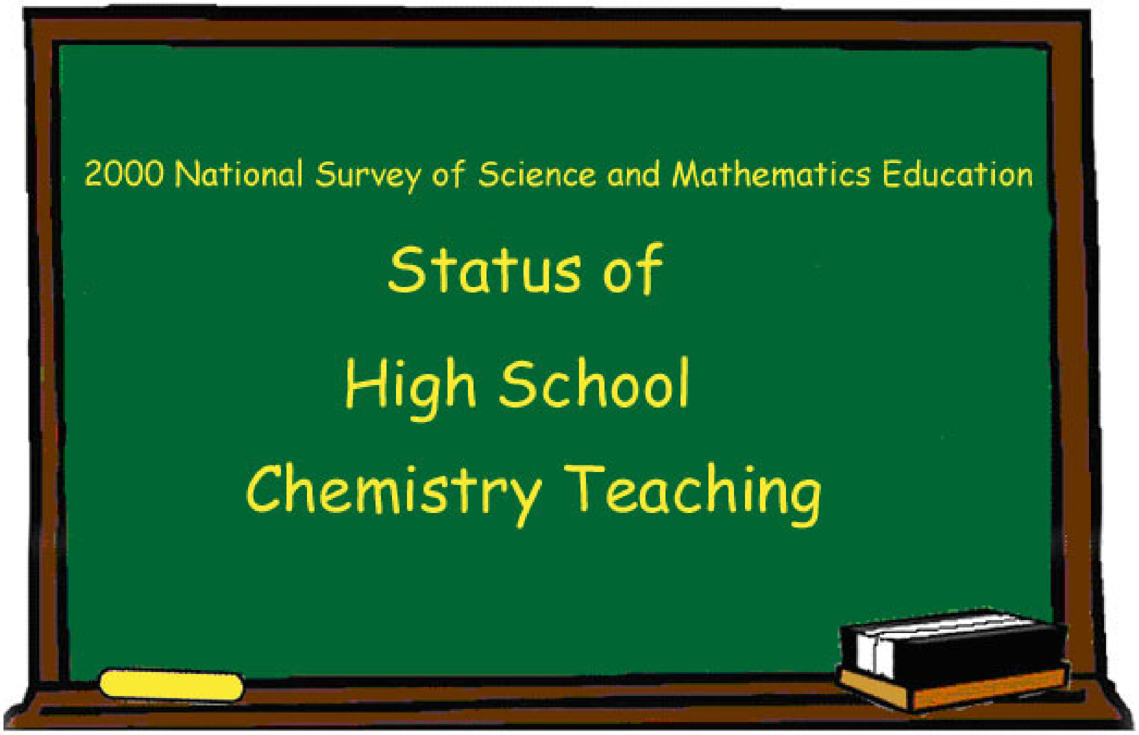

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Horizon Research, Inc.
326 Cloister Court
Chapel Hill, NC. 27514

P. Sean Smith

www.horizon-research.com

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Status of High School Chemistry Teaching

Introduction

The 2000 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 5,728 science and mathematics teachers in schools across the United States participated in this survey, a response rate of 74 percent. Among the questions addressed by the survey:

- How well prepared are science and mathematics teachers in terms of both content and pedagogy?

- What are teachers trying to accomplish in their science and mathematics instruction, and what activities do they use to meet these objectives?

The 2000 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.

Since 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 506 chemistry teachers.[1] For comparison purposes, many of the tables include data from teachers who do *not* teach chemistry (N=814); i.e., all other high school science teachers. These data include responses from high school biology, physics, earth science, 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 2000 National Survey of Science and Mathematics Education* (Weiss, Banilower, McMahon, & Smith, 2001). The standard errors for the estimates presented in this report are included in parentheses in the tables. The narrative sections of the report

[1] A chemistry teacher is defined as someone who teaches at least one class of general or advanced chemistry.

generally point out only those differences which are substantial as well as statistically significant at the 0.05 level or beyond.

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

- Characteristics of the chemistry teaching force in the United States;
- Professional development of chemistry teachers, both needs and participation;
- Chemistry classes offered;
- Chemistry instruction, in terms of both objectives and class activities; and
- Resources available for chemistry instruction.

Characteristics of the Chemistry Teaching Force

General Demographics
Slightly more than half of all chemistry teachers in the United States are female, and 93 percent are white, as shown in Table 1. Roughly half have a master's degree. Judging by the age of chemistry teachers, it appears that as many as one-third may be nearing retirement in the next 10 years.

Roughly one-third of those who teach chemistry have three or more preparations a day; either different levels of chemistry, other sciences, or subjects outside of science.

