.0)
It is better for science instruction to focus on ideas in depth, even if that means covering fewer topics	73 (1.7)	73 (2.3)
At the beginning of instruction on a science idea, students should be provided with definitions for new scientific vocabulary that will be used	71 (2.3)	66 (2.6)
Students learn science best in classes with students of similar abilities	66 (2.1)	65 (2.6)
Students should be assigned homework most days	42 (2.0)	59 (2.3)
Hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned	54 (2.2)	58 (2.5)
Teachers should explain an idea to students before having them consider evidence that relates to the idea	39 (2.2)	36 (2.5)

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

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 address diverse learners in their instruction. 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.

As can be seen in Table 9, the majority of chemistry teachers feel very well prepared to manage classroom discipline, encourage the participation of females in science/engineering, and encourage students' interest in science/engineering. About one-third or fewer chemistry teachers feel very well prepared to differentiate instruction.

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

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Manage classroom discipline	60 (3.1)	59 (3.1)
Encourage participation of females in science and/or engineering	56 (3.1)	57 (2.6)
Encourage students' interest in science and/or engineering	54 (2.9)	53 (3.0)
Encourage participation of students from low socioeconomic backgrounds in science and/or engineering	43 (3.0)	46 (2.9)
Encourage participation of racial or ethnic minorities in science and/or engineering	44 (2.8)	45 (2.9)
Plan instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity	38 (2.3)	38 (3.0)
Provide enrichment experiences for gifted students	34 (2.5)	32 (2.9)
Teach science to students who have physical disabilities	22 (2.3)	17 (2.1)
Teach science to students who have learning disabilities	22 (2.2)	17 (2.2)
Teach science to English-language learners	15 (2.0)	13 (2.1)

Table 10 shows the percentage of classes taught by teachers who feel very well prepared for each of a number of tasks related to instruction. In the majority of high school chemistry classes, teachers feel very well prepared to assess student understanding at the end of a unit, to monitor student understanding during instruction, to anticipate student difficulties, and to implement their designated textbook. In roughly 4 out of 10 chemistry classes, teachers feel very well prepared to elicit students' prior ideas about a topic.

Table 10
High School Science Classes in which Teachers Feel Very Well Prepared for Each of a Number of Tasks in the Most Recent Unit

	Percent of Classes	
	All Other Sciences	**Chemistry**
Assess student understanding at the conclusion of this unit	63 (2.1)	67 (2.4)
Monitor student understanding during this unit	56 (1.9)	58 (2.4)
Anticipate difficulties that students may have with particular science ideas and procedures in this unit	46 (1.9)	56 (2.3)
Implement the science textbook/module to be used during this unit†	51 (2.8)	56 (3.5)
Find out what students thought or already knew about the key science ideas	41 (2.0)	42 (2.6)

† This item was presented only to teachers who indicated using commercially published textbooks/modules in the most recent unit.

PROFESSIONAL DEVELOPMENT OF HIGH SCHOOL CHEMISTRY TEACHERS

One important measure of teachers' continuing education is how long it has been since they participated in professional development. As can be seen in Table 11, 86 percent of chemistry teachers have participated in science-focused professional development (i.e., focused on science content or the teaching of science) in the last three years.

Table 11
High School Science Teachers' Most Recent Participation in Science-Focused† Professional Development

	Percent of Teachers	
	All Other Sciences	**Chemistry**
In the last 3 years	86 (1.6)	86 (1.8)
4–6 years ago	6 (0.9)	9 (1.6)
7–10 years ago	1 (0.3)	2 (0.6)
More than 10 years ago	2 (0.8)	1 (0.3)
Never	5 (1.3)	3 (0.8)

† Includes professional development focused on science or science teaching.

However, chemistry teachers, like high school science teachers in general, report low levels of participation in professional development specific to science teaching. Only about one-third have spent more than 35 hours in science-related professional development in the last three years (see Table 12).

Table 12
Time Spent on Professional Development in the Last Three Years

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Less than 6 hours	22 (2.0)	23 (2.2)
6–15 hours	20 (1.4)	22 (2.2)
16–35 hours	21 (1.8)	19 (2.0)
More than 35 hours	37 (1.6)	36 (2.3)

As to how this time is spent, the workshop is by far the most common form of professional development, with 89 percent of chemistry teachers having attended one in the previous three years (see Table 13). Two-thirds of chemistry teachers have participated in a professional learning community or other type of teacher study group.

Table 13
High School Science Teachers Participating in
Various Professional Development Activities in the Last Three Years

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Attended a workshop on science or science teaching	90 (1.3)	89 (2.3)
Participated in a professional learning community/lesson study/teacher study group focused on science or science teaching	75 (2.0)	66 (3.1)
Received feedback about your science teaching from a mentor/coach formally assigned by the school/district/diocese†	57 (3.3)	50 (3.8)
Attended a national, state, or regional science teacher association meeting	45 (2.3)	44 (2.8)

† This item was asked of all teachers whether or not they had participated in professional development in the last three years.

The emerging consensus about effective professional development suggests that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include engaging teachers in investigations, both to learn disciplinary content and to experience inquiry-oriented learning; to examine student work and other classroom artifacts for evidence of what students do and do not understand; and to apply what they have learned in their classrooms and subsequently discuss how it went.[4] 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 14, just over half of chemistry teachers have had substantial opportunity to work closely with other teachers from their school and/or subject, compared to two-thirds of all other science teachers. Relatively few chemistry teachers have had opportunities to examine classroom artifacts as part of their professional development.