Table 1
Characteristics of the
High School Chemistry Teaching Force

	Percent of Teachers			
	Chemistry		All Other Sciences	
Sex				
Male	47	(4.5)	52	(2.1)
Female	53	(4.5)	48	(2.1)
Race				
White	93	(1.6)	88	(1.4)
Black or African-American	2	(1.1)	6	(1.0)
Hispanic or Latino	1	(0.5)	3	(0.6)
American Indian or Alaskan Native	0	(0.3)	2	(0.7)
Native Hawaiian or Other Pacific Islander	0	(0.1)	0	(0.2)
Asian	2	(0.7)	2	(0.7)
Age				
≤ 30 years	23	(5.7)	19	(2.1)
31–40 years	20	(2.7)	25	(2.0)
41–50 years	27	(3.5)	30	(2.2)
51+ years	31	(3.5)	26	(2.0)
Experience				
0–2 years	18	(4.6)	16	(2.0)
3–5 years	16	(4.5)	16	(1.6)
6–10 years	14	(2.3)	20	(1.8)
11–20 years	22	(2.7)	20	(1.9)
≥ 21 years	31	(3.4)	28	(2.1)
Master's Degree				
Yes	53	(4.3)	58	(2.6)
No	47	(4.3)	42	(2.6)

Content Preparedness

In general, chemistry teachers appear to be well prepared in terms of the number of college chemistry courses they have taken. Two-thirds of them have taken six or more courses in the subject, suggesting the equivalent of at least a minor. (See Table 2.) Virtually all (97 percent) have taken at least three chemistry courses. It is also clear that chemistry teachers are generally better prepared in their own subject than in other science disciplines; e.g., life science or physics.

Table 2
Number of Semesters† Completed by High School Chemistry Teachers in Various Course Categories

	Percent of Teachers							
	Zero Semesters		1–2 Semesters		3–5 Semesters		6 or More Semesters	
Chemistry								
Chemistry	0	(0.2)	3	(1.1)	29	(4.5)	67	(4.5)
Life science	6	(1.2)	23	(4.4)	14	(2.2)	57	(4.5)
Physics/physical science	2	(0.5)	38	(4.1)	26	(3.1)	34	(4.7)
Earth/space science	30	(4.9)	31	(3.2)	26	(3.2)	13	(2.3)
Science education	20	(4.7)	31	(4.5)	24	(3.2)	24	(2.9)
All Other Science								
Chemistry	4	(0.7)	24	(2.3)	44	(2.3)	28	(2.0)
Life science	7	(1.3)	9	(2.1)	12	(1.4)	72	(2.5)
Physics/physical science	9	(1.3)	40	(2.7)	26	(2.4)	25	(1.9)
Earth/space science	20	(2.5)	33	(2.1)	26	(2.0)	21	(1.9)
Science education	20	(2.4)	31	(2.4)	24	(1.9)	25	(1.9)

† The highest number of courses a teacher could indicate for each of the four categories—life science, chemistry, physics/physical science, and earth/space science—was "> 8," and 9 was used as the number of courses in those cases. As a result, these figures underestimate the total for any teacher who completed more than eight courses in a particular category.

Looking at high school science classes in the different disciplines, chemistry classes are at least as likely as earth science and physics classes to be taught by teachers who have completed six or more courses in their field (74 percent); only biology classes were more likely to have teachers with that amount of college course work (94 percent). (See Table 3.) Note that while only two-thirds of chemistry teachers have taken six or more chemistry courses, three-fourths of the chemistry classes are taught by teachers with six or more courses in the field, indicating that the most prepared chemistry teachers are more likely to teach multiple sections.

Table 3
Science Classes Taught by Teachers with Six or More College Courses in Field, in Another Science Field, and Lacking In-Depth Preparation in Any Science

	Percent of Classes					
	Six or More Courses In Field		Not In-Depth in Field, But Six or More in Another Science		Not In-Depth in Any Science	
Biology	94	(1.8)	2	(0.8)	4	(1.5)
Chemistry	74	(4.0)	17	(3.1)	9	(2.7)
Earth science	58	(5.9)	34	(5.2)	8	(3.7)
Physics	37	(2.8)	54	(5.4)	9	(1.7)

In terms of the specific courses taken by chemistry teachers, more than 9 in 10 have taken general chemistry and organic chemistry. (See Table 4.) Half have taken physical chemistry, again suggesting they have course work equivalent to at least a minor. With the exception of general chemistry, it is clear that chemistry teachers are much more likely than other science teachers to have taken college-level chemistry courses.

Only three-fourths of chemistry teachers have had a course in science teaching methods, and only two-thirds have completed supervised student teaching, suggesting there may be a substantial number of lateral entry teachers in the chemistry teaching force. These percentages are not, however, significantly different than those for other science teachers.

Table 4
High School Chemistry Teachers
Completing Various College Courses

	Percent of Teachers			
	Chemistry		All Other Sciences	
General methods of teaching	90	(4.7)	90	(1.8)
Methods of teaching science	73	(5.1)	77	(2.4)
Supervised student teaching in science	66	(4.5)	71	(2.5)
Instructional uses of computers/other technologies	42	(4.4)	51	(2.3)
General/introductory chemistry	99	(0.3)	92	(1.3)
Organic chemistry	93	(1.5)	64	(2.4)
Analytical chemistry	68	(4.4)	30	(2.1)
Physical chemistry	51	(4.1)	21	(1.8)
Biochemistry	47	(4.1)	35	(2.2)
Other chemistry	44	(3.8)	16	(1.6)
Quantum chemistry	16	(2.3)	3	(0.6)

Judging from the data in Table 4, virtually all chemistry teachers have had college course work equivalent to and beyond the topics they would be likely to teach in a high school chemistry class. This is reflected in chemistry teachers' ratings of their own content preparedness. The survey asked them to rate how qualified they felt to teach a number of fundamental topics in chemistry:

- Structure of matter and chemical bonding;
- Properties and states of matter;
- Chemical reactions; and
- Energy and chemical change.

Eighty-five percent or more responded that they felt "very well qualified" to teach each of these topics, and fewer than 1 percent felt "not well qualified." (See Table 5.)

Table 5
High School Chemistry Teachers' Perceptions of Their Qualifications to Teach Each of a Number of Chemistry Topics

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Chemistry						
Structure of matter and chemical bonding	0	(0.2)	11	(2.0)	90	(2.1)
Properties and states of matter	0	(0.2)	9	(2.0)	89	(2.0)
Chemical reactions	0	(0.2)	12	(2.4)	87	(2.4)
Energy and chemical change	0	(0.2)	14	(2.5)	85	(2.5)
All Other Sciences						
Structure of matter and chemical bonding	11	(1.3)	51	(2.5)	38	(2.4)
Properties and states of matter	9	(1.1)	45	(2.3)	46	(2.3)
Chemical reactions	18	(1.8)	50	(2.6)	32	(2.4)
Energy and chemical change	19	(1.8)	47	(2.4)	34	(2.1)

A similar question was asked of teachers in the various high school science disciplines, with topics appropriate to the discipline (e.g., biology teachers were asked how well qualified they felt to teach about the structure and function of human systems, among other topics). Each discipline-specific series was combined into a composite variable. (Definitions of all composite variables, descriptions of how they were created, and reliability information are included in the Appendix.) Each composite has a minimum possible score of 0 and a maximum possible score of 100. In terms of being prepared to teach the content in their discipline, chemistry teachers are more likely than those in other disciplines to consider themselves well qualified, with an average composite score of 90; the next closest group was biology teachers, with an average composite score of 84. (See Table 6.)

Table 6
Content Preparedness Composite Scores of High School Science Teachers

	Mean Score			
	Teach Subject		Do Not Teach Subject	
Chemistry	90	(1.2)	70	(1.1)
Biology/Life science	84	(1.4)	60	(1.6)
Physics	82	(3.1)	55	(1.1)
Earth science	81	(1.5)	63	(0.9)
Environmental science	73	(2.8)	68	(0.9)
Physical science	66	(3.3)	60	(1.0)
Integrated/general science	64	(1.4)	62	(0.9)

The overall picture of chemistry teachers is that they are relatively well qualified in their subject area. This is not to suggest that out-of-field teaching does not exist. It is clear from Table 4, that at least some chemistry teachers have had only one or two college courses in the subject. By and large, though, students appear to be receiving instruction from teachers with adequate content backgrounds. This conclusion is supported by a recent report from the National Center for

Education Statistics based on data from the 1999–2000 Schools and Staffing Survey. This study found that over 90 percent of chemistry students nationwide are taught by a teacher who has either a major, minor, or certification in chemistry.[2]

Pedagogical Preparedness

The National Research Council (NRC) *National Science Education Standards*, while not specific to chemistry, provide a useful frame for interpreting data on chemistry teachers' pedagogical preparedness. Responding to an item about the NRC *Standards*, 60 percent of chemistry teachers indicated they were at least somewhat familiar with the document, and of these, 73 percent said they agreed with the *Standards*. (See Table 7.) These percentages are consistent with those for other science teachers.

Table 7
High School Chemistry Teachers' Familiarity with, Agreement with, and Implementation of the NRC *Standards*

	Percent of Teachers			
	Chemistry		All Other Sciences	
Familiarity with NRC *Standards*				
Not at all familiar	40	(4.7)	36	(2.3)
Somewhat familiar	33	(4.4)	35	(2.7)
Fairly familiar	21	(2.8)	17	(1.6)
Very familiar	6	(1.0)	12	(1.5)
Extent of agreement with NRC *Standards*†				
Strongly Disagree	0	—§	1	(0.3)
Disagree	9	(3.9)	6	(1.3)
No Opinion	18	(3.4)	24	(2.5)
Agree	65	(5.1)	65	(3.0)
Strongly Agree	8	(2.1)	4	(0.9)
Extent to which recommendations have been implemented†				
Not at all	4	(1.1)	5	(1.4)
To a minimal extent	26	(4.8)	29	(3.1)
To a moderate extent	61	(5.4)	54	(2.9)
To a great extent	10	(1.8)	13	(2.3)

† These analyses included only those teachers indicating they were at least somewhat familiar with the *Standards*.
§ No teachers in the sample selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

The survey asked teachers how well prepared they felt to use a number of instructional strategies in their teaching. As with content preparedness items, composite variables were created from these individual strategies. Mean scores on these composites suggest that chemistry teachers are least likely to feel prepared in technology-related areas. (See Table 8.) In particular, relatively few chemistry teachers indicated they felt well prepared to use the Internet for collaborative

[2] U.S. Department of Education, National Center for Education Statistics. *Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching,1987–88 to 1999–2000*, NCES 2002-603, by Marilyn McMillen, Seastrom, Kerry J. Gruber, Robin Henke, Daniel J. McGrath, and Benjamin A. Cohen. Washington, DC: 2002.

projects across classes or schools. (See Table 9.) With one exception (recognize and respond to cultural diversity), 80 percent or more rated themselves as being well prepared to implement a number of practices in the "Standards-Based Teaching Practices" Composite (Table 9), such as:

- Develop students' conceptual understanding of science;
- Make connections between science and other disciplines;
- Provide deeper coverage of fewer science concepts;
- Lead a class of students using investigative strategies; and
- Take students' prior understanding into account when planning curriculum and instruction.