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

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

Table 14
High School Science Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent†

	Percent of Teachers	
	All Other Sciences	Chemistry
Worked closely with other science teachers from your school	67 (3.2)	54 (4.4)
Worked closely with other science teachers who taught the same grade and/or subject whether or not they were from your school	60 (3.2)	53 (4.2)
Had opportunities to engage in science investigations	46 (3.5)	43 (4.2)
Had opportunities to try out what you learned in your classroom and then talk about it as part of the professional development	51 (3.3)	40 (3.5)
Had opportunities to examine classroom artifacts (e.g., student work samples)	34 (3.3)	31 (3.3)
The professional development was a waste of time	8 (1.6)	6 (1.4)

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

College courses have the potential to address content in more depth than may be possible in other professional development venues, such as workshops. As another indicator of the extent to which teachers are staying current in their field, the 2012 National Survey asked teachers when they had last taken a formal course for college credit in both science and how to teach science. As can be seen in Table 15, about a third of chemistry teachers took their most recent course for college credit in either science or the teaching of science more than 10 years ago.

Table 15
High School Science Teachers' Most Recent College Coursework in Field

	Percent of Teachers	
	All Other Sciences	Chemistry
Science		
In the last 3 years	26 (1.6)	21 (1.7)
4–6 years ago	18 (1.5)	21 (2.1)
7–10 years ago	19 (1.5)	16 (1.9)
More than 10 years ago	36 (1.6)	42 (2.2)
Never	1 (0.7)	0 (0.4)
The Teaching of Science		
In the last 3 years	26 (1.8)	23 (2.1)
4–6 years ago	17 (1.4)	16 (1.8)
7–10 years ago	14 (1.3)	14 (2.0)
More than 10 years ago	28 (2.0)	30 (2.2)
Never	15 (2.0)	17 (2.5)
Science or the Teaching of Science		
In the last 3 years	34 (1.8)	31 (2.3)
4–6 years ago	20 (1.4)	20 (1.8)
7–10 years ago	15 (1.4)	16 (2.0)
More than 10 years ago	30 (1.7)	33 (2.0)
Never	1 (0.7)	0 (0.4)

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, whether through professional development or college coursework. More than half of chemistry teachers have had professional growth opportunities that gave heavy emphasis to assessing students at the end of instruction, planning instruction for students at different levels of achievement, and monitoring student understanding during instruction (see Table 16). Relatively few chemistry teachers have had professional development with a heavy emphasis on providing alternative experiences for students with special needs or teaching science to English-language learners.

Table 16
High School Science Teachers Reporting that their Professional Development/ Coursework in the Last Three Years Gave Heavy Emphasis† to Various Areas

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Assessing student understanding at the conclusion of instruction on a topic	58 (2.8)	60 (2.9)
Planning instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity	57 (2.6)	55 (4.1)
Monitoring student understanding during science instruction	57 (3.5)	53 (3.5)
Deepening your own science content knowledge	47 (3.1)	50 (2.6)
Learning about difficulties that students may have with particular science ideas and procedures	51 (3.2)	47 (4.0)
Finding out what students think or already know about the key science ideas prior to instruction on those ideas	47 (2.8)	39 (3.4)
Providing enrichment experiences for gifted students	34 (2.9)	31 (3.7)
Implementing the science textbook/module to be used in your classroom	29 (2.5)	29 (3.3)
Providing alternative science learning experiences for students with special needs	30 (2.7)	25 (3.0)
Teaching science to English-language learners	21 (2.8)	13 (1.9)

† Includes teachers responding 4 or 5 on a 5-point scale ranging from 1 "Not at all" to 5 "To a great extent."

In addition to asking teachers about their involvement as participants in professional development, the survey asked teachers whether they had served in various leadership roles in the profession in the last three years. As can be seen in Table 17, about 1 in 5 chemistry teachers led a teacher study group or workshop, served as a mentor/coach, or supervised a student teacher.

Table 17
High School Science Teachers Serving in Various Leadership Roles in the Last Three Years

	Percent of Teachers	
	All Other Sciences	**Chemistry**
Led a teacher study group focused on science teaching	29 (3.0)	24 (2.7)
Served as a formally assigned mentor/coach for science teaching	26 (3.0)	23 (3.1)
Supervised a student teacher	26 (2.5)	17 (2.3)
Taught in-service workshops on science or science teaching	17 (2.3)	17 (2.0)

HIGH SCHOOL CHEMISTRY CLASSES OFFERED

Of the high schools (schools including grades 9, 10, 11, and 12) in the United States, almost all (94 percent) offer at least one chemistry course (see Table 18). Eighty-five percent of high schools offer a 1st year chemistry course, and 44 percent offer a 2nd year course. One-third of high schools offer Advanced Placement (AP) chemistry. There is a large disparity between the percentage of high schools offering AP Chemistry and the percentage of high school students with access to the course, most likely due to the fact that large schools are more likely than small ones to offer advanced chemistry courses, and that small schools outnumber large schools in the United States.