Table 8
Composite Scores of High School
Chemistry Teachers' Pedagogical Preparedness

	Mean Score			
	Chemistry		All Other Sciences	
Preparedness to Use Standards-Based Teaching Practices	77	(1.4)	76	(0.8)
Preparedness to Teach Students from Diverse Backgrounds	77	(1.7)	76	(0.9)
Preparedness to Use Calculators/Computers	59	(2.6)	52	(1.3)
Preparedness to Use the Internet	49	(2.6)	50	(1.5)

Table 9
High School Chemistry Teachers Considering Themselves Well Prepared† for Each of a Number of Tasks

	Percent of Teachers			
	Chemistry		All Other Sciences	
Encourage participation of females in science	98	(0.7)	94	(1.0)
Listen/ask questions as students work in order to gauge their understanding	97	(1.0)	95	(1.1)
Encourage students' interest in science	96	(2.2)	94	(1.2)
Develop students' conceptual understanding of science	94	(1.6)	92	(1.2)
Manage a class of students engaged in hands-on/project-based work	91	(2.5)	92	(1.4)
Make connections between science and other disciplines	89	(2.7)	90	(1.3)
Provide deeper coverage of fewer science concepts	88	(1.8)	87	(1.4)
Encourage participation of minorities in science	87	(3.0)	91	(1.3)
Have students work in cooperative learning groups	85	(2.1)	86	(1.9)
Use the textbook as a resource rather than the primary instructional tool	84	(2.6)	85	(1.8)
Lead a class of students using investigative strategies	83	(3.0)	82	(2.0)
Teach groups that are heterogeneous in ability	82	(2.8)	79	(2.5)
Take students' prior understanding into account when planning curriculum and instruction	81	(2.3)	75	(1.9)
Use calculators/computers for drill and practice	78	(3.2)	63	(2.2)
Use calculators/computers to collect and/or analyze data	74	(3.0)	63	(2.3)
Use the Internet in your science teaching for general reference	63	(3.8)	66	(2.3)
Recognize and respond to student cultural diversity	60	(3.7)	62	(2.6)
Use the Internet in your science teaching for data acquisition	57	(4.0)	56	(2.4)
Use computers to demonstrate scientific principles	55	(4.4)	50	(2.5)
Use calculators/computers for science learning games	53	(4.3)	46	(2.2)
Involve parents in the science education of their children	49	(4.7)	41	(2.1)
Use computers for laboratory simulations	48	(4.3)	44	(2.4)
Use the Internet in your science teaching for collaborative projects with classes/individuals in other schools	29	(4.1)	30	(2.1)
Teach students who have limited English proficiency	20	(4.7)	21	(1.7)

† Includes teachers responding "very well prepared" or "fairly well prepared" to each statement.

The similarities between chemistry teachers and other science teachers in their pedagogical preparedness are striking. Two areas where chemistry teachers appear better prepared than other science teachers relate to the use of calculators and computers, both for drill and practice and to collect/analyze data.

Teachers' ratings of their pedagogical preparedness are reflected in the areas they identify as needs for professional development. The survey asked about six different areas, shown in Table 10. Learning how to use technology in science instruction, along with learning to accommodate students with special needs, were the areas most likely to be rated by chemistry teachers as a moderate or substantial need. It may be that the trend toward mainstreaming over the last decade accounts for teachers recognizing they need help accommodating students with special needs.

Similarly, the infusion of technology in classrooms and the push for its use has likely made teachers more aware of their needs in this area.

About half of the chemistry teachers indicated they need professional development related to teaching through inquiry/investigation, and a similar percentage indicated a need for help in understanding student thinking. Slightly more than a third of the chemistry teachers perceived a need for help in assessment or in deepening their own content knowledge. (See Table 10.) In no instance were chemistry teachers significantly different than other science teachers in their perceived needs for professional development.

Table 10
High School Chemistry Teachers Reporting They Perceived a Moderate or Substantial Need for Professional Development in the Preceding Three Years

	Percent of Teachers			
	Chemistry		All Other Sciences	
Learning how to use technology in science instruction	68	(4.7)	72	(2.1)
Learning how to teach science in a class that includes students with special needs	57	(4.3)	60	(2.6)
Learning how to use inquiry/investigation-oriented teaching strategies	51	(4.5)	53	(2.2)
Understanding student thinking in science	46	(4.6)	48	(2.3)
Learning how to assess student learning in science	38	(4.0)	44	(2.4)
Deepening my own science content knowledge	37	(4.3)	39	(2.4)

Professional Development of Chemistry Teachers

Chemistry teachers, like high school science teachers generally, report low levels of participation in professional development specific to science teaching. Only about half of the chemistry teachers have spent more than 35 hours in science-related professional development in the previous three years, quite similar to other science teachers. (See Table 11.)

Table 11
Time Spent on Science-Related, In-Service Education by High School Chemistry Teachers

	Percent of Teachers			
	Chemistry		All Other Sciences	
None	6	(1.6)	8	(1.4)
Less than 6 hours	7	(1.7)	9	(2.0)
6–15 hours	16	(2.3)	17	(1.7)
16–35 hours	25	(3.1)	21	(1.9)
More than 35 hours	46	(3.8)	44	(2.6)

As to how this time is spent, the workshop is by far the most common form of professional development (72 percent of teachers have attended one in the previous three years), followed by collaborating with teachers locally, either observing their classrooms (55 percent) or meeting regularly to discuss science teaching (52 percent). (See Table 12.) Forty-three percent report attending a state or national science teachers meeting in the previous three years, and 42 percent have taken a college/university science course.

Table 12
High School Chemistry Teachers Participating in Various Professional Development Activities in the Preceding Three Years

	Percent of Teachers			
	Chemistry		All Other Sciences	
Attended a workshop on science teaching	72	(5.2)	69	(2.1)
Observed other teachers teaching science as part of your own professional development (formal or informal)	55	(4.3)	58	(2.4)
Met with a local group of teachers to study/discuss science teaching issues on a regular basis	52	(4.9)	54	(2.3)
Attended a national or state science teacher association meeting	43	(4.5)	43	(2.1)
Taken a formal college/university science course	42	(3.9)	35	(2.5)
Taken a formal college/university course in the teaching of science	27	(3.4)	26	(2.2)
Served as a mentor and/or peer coach in science teaching, as part of a formal arrangement that is recognized or supported by the school or district	22	(3.1)	25	(2.4)
Collaborated on science teaching issues with a group of teachers at a distance using telecommunications	18	(2.8)	16	(1.8)

Teachers were asked to consider their professional development as a whole and characterize it in terms of different potential emphases. (See Table 13.) Roughly one-third of the chemistry teachers indicated that their professional development emphasized learning to teach through inquiry/investigation or deepening their science content knowledge, and half of all chemistry teachers indicated that their professional development experiences emphasized learning how to use technology in science instruction. In technology, there appears to be a good match between perceived need and emphasis in professional development opportunities; i.e., this area was mostly likely to be rated as a need and also most likely to be emphasized in professional development opportunities. It is not clear if teachers are actively pursuing these types of opportunities or if they are simply what are being offered most often.

In contrast, there seems to be a very poor match between what teachers need and opportunities they have in terms of learning to accommodate students with special needs; this was an area where more than 50 percent of the teachers noted they could use help, but only 15 percent indicated their professional development emphasized this topic.

Table 13
High School Chemistry Teachers Reporting that Their Professional Development Gave Heavy Emphasis† to Various Areas

	Percent of Teachers			
	Chemistry		All Other Sciences	
Learning how to use technology in science instruction	49	(4.5)	46	(2.6)
Learning how to use inquiry/investigation-oriented teaching strategies	35	(4.5)	35	(2.1)
Deepening my own science content knowledge	33	(4.4)	23	(2.0)
Learning how to assess student learning in science	27	(4.1)	22	(2.0)
Understanding student thinking in science	22	(3.0)	20	(2.1)
Learning how to teach science in a class that includes students with special needs	15	(5.1)	12	(1.8)

† Teachers responding with 4 or 5 on a five-point scale, where 1 was "Not at all" and 5 was "To a great extent."

Chemistry Classes Offered

Of the high schools (schools including grades 10, 11, or 12, and no grade lower than 9) in the United States, 95 percent offer at least one 1st year chemistry course. (See Table 14.) Roughly half of high schools offer a 2nd year course in chemistry, and 1 in 3 offer Advanced Placement (AP) chemistry. Regarding 2nd year courses, some large disparities exist between the percent of high schools offering courses and the percent of high school students with access to the courses, since larger schools are more likely than small ones to offer advanced chemistry courses.

Table 14
Availability of Chemistry Courses at the High School† Level

	Percent of High Schools Offering Course		Percent of Students With Access to Course	
1st Year	94	(2.1)	96	(1.0)
1st Year, Applied	17	(2.5)	17	(2.0)
Any 1st Year	95	(1.8)	97	(0.9)
2nd Year, AP	33	(2.4)	45	(2.6)
2nd Year, Advanced	22	(2.4)	24	(2.5)
Any 2nd Year	48	(3.0)	60	(3.0)

† A high school is defined as any school containing grades 10, 11, or 12, and no grades lower than 9.

In terms of the percentage of classes offered in the nation, chemistry (1st year or advanced) accounts for 22 percent of all high school science classes offered; this percentage ranks second between biology (36 percent) and physics (12 percent). (See Table 15.)