Table 18
Availability of Chemistry Courses at High Schools

	Percent of High Schools Offering	Percent of High School Students with Access
Any level	94 (1.8)	99 (0.5)
Non-college prep	51 (2.7)	53 (2.1)
1st year college prep, including honors	85 (2.5)	97 (0.5)
2nd year advanced, including AP	44 (2.6)	72 (1.6)
AP Chemistry	34 (2.3)	67 (1.8)

In terms of the percentage of classes offered in the nation, chemistry (any level) accounts for 22 percent of all high school science classes (see Table 19). This percentage ranks second behind biology (39 percent).

Table 19
Most Commonly Offered High School Science Courses

	Percent of Classes
Life Science/Biology	
Non-college prep	8 (0.7)
1st year college prep, including honors	24 (1.3)
2nd year advanced	7 (0.9)
Chemistry	
Non-college prep	3 (0.5)
1st year college prep, including honors	17 (0.8)
2nd year advanced	2 (0.4)
Physics	
Non-college prep	2 (0.4)
1st year college prep, including honors	10 (0.9)
2nd year advanced	2 (0.4)
Earth/Space Science	
Non-college prep	4 (0.6)
1st year college prep, including honors	4 (0.6)
2nd year advanced	0 (0.2)
Environmental Science/Ecology	
Non-college prep	2 (0.4)
1st year college prep, including honors	1 (0.4)
2nd year advanced	2 (0.5)
Coordinated or Integrated Science Courses (including General Science and Physical Science)	
Non-college prep	6 (0.8)
College prep, including honors	5 (0.7)

The typical chemistry class has approximately 22 students; two-thirds of the classes have between 15 and 28 students. Fifty-one percent of chemistry students are female, similar to the 49 percent in biology and physics (see Table 20). Thirty percent of students who take 1st year chemistry are from race/ethnic groups historically underrepresented in science.[5] Chemistry classes are about as likely as biology classes to be composed of high-achieving or mostly average-achieving, but they are much less likely than physics classes to be composed of high-achieving students (see Table 21).

Table 20
Demographics of Students in 1st Year High School Science Courses

	Percent of Students	
	Female	**Historically Underrepresented**
1st Year Biology	49 (1.6)	33 (2.7)
1st Year Chemistry	51 (1.4)	30 (1.8)
1st Year Physics	49 (1.8)	23 (2.7)

[5] Includes students identified as American Indian or Alaskan Native, Black, Hispanic or Latino, or Native Hawaiian or Other Pacific Islander.

Table 21
Prior-Achievement Grouping in 1st Year High School Science Classes

	Percent of Classes							
	Mostly Low Achievers		Mostly Average Achievers		Mostly High Achievers		A Mixture of Levels	
1st Year Biology	16	(2.7)	31	(3.0)	22	(2.9)	31	(3.7)
1st Year Chemistry	6	(1.2)	36	(3.3)	28	(2.6)	30	(2.9)
1st Year Physics	4	(1.8)	19	(2.9)	48	(5.0)	30	(4.2)

HIGH SCHOOL CHEMISTRY INSTRUCTION

Each teacher responding to the survey was asked to provide detailed information about a randomly selected class. Science teachers who were assigned to teach both chemistry and other science classes may have been asked about any of those classes. Accordingly, the number of chemistry classes included in the analyses reported below (558) is smaller than the number of responding teachers of chemistry. Generally, the larger standard errors are a reflection of the reduced sample size. The data reported in the "All Other Sciences" column are based on 1,160 non-chemistry high school science classes.

The next three sections draw on teachers' descriptions of what transpires in chemistry classrooms, in terms of teachers' autonomy for making decisions regarding the content and pedagogy of their classes, instructional objectives, and class activities.

Teachers' Perceptions of Their Decision Making Autonomy

Teachers were asked the extent to which they had control over a number of curriculum and instruction decisions for their classes. Similar to other science classes, in chemistry classes, teachers are more likely to 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 22). In fewer classes, teachers perceive themselves as having strong control in determining course goals and objectives, selecting what content/skills to teach, and selecting textbooks/modules.

Table 22
High School Science Classes in which Teachers Report Having Strong Control Over Various Curriculum and Instruction Decisions

	Percent of Classes			
	All Other Sciences		Chemistry	
Determining the amount of homework to be assigned	77	(2.2)	74	(3.5)
Selecting teaching techniques	75	(2.4)	71	(3.4)
Choosing criteria for grading student performance	62	(2.6)	59	(4.2)
Determining course goals and objectives	38	(2.8)	32	(3.7)
Selecting content, topics, and skills to be taught	37	(3.2)	32	(3.7)
Selecting textbooks/modules	35	(3.2)	29	(3.5)

These items were combined into two composite variables: Curriculum Control and Pedagogical Control. Scores on both composites are not significantly different from the mean scores for all other science classes (see Table 23).

Table 23
High School Science Class Mean Scores for
Curriculum Control and Pedagogical Control Composites

	Mean Score	
	All Other Sciences	**Chemistry**
Pedagogical Control	90 (0.9)	88 (1.4)
Curriculum Control	61 (1.9)	57 (2.5)

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate each in terms of the emphasis they receive in the randomly selected class. As can be seen in Table 24, chemistry classes are quite similar to other science classes with a couple of exceptions. Chemistry classes are somewhat less likely to emphasize increasing students' interest in science (41 percent vs. 52 percent) and substantially less likely to emphasize learning about real-life applications of science (26 percent vs. 50 percent).

Table 24
High School Science Classes with Heavy
Emphasis on Various Instructional Objectives

	Percent of Classes	
	All Other Sciences	**Chemistry**
Understanding science concepts	80 (1.7)	82 (2.3)
Learning science process skills (e.g., observing, measuring)	47 (1.9)	53 (2.8)
Preparing for further study in science	45 (1.5)	49 (3.0)
Increasing students' interest in science	52 (1.7)	41 (2.5)
Learning about real-life applications of science	50 (1.9)	26 (2.0)
Learning test taking skills/strategies	20 (1.4)	24 (2.3)
Memorizing science vocabulary and/or facts	16 (1.7)	7 (1.3)

Class Activities

The 2012 National Survey included several items that provide information about how chemistry is taught at the high 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 25, the vast majority of chemistry classes include the teacher explaining science ideas, students working in small groups, and whole class discussions on a weekly basis. About 7 in 10 classes engage students in hands-on/laboratory activities. Roughly two-thirds of chemistry classes require students to support their claims with evidence, and a little more than half have students represent and/or analyze data at least once a week. It is somewhat striking that, in contrast to what is known from learning theory about the importance of reflection, only 15 percent of chemistry classes have students write reflections on what they are learning.

Table 25
High School Science Classes in which Teachers Report Using Various Activities at Least Once a Week

	Percent of Classes	
	All Other Sciences	Chemistry
Explain science ideas to the whole class	94 (1.0)	97 (0.8)
Have students work in small groups	84 (1.4)	83 (2.5)
Engage the whole class in discussions	83 (1.4)	78 (2.0)
Do hands-on/laboratory activities	71 (1.8)	70 (2.7)
Require students to supply evidence in support of their claims	59 (2.1)	63 (2.8)
Have students represent and/or analyze data using tables, charts, or graphs	59 (1.8)	53 (2.7)
Give tests and/or quizzes that include constructed-response/open-ended items	39 (1.7)	41 (2.7)
Give tests and/or quizzes that are predominantly short-answer (e.g., multiple choice, true /false, fill in the blank)	46 (1.9)	36 (2.6)
Have students read from a science textbook, module, or other science-related material in class, either aloud or to themselves	41 (2.1)	24 (2.2)
Have students practice for standardized tests	20 (1.6)	19 (2.0)
Focus on literacy skills (e.g., informational reading or writing strategies)	27 (1.9)	16 (2.0)
Have students write their reflections (e.g., in their journals) in class or for homework	22 (1.6)	15 (1.8)
Engage the class in project-based learning (PBL) activities	20 (1.4)	9 (1.3)
Have students make formal presentations to the rest of the class (e.g., on individual or group projects)	10 (1.2)	4 (0.7)
Have students attend presentations by guest speakers focused on science and/or engineering in the workplace	2 (0.6)	1 (0.3)

With one exception, chemistry classes are quite similar to all other classes in the frequency of use of instructional technology. As can be seen in Table 26, chemistry classes are substantially more likely than all other science classes to use graphing calculators.

Table 26
High School Science Classes in which Teachers Report that Students Use Various Instructional Technologies at Least Once a Week

	Percent of Classes	
	All Other Sciences	Chemistry
Graphing Calculators	15 (1.8)	34 (3.6)
Internet	36 (2.6)	32 (3.7)
Personal computers, including laptops	32 (2.6)	29 (4.2)
Hand-held computers	7 (1.4)	13 (3.5)
Probes for collecting data	7 (1.2)	10 (2.3)
Classroom response system or “Clickers”	5 (1.1)	7 (1.5)

In addition to asking about class activities in the course as a whole, the 2012 National Survey asked teachers about activities that took place during their most recent science lesson in the randomly selected class. Ninety percent of chemistry classes include the teacher explaining a science idea to the whole class in the most recent lesson (see Table 27). Students completing textbook/worksheet problems and whole class discussion and occur in 71 percent and 59 percent of chemistry lessons, respectively. Students completing worksheets is more common in chemistry classes than other science classes (71 percent and 56 percent of most recent lessons, respectively), and students reading about science is less common (22 percent vs. 39 percent of most recent lessons). In addition, chemistry classes are less likely than other science classes to include students doing hands-on/laboratory activities (32 percent vs. 41 percent of most recent lessons).

Table 27
High School Science Classes Participating in Various Activities in the Most Recent Lesson

	Percent of Classes	
	All Other Sciences	**Chemistry**
Teacher explaining a science idea to the whole class	90 (1.2)	90 (1.7)
Students completing textbook/worksheet problems	56 (1.8)	71 (2.5)
Whole class discussion	68 (2.0)	59 (2.7)
Teacher conducting a demonstration while students watched	30 (1.7)	34 (2.7)
Students doing hands-on/laboratory activities	41 (1.9)	32 (2.4)
Students reading about science	39 (1.8)	22 (2.3)
Students using instructional technology	28 (1.6)	22 (2.3)
Test or quiz	20 (1.8)	14 (1.7)
Practicing for standardized tests	9 (0.9)	12 (1.8)

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. There is essentially no difference between chemistry and non-chemistry classes (see Table 28). Just over 40 percent of class time is spent on whole class activities, 30 percent on small group work, and 18 percent on students working individually. Non-instructional activities, including attendance taking and interruptions, account for less than 10 percent of science class time.