Table 15
Most Commonly Offered
Grade 9–12 Science Courses

	Percent of Classes	
1st Year Biology	30	(2.1)
Advanced Biology	6	(0.8)
1st Year Chemistry	19	(1.2)
Advanced Chemistry	3	(1.6)
1st Year Physics	10	(1.0)
Advanced Physics	2	(0.3)
Physical Science	7	(1.0)
Earth Science	7	(1.0)
General Science	3	(0.7)
Integrated/Coordinated Science	6	(0.8)
Other Science	8	(1.1)

The typical chemistry class has approximately 22 students, with two-thirds of the classes having 16–26 students. Fifty-six percent of chemistry students are female, compared to 52 percent in biology and 46 percent in physics. (See Table 16.)

Table 16
Female and Non-Asian Minority
Students in 1st Year Science Classes

	Percent of Students			
	Female		Non-Asian Minority	
1st Year Biology	52	(1.0)	25	(2.1)
1st Year Chemistry	56	(1.3)	21	(2.4)
1st Year Physics	46	(1.9)	19	(3.5)

Regarding the ability level of chemistry students, teachers in one-third of chemistry classes describe their students as homogeneous and high in ability, 30 percent as homogeneous and average, and 35 percent as heterogeneous. Only 3 percent of chemistry classes were categorized as "low ability." (See Table 17.)

Table 17
Ability Grouping in Selected
High School 1st Year Science Classes

	Percent of Classes							
	Low		Average		High		Heterogeneous	
1st Year Biology	9	(1.8)	34	(4.5)	17	(2.5)	41	(3.9)
1st Year Chemistry	3	(0.9)	30	(3.7)	33	(3.9)	35	(4.2)
1st Year Physics	1	(0.4)	20	(4.5)	46	(6.2)	33	(6.7)

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, and as a result, the number of chemistry classes included in the analyses reported below (381) is less than the 506 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 937 non-chemistry high school science classes.

The next two sections draw on teachers' descriptions of what transpires in chemistry classrooms in the United States, in terms of both instructional objectives and class activities.

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate each in terms of the emphasis it receives in the randomly selected class. As can be seen in Table 18, teachers in the vast majority of chemistry classes (86 percent) report giving a heavy emphasis to learning basic science concepts, followed by learning science process/inquiry skills (74 percent). In only about half of the chemistry classes did teachers report a strong focus on learning facts and terms of science.

Table 18
High School Chemistry Classes with
Heavy Emphasis on Various Instructional Objectives

	Percent of Classes			
	Chemistry		All Other Sciences	
Learn basic science concepts	86	(2.3)	79	(1.6)
Learn science process/inquiry skills	74	(3.6)	63	(2.4)
Prepare for further study in science	63	(4.2)	44	(2.6)
Learn important terms and facts of science	52	(5.4)	51	(2.6)
Learn how to communicate ideas in science effectively	44	(5.6)	37	(2.4)
Learn to evaluate arguments based on scientific evidence	39	(5.4)	25	(1.9)
Increase students' interest in science	35	(4.5)	47	(2.7)
Learn about the relationship between science, technology, and society	27	(6.3)	30	(2.2)
Learn about the applications of science in business and industry	24	(6.8)	20	(1.8)
Prepare for standardized tests	20	(3.1)	22	(1.8)
Learn about the history and nature of science	9	(1.9)	12	(1.1)

Given the reports of emphasis on process/inquiry skills in chemistry classes, it is somewhat surprising that a number of objectives commonly thought of as being aligned with the *Standards* are heavily emphasized in fewer than half the nation's chemistry classes. These include:

- Learning how to communicate ideas in science effectively;
- Learning to evaluate arguments based on scientific evidence;

- Learning about the relationship between science, technology, and society;
- Learning about the applications of science in business and industry; and
- Learning about the history and nature of science.

This contrast is captured again in two composite variables created from the list of objectives in Table 18. The two composites are shown here with the objectives that comprise them:

Nature of Science

- Learn to evaluate arguments based on scientific evidence
- Learn about the history and nature of science
- Learn how to communicate ideas in science effectively
- Learn about the applications of science in business and industry
- Learn about the relationship between science, technology, and society

Science Content

- Learn basic science concepts
- Learn important terms and facts of science
- Learn science process/inquiry skills
- Prepare for further study in science

As shown in Table 19, science content objectives are much more likely than nature of science objectives to receive heavy emphasis in chemistry instruction, and in other high school science instruction as well.

Table 19
Mean Composite Scores Related to
High School Chemistry Class Objectives

	Mean Score			
	Chemistry		All Other Sciences	
Science Content	88	(1.3)	84	(0.6)
Nature of Science	67	(2.4)	65	(0.7)

Some differences between chemistry instruction and instruction in other sciences are apparent in terms of individual objectives. Chemistry classes are more likely to emphasize learning science process/inquiry skills, learning to evaluate scientific arguments, and, in particular, preparing for further study in science. Chemistry classes are less likely to stress increasing students' interest in science. (See Table 18.)

Class Activities

The 2000 National Survey of Science and Mathematics Education provides three sources of information about how chemistry is taught at the high school level. One series of items listed various instructional strategies and asked chemistry teachers to indicate the frequency with which they used each in a randomly selected class. A second item listed a number of activities and asked teachers to indicate which occurred in the most recent lesson in their randomly selected class. Finally, a third item asked teachers to indicate the number of minutes devoted to each of several activities in their most recent lesson. The data for chemistry instruction from these three items are presented in Tables 20–23.