Table 28
Average Percentage of Time Spent on Different Activities in the Most Recent High School Science Lesson

	Average Percent of Class Time	
	All Other Sciences	**Chemistry**
Whole class activities (e.g., lectures, explanations, discussions)	42 (0.8)	44 (1.2)
Small group work	30 (0.9)	30 (1.5)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	18 (0.7)	18 (1.1)
Non-instructional activities (e.g., attendance taking, interruptions)	9 (0.4)	8 (0.3)

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. As can be seen in Table 29, most chemistry classes assign between 31 and 90 minutes of homework per week.

Table 29
Amount of Homework Assigned in High School Science Classes per Week

	Percent of Classes	
	All Other Sciences	**Chemistry**
Fewer than 15 minutes per week	10 (1.4)	3 (0.9)
15–30 minutes per week	18 (2.0)	16 (2.9)
31–60 minutes per week	35 (2.6)	32 (3.9)
61–90 minutes per week	23 (2.2)	27 (2.9)
91–120 minutes per week	7 (1.5)	7 (1.8)
More than 120 minutes per week	7 (1.2)	15 (2.2)

Teachers were also given a list of ways that they might assess student progress and asked to describe which practices they used in the most recently completed unit in the randomly selected class. The vast majority of chemistry and non-chemistry classes included informal assessment practices during the unit to see if students were "getting it" (see Table 30). For example, 97 percent of all high school science classes involved the teacher questioning students during activities to monitor understanding. Using whole class informal assessments such as "thumbs up/thumbs down" was another common practice, used in 81 percent of science classes.

In addition, the use of formal assessment techniques such as grading student work, quizzes, and tests, as well as reviewing the correct answers to assignments were also prevalent features of science units. Teachers in roughly 9 out of 10 high school science classes administered a test or quiz to assign grades and assigned grades to student work. Probing student thinking at the beginning of a unit was included in only about half of high school science classes.

Table 30
High School Science Classes in which Teachers Report Assessing Students Using Various Methods in the Most Recent Unit

	Percent of Classes	
	All Other Sciences	Chemistry
Questioned individual students during class activities to see if they were "getting it"	97 (0.6)	98 (0.8)
Reviewed student work (e.g., homework, notebooks, journals, portfolios, projects) to see if they were "getting it"	95 (0.9)	96 (1.0)
Administered one or more quizzes and/or tests to assign grades	91 (0.9)	93 (1.5)
Went over the correct answers to assignments, quizzes, and/or tests with the class as a whole	87 (1.2)	92 (1.4)
Assigned grades to student work (e.g., homework, notebooks, journals, portfolios, projects)	94 (0.8)	89 (1.6)
Administered one or more quizzes and/or tests to see if students were "getting it"	78 (1.8)	87 (1.9)
Used information from informal assessments of the entire class (e.g., asking for a show of hands, thumbs up/thumbs down, clickers, exit tickets) to see if students were "getting it"	81 (1.5)	81 (2.0)
Administered an assessment, task, or probe at the beginning of the unit to find out what students thought or already knew about the key science ideas	54 (1.8)	46 (2.3)
Had students use rubrics to examine their own or their classmates' work	19 (1.4)	13 (1.6)

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. About two-thirds of chemistry classes are required to take such an assessment at least once a year, roughly equivalent to all other science classes (see Table 31).

Table 31
Frequency of Required External Testing in High School Science Classes

	Percent of Classes	
	All Other Sciences	Chemistry
Never	29 (1.7)	34 (2.8)
Once a year	36 (2.0)	30 (2.3)
Twice a year	12 (1.4)	13 (1.5)
Three or four times a year	14 (1.3)	11 (1.4)
Five or more times a year	8 (1.0)	11 (2.0)

Resources Available for High School Chemistry Instruction

Instructional Materials

The 2012 National Survey collected data on the use of instructional materials in science classes. Chemistry classes are somewhat less likely than non-chemistry classes to use commercially published materials; 71 and 79 percent, respectively (see Table 32).

Table 32
High School Science Classes Using
Commercially Published Instructional Materials

	Percent of Classes
All Other Sciences	79 (1.4)
Chemistry	71 (2.3)

The survey also asked if one textbook/module is used all or most of the time, or if multiple materials are used. Interestingly, chemistry classes, and other high school science classes in general, tend to use a single textbook or non-commercially published instructional materials (see Table 33).

Table 33
Instructional Materials Used in High School Science Classes

	Percent of Classes	
	All Other Sciences	**Chemistry**
Mainly commercially published textbook(s)		
One textbook	52 (1.8)	50 (2.8)
Multiple textbooks	7 (0.9)	5 (0.9)
Mainly commercially published modules		
Modules from a single publisher	2 (0.5)	2 (0.5)
Modules from multiple publishers	2 (0.6)	1 (0.4)
Other		
A roughly equal mix of commercially published textbooks and commercially published modules most of the time	15 (1.5)	13 (1.9)
Non-commercially published materials most of the time	21 (1.4)	29 (2.3)

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 chemistry materials are:

- *Chemistry* (Pearson);
- *Modern Chemistry* (Houghton Mifflin Harcourt);
- *Chemistry - Matter and Change* (McGraw-Hill);
- *Chemistry - The Central Science* (Pearson); and
- *Chemistry* (Houghton Mifflin Harcourt).