Each source paints the same picture of chemistry instruction: the predominant instructional strategies are lecture/discussion and practice using textbook/worksheet problems, with the occasional lab.

Table 20
High School Chemistry Classes Where Teachers Report that Students Take Part in Various Instructional Activities

	Percent of Classes									
	Never		Few times a year		Once or twice a month		Once or twice a week		All or almost all lessons	
Use mathematics as a tool in problem-solving	0	(0.2)	1	(0.4)	8	(2.2)	45	(4.9)	46	(5.6)
Listen and take notes during presentation by teacher	0	—§	1	(0.3)	8	(1.8)	48	(4.9)	43	(5.7)
Answer textbook or worksheet questions	1	(0.7)	4	(1.2)	10	(2.0)	60	(5.5)	25	(6.6)
Work in groups	0	—§	2	(0.8)	16	(2.7)	60	(5.5)	22	(6.5)
Follow specific instructions in an activity or investigation	0	(0.1)	3	(1.6)	24	(6.8)	64	(6.0)	9	(1.8)
Do hands-on/laboratory science activities or investigations	0	—§	1	(0.5)	28	(6.6)	63	(6.0)	9	(1.9)
Record, represent, and/or analyze data	0	—§	2	(0.8)	34	(6.2)	57	(5.5)	8	(1.8)
Watch a science demonstration	1	(0.6)	3	(1.0)	45	(4.7)	47	(4.4)	4	(1.4)
Read from a science textbook in class	18	(3.3)	41	(6.2)	22	(3.5)	15	(3.1)	5	(1.3)
Write reflections	53	(5.1)	18	(2.7)	20	(3.0)	7	(2.0)	3	(1.3)
Prepare written science reports	3	(1.0)	28	(6.1)	37	(4.3)	30	(3.7)	2	(1.1)
Watch audiovisual presentations	5	(1.1)	33	(3.9)	47	(5.0)	13	(2.3)	2	(1.1)
Use computers as a tool	20	(2.7)	36	(5.3)	29	(3.8)	13	(2.8)	2	(1.4)
Read other science-related materials in class	15	(2.3)	45	(5.2)	32	(4.1)	7	(1.6)	1	(0.4)
Design or implement their *own* investigation	9	(1.8)	44	(6.0)	40	(5.2)	6	(1.7)	1	(1.1)
Make formal presentations to the rest of the class	16	(2.3)	59	(4.5)	21	(3.4)	3	(0.8)	1	(1.1)
Work on extended science investigations or projects	23	(2.5)	56	(4.2)	16	(3.1)	3	(0.9)	1	(1.1)
Participate in field work	47	(4.8)	39	(5.4)	10	(2.9)	2	(0.8)	1	(1.1)
Take field trips	65	(4.3)	29	(4.0)	5	(2.1)	1	(0.5)	0	—§

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

Table 21
High School Chemistry Classes Where Teachers Report That Students Take Part in Various Instructional Activities at Least Once a Week

	Percent of Classes			
	Chemistry		All Other Sciences	
Use mathematics as a tool in problem-solving	91	(2.3)	41	(2.4)
Listen and take notes during presentation by teacher	91	(1.9)	85	(1.6)
Answer textbook or worksheet questions	85	(2.7)	69	(2.4)
Work in groups	82	(2.9)	80	(2.3)
Follow specific instructions in an activity or investigation	73	(6.3)	71	(2.5)
Do hands-on/laboratory science activities or investigations	71	(6.5)	71	(2.3)
Record, represent, and/or analyze data	65	(5.8)	52	(2.5)
Watch a science demonstration	51	(4.4)	42	(2.3)
Read from a science textbook in class	20	(3.5)	31	(2.5)
Write reflections	10	(2.3)	16	(1.6)
Prepare written science reports	32	(3.7)	23	(2.3)
Watch audiovisual presentations	15	(2.5)	23	(2.0)
Use computers as a tool	15	(3.1)	17	(2.5)
Read other science-related materials in class	8	(1.7)	23	(2.7)
Design or implement their *own* investigation	7	(2.0)	10	(1.2)
Make formal presentations to the rest of the class	4	(1.3)	6	(1.0)
Work on extended science investigations or projects	5	(1.4)	9	(1.2)
Participate in field work	3	(1.3)	5	(0.9)
Take field trips	1	(0.5)	2	(0.7)

Table 22
High School Chemistry Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes			
	Chemistry		All Other Sciences	
Discussion	80	(3.5)	81	(1.6)
Lecture	70	(4.4)	72	(2.1)
Students completing textbook/worksheet problems	61	(4.4)	49	(2.4)
Students working in small groups	59	(4.4)	50	(2.0)
Students using calculators	56	(4.5)	19	(1.7)
Students doing hands-on/laboratory activities	34	(4.2)	45	(2.2)
Students reading about science	16	(2.9)	28	(2.4)
Test or quiz	13	(2.5)	12	(1.2)
Students using other technologies	6	(1.6)	10	(1.5)
Students using computers	5	(1.3)	8	(1.3)
None of the above	1	(0.5)	2	(0.6)