Table 34 shows the publication year of commercially published instructional materials used. In 2012, two-thirds of high school chemistry classes were using materials published prior to 2007.

Table 34
Publication Year of Instructional Materials in High School Science Classes

	Percent of Classes[†]	
	All Other Sciences	Chemistry
2006 or earlier	58 (2.3)	66 (3.0)
2007–09	26 (2.2)	25 (2.9)
2010–12	16 (1.6)	9 (1.5)

† Only classes using commercially published textbooks/modules were included in these analyses.

It is interesting to note that while national experts in science and mathematics education are often critical of textbook quality,[6] most chemistry teachers consider their instructional materials to be of relatively high quality, as those in over 80 percent of chemistry classes rated their materials as good or better (see Table 35).

Table 35
Perceived Quality of
Instructional Materials Used in High School Science Classes

	Percent of Classes[†]	
	All Other Sciences	Chemistry
Very Poor	1 (0.6)	0 (0.3)
Poor	3 (0.9)	2 (1.1)
Fair	20 (3.2)	15 (3.2)
Good	32 (2.6)	39 (4.1)
Very Good	34 (3.1)	31 (3.9)
Excellent	10 (1.9)	12 (2.9)

† Only classes using commercially published textbooks/modules were included in these analyses.

Despite these ratings, there does seem to be an issue with the number of topics in chemistry materials. Only about one-third of chemistry classes address three-fourths or more of their instructional materials, possibly a reflection of publishers' efforts to meet as many state and district criteria as possible by including all of the content anyone might seek (see Table 36). Furthermore, over half of high school chemistry classes spend less than 25 percent of their instructional time using the materials (see Table 37).

[6] For example, American Association for the Advancement of Science (2000). *Middle grades mathematics textbooks: A benchmarks-based evaluation.* Washington, DC: Author.

Table 36
Percentage of Instructional Materials
Covered during High School Science Courses

	Percent of Classes†	
	All Other Sciences	**Chemistry**
Less than 25 percent	9 (2.3)	3 (1.5)
25–49 percent	18 (2.7)	16 (4.2)
50–74 percent	30 (3.2)	45 (4.9)
75 percent or more	43 (4.2)	35 (5.1)

† Only classes using commercially published textbooks/modules were included in these analyses.

Table 37
Percentage of Instructional Time Spent
Using Instructional Materials during High School Science Courses

	Percent of Classes†	
	All Other Sciences	**Chemistry**
Less than 25 percent	44 (3.5)	56 (4.9)
25–49 percent	28 (3.0)	22 (4.5)
50–74 percent	16 (3.0)	13 (3.7)
75 percent or more	12 (2.4)	9 (2.8)

† Only classes using commercially published textbooks/modules were included in these analyses.

A similar story emerges from responses to questions asking teachers to describe how they used their textbook/module in their most recent unit. As can be seen in Table 38, teachers in 77 percent of chemistry classes indicate that they supplemented their textbook/module; 56 percent indicated that they picked what was important from the materials and skipped the rest. Still, in the majority of chemistry classes, teachers use the textbook/module to guide the overall structure and content emphasis of their units.

Table 38
Ways High School Science Teachers
Substantially† Used Their Instructional Materials in the Most Recent Unit

	Percent of Classes‡	
	All Other Sciences	**Chemistry**
You incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what the textbook/module was lacking	79 (2.1)	77 (3.3)
You used the textbook/module to guide the overall structure and content emphasis of the unit	66 (2.4)	56 (3.6)
You picked what is important from the textbook/module and skipped the rest	50 (2.2)	56 (3.7)
You followed the textbook/module to guide the detailed structure and content emphasis of the unit	47 (2.7)	39 (3.6)

† Includes those responding 4 or 5 on a 5-point scale ranging from 1 “not at all” to 5 “to a great extent.”
‡ Only classes using commercially published textbooks/modules in the most recent unit were included in these analyses.

Teachers in nearly all chemistry classes that supplement their textbook/module do so to provide students with additional practice (see Table 39). Similarly, teachers in 91 percent of chemistry classes that supplement are trying to help students at different levels of achievement learn targeted ideas. In almost half of chemistry classes, teachers supplement to prepare students for standardized tests.

Table 39
Reasons Why High School Science Instructional Materials Are Supplemented

	Percent of Classes†			
	All Other Sciences		Chemistry	
Supplemental activities were needed to provide students with additional practice	93	(2.0)	95	(2.3)
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity	93	(1.6)	91	(2.6)
Supplemental activities were needed to prepare students for standardized tests	54	(3.8)	45	(6.3)
Your pacing guide indicated that you should use supplemental activities	38	(3.5)	33	(5.2)

† Only classes using commercially published textbooks/modules in the most recent unit and whose teachers reported supplementing some activities were included in these analyses.

Teachers were also asked why they skipped parts of their textbook/module. As can be seen in Table 40, teachers in 81 percent of these chemistry classes skip activities because they have other ones that work better. In 56 percent of chemistry classes, teachers skip activities because students already knew the content. Skipping activities because teachers lack the materials, the ideas are not in their pacing guides/state standards, or the activities were too difficult was reported by teachers in 44–55 percent of chemistry classes.

Table 40
Reasons Why Parts of High School Science Instructional Materials Are Skipped

	Percent of Classes†			
	All Other Sciences		Chemistry	
You have different activities for those science ideas that work better than the ones you skipped	90	(1.8)	81	(4.2)
Your students already knew the science ideas or were able to learn them without the activities you skipped	57	(3.6)	56	(5.5)
The science ideas addressed in the activities you skipped are not included in your pacing guide and/or current state standards	61	(4.0)	55	(5.6)
The activities you skipped were too difficult for your students	49	(3.8)	50	(5.8)
You did not have the materials needed to implement the activities you skipped	51	(3.8)	44	(5.2)

† Only classes using commercially published textbooks/modules in the most recent unit and whose teachers reported skipping some activities were included in these analyses.

Facilities and Equipment

Teachers were presented with a list of instructional technologies and asked about their availability in the randomly selected class. The three response options were:

- Do not have one per group available;

- At least one per group available upon request or in another room; and
- At least one per group located in your classroom.

As can be seen in Table 41, high school chemistry classes are more likely than other science classes to have access to non-graphing calculators (85 percent vs. 75 percent), probes for data collection (74 percent vs. 61 percent), and graphing calculators (55 percent vs. 40 percent). Access to computers and the Internet is similar in both groups of classes.

Table 41
Availability† of Instructional Technologies in High School Science Classes

	Percent of Classes	
	All Other Sciences	**Chemistry**
Internet access	87 (1.6)	85 (2.4)
Non-graphing calculators	75 (2.7)	85 (2.6)
Personal computers, including laptops	80 (2.0)	78 (3.1)
Probes for collecting data (e.g., motion sensors, temperature probes)	61 (2.9)	74 (3.6)
Microscopes	83 (2.2)	72 (3.7)
Graphing calculators	40 (2.8)	55 (3.8)
Classroom response system or "Clickers" (handheld devices used to respond electronically to questions in class)	48 (2.8)	46 (3.4)
Hand-held computers (e.g., PDAs, tablets, smartphones, iPads)	19 (1.8)	22 (2.6)

† Includes only those rating the availability as at least one per group available, either in the classroom, upon request, or in another room.

Although the majority of chemistry classes have access to graphing calculators, 29 percent expect students to provide their own (see Table 42).

Table 42
Expectations that Students will Provide their Own Instructional Technologies

	Percent of Classes	
	All Other Sciences	**Chemistry**
Non-graphing calculators	41 (2.9)	61 (3.9)
Graphing calculators	23 (2.1)	29 (3.2)
Laptop computers	7 (1.3)	9 (1.8)
Hand-held computers	6 (1.2)	7 (1.6)

When asked about the adequacy of resources for instruction, teachers in the majority of high school chemistry classes rated their facilities, access to consumable supplies and equipment, and instructional technology as adequate (see Table 43). On a composite variable created from these items titled “Adequacy of Resources for Instruction,” chemistry classes have a higher mean score than other science classes (see Table 44).

Table 43
High School Science Classes with Adequate† Resources for Instruction

	Percent of Classes			
	All Other Sciences		Chemistry	
Facilities (e.g., lab tables, electric outlets, faucets and sinks)	70	(1.7)	76	(2.5)
Consumable supplies (e.g., chemicals, living organisms, batteries)	58	(2.2)	72	(2.5)
Equipment (e.g., microscopes, beakers, photogate timers, Bunsen burners)	60	(1.9)	71	(2.6)
Instructional technology (e.g., calculators, computers, probes/sensors)	49	(2.4)	53	(2.4)

† Includes those responding 4 or 5 on a 5-point scale ranging from 1 "not adequate" to 5 "adequate."

Table 44
Class Mean Scores on the Adequacy of Resources for Instruction Composite

	Mean Score	
All Other Sciences	67	(1.1)
Chemistry	73	(1.5)

FACTORS AFFECTING HIGH SCHOOL CHEMISTRY INSTRUCTION

Teachers were asked about factors that affect instruction in their randomly selected class. As can be seen in Table 45, in the majority of chemistry classes, teachers think that most of the factors promote effective instruction, including principal support, college entrance requirements, and curriculum frameworks. Student motivation and abilities, as well as parent expectations and involvement, are also likely to be seen as promoting effective instruction in chemistry classes. Teacher evaluation policies and accountability policies, among others, are seen as promoting effective instruction in a minority of chemistry classes.

Table 45
Factors Promoting† Effective Instruction in High School Science Classes

	Percent of Classes	
	All Other Sciences	**Chemistry**
Principal support	74 (2.6)	72 (3.4)
College entrance requirements	59 (2.8)	65 (3.8)
Students' motivation, interest, and effort in science	62 (2.7)	59 (3.7)
District/Diocese curriculum frameworks‡	55 (2.6)	57 (3.3)
Time for you to plan, individually and with colleagues	60 (2.8)	56 (4.2)
Students' reading abilities	50 (2.9)	53 (3.6)
Parent expectations and involvement	51 (2.7)	52 (4.0)
Textbook/module selection policies	48 (2.7)	50 (3.9)
Current state standards	54 (2.5)	49 (4.1)
Time available for your professional development	51 (3.0)	49 (4.3)
Teacher evaluation policies	52 (2.6)	48 (4.3)
District/Diocese/School pacing guides	48 (2.5)	48 (4.8)
Community views on science instruction	49 (2.5)	44 (3.8)
District/Diocese testing/accountability policies‡	33 (2.8)	38 (4.2)
State testing/accountability policies‡	29 (2.8)	33 (4.0)

† Includes those responding 4 or 5 on a 5-point scale ranging from 1 "inhibits effective instruction" to 5 "promotes effective instruction."
‡ Item presented only to public and catholic school teachers.

The teacher survey also included a series of items about technology-related issues. Teachers were asked to indicate how great a problem each posed for instruction in their randomly selected class. As can be seen in Table 46, these resources are generally not seen as problematic in chemistry or other high school science classes.

Table 46
Extent to Which Technology Quality Is a Serious Problem for Instruction in the Randomly Selected High School Science Class

	Percent of Classes	
	All Other Sciences	**Chemistry**
Old age of computers	14 (2.1)	10 (2.0)
Lack of availability of technology support	13 (2.0)	7 (1.8)
Lack of access to computers	13 (2.0)	6 (1.3)
Slow speed of the Internet connection	13 (1.9)	5 (1.4)
Unreliability of the Internet connection	11 (1.9)	4 (1.4)
Lack of availability of appropriate computer software	11 (2.1)	4 (1.2)
Lack of access to the Internet	8 (1.8)	3 (1.2)

Composites from these two series of questionnaire items were created to summarize the extent to which various factors support effective instruction. The means are shown in Table 47. Overall, these data indicate that the climate is generally supportive for high school science instruction. The quality of instructional technology appears to be less of a problem in chemistry than in other sciences.

Table 47
Class Mean Scores for the Factors Affecting Instruction Composites

	Mean Score	
	All Other Sciences	**Chemistry**
Extent to which Stakeholder Support Promotes Effective Instruction	65 (1.4)	64 (1.7)
Extent to which School Support Promotes Effective Instruction	65 (1.9)	63 (2.0)
Extent to which the Policy Environment Promotes Effective Instruction	61 (1.2)	62 (1.5)
Extent to which IT Quality is Problematic for Instruction	27 (1.5)	19 (1.4)

SUMMARY

Nearly all high school chemistry teachers are white, and just over half are female. Twenty-nine percent have a degree in chemistry, and an additional 47 percent have three or more college courses in chemistry beyond the introductory level. Chemistry teachers feel better prepared to teach chemistry than other science teachers do to teach their subject. Although chemistry 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, two-thirds of chemistry teachers believe that students should be provided with definitions for new vocabulary at the beginning of instruction on an idea.

When asked about their professional development experiences, the vast majority of high school chemistry teachers have participated in science-focused professional development in the last three years. However, only one-third have had sustained professional development (more than 35 hours) in that time period. They are also less likely than other science teachers to have had opportunities to work closely with other science teachers from their school in those professional development experiences, perhaps because many schools have only one chemistry teacher.

Data on chemistry courses indicate that virtually all students in the nation have access to one or more chemistry courses at their schools. However, chemistry accounts for only 22 percent of high school science courses, a distant second behind biology (39 percent), indicating that fewer students enroll in chemistry. Female students are just as likely as male students to take chemistry, and female students are just as likely to take chemistry as they are to take biology and physics.

Data on instruction indicate that chemistry instruction relies heavily on lecture and discussion, with students often completing textbook/worksheet problems. However, the data also indicate that students are engaged in hands-on laboratory activities and required to use evidence to support claims fairly regularly. In addition, although 71 percent of chemistry classes use commercially published instructional materials, two-thirds cover less than 75 percent of the material in their textbook and spend less than half of instructional time using the text. Chemistry classes also have higher scores than non-chemistry classes on a composite variable measuring adequacy of resources for instruction.

APPENDIX

Table A-1
Teacher Mean Scores for Composites

	Mean Score	
	All Other Sciences	**Chemistry**
Perceptions of Preparedness to Teach Science Content	83 (1.0)	93 (1.7)
Perceptions of Preparedness to Encourage Students' Interest in Science	77 (1.7)	78 (1.4)
Perceptions of Preparedness to Teach Students from Diverse Backgrounds	59 (1.4)	57 (1.6)
Quality of Professional Development	64 (1.2)	58 (2.6)
Extent to which PD/Coursework Focused on Student-Centered Instruction	62 (1.8)	63 (1.6)

Table A-2
Class Mean Scores for Composites

	Mean Score	
	All Other Sciences	**Chemistry**
Perceptions of Preparedness to Implement Instruction in Particular Unit	81 (0.7)	82 (1.0)
Curriculum Control	61 (1.9)	57 (2.5)
Pedagogical Control	90 (0.9)	88 (1.4)
Reform-Oriented Instructional Objectives	82 (0.5)	81 (0.7)
Use of Reform-Oriented Teaching Practices	60 (0.6)	57 (0.8)
Use of Instructional Technology	33 (1.1)	37 (1.3)
Adequacy of Resources for Instruction	67 (1.1)	73 (1.5)
Extent to which Stakeholder Support Promotes Effective Instruction	65 (1.4)	64 (1.7)
Extent to which the Policy Environment Promotes Effective Instruction	61 (1.2)	62 (1.5)
Extent to which School Support Promotes Effective Instruction	65 (1.9)	63 (2.0)
Extent to which IT Quality is Problematic for Instruction	27 (1.5)	19 (1.4)