Table 23
Average Percentage of High School Chemistry Class Time Spent on Different Types of Activities

	Average Percent			
	Chemistry		All Other Sciences	
Whole class lecture/discussion	41	(2.4)	36	(1.1)
Working with hands-on, manipulative, or laboratory materials	18	(2.7)	23	(1.2)
Individual students reading textbooks, completing worksheets, etc.	14	(2.0)	14	(1.0)
Non-laboratory small group work	12	(1.6)	9	(0.7)
Daily routines, interruptions, and other non-instructional activities	10	(0.4)	11	(0.3)
Other activities	6	(0.9)	7	(0.7)

Lecture/Discussion

Teachers in 91 percent of high school chemistry classes report that their students listen and take notes during a presentation by the teacher on at least a weekly basis, and in 43 percent of classes, this activity occurs in all or almost all lessons. (See Table 20.) In 70 percent of most recent chemistry lessons, teachers reported lecturing, and in 80 percent, discussion occurred. (See Table 22.) On the average, 41 percent of instructional time is devoted to lecture/discussion, more than twice that allotted to any other activity. (See Table 23.)

Students Working Problems

Based on teacher responses, 91 percent of chemistry classes use mathematics as a tool in problem-solving at least weekly; 85 percent answer textbook or worksheet problems at least weekly. (See Table 21.) In 61 percent of chemistry classes, students completed textbook/ worksheet problems in their most recent lesson. (See Table 22.) All of these activities, especially using mathematics as a tool, are more common in chemistry classes than in other high school science classes. (See Table 21.)

Laboratory Activities

In 71 percent of chemistry classes, teachers report students doing a lab or investigation at least weekly (Table 21), but only one-third indicated that this happened in the most recent lesson, compared to 80 percent for discussion and 61 percent for completing textbook/worksheet problems. (See Table 22.) Across all chemistry lessons, 18 percent of instructional time is spent working with hands-on, manipulative, or laboratory materials, a distant second to the 41 percent of class time spent on lecture/discussion.

Other Frequent Activities

From the three data sources described above, it is clear that some other activities are frequent in addition to lecture/discussion, working problems, and laboratory activities. Students working together in small groups is quite frequent (Tables 20–22), which is likely a combination of students working problems and doing labs together. Student use of calculators is also quite common (Table 22), possibly a reflection of students doing textbook/worksheet problems. Calculator use is much more common in chemistry classes than in other science classes. (See Tables 22 and 27.)

Roughly 10 percent of time in chemistry classes is devoted to non-instructional activities, including daily routines and interruptions. (See Table 23.) Over a year, this amounts to a loss of 3–4 weeks of instructional time. The amount of non-instructional time, however, is no different than in other high school science classes.

In virtually all chemistry classes (97 percent), teachers assign more than ½ hour of homework per week. In 53 percent of classes, teachers assign more than 1½ hours per week, compared to 34 percent in other high school science classes. (See Table 24.)

Table 24
Amount of Homework Assigned in
High School Chemistry Classes per Week

	Percent of Classes			
	Chemistry		All Other Sciences	
0–30 minutes	3	(0.9)	13	(1.4)
31–60 minutes	20	(2.8)	29	(2.1)
61–90 minutes	23	(3.1)	25	(2.0)
91–120 minutes	21	(3.5)	14	(1.4)
2–3 hours	24	(6.1)	12	(1.2)
More than 3 hours	8	(1.9)	8	(2.0)

Activities That Are Not Frequent

Survey data also point to some activities that are not very frequent but might be expected to be. The NRC *Standards* call for a shift from "cookbook" labs to ones where students are involved in identifying the question and designing the experimental procedure to answer that question. Chemistry, however, presents unique concerns about students doing any activities that have not been thoroughly tested. Safety considerations dictate that teachers maintain very tight control over what happens in the laboratory and likely account in large part for the low frequency of students designing their own experiments. In just under half of chemistry classes, teachers report that students design their own investigations at least once a month. (See Table 20.) These same considerations may also explain the relative prevalence of students following specific instructions in an activity or investigation. (See Table 20.)

Less easily explained is the fact that in only half of high school chemistry classes do teachers report doing demonstrations at least weekly, especially when demonstrations can be a way of compensating for equipment shortages or safety considerations. (See Table 21.)

Finally, the frequency of computer use is surprisingly low. Although most chemistry classes (84 percent) use computers at least once during the year (Table 27), only about 1 in 20 chemistry lessons incorporate computer use. (See Table 22.) The most common uses are for working with data—whether retrieving, exchanging, or collecting data with sensors or probes. (See Table 25.) Computers are also used for simulations and demonstrations.

Table 25
High School Chemistry Classes Where Teachers Report that Students Use Computers to do Particular Activities

	Percent of Classes									
	Never		Few times a year		Once or twice a month		Once or twice a week		All or almost all lessons	
Retrieve or exchange data	38	(4.1)	31	(4.2)	23	(6.0)	7	(2.3)	0	(0.3)
Demonstrate scientific principles	41	(4.5)	26	(3.9)	27	(6.6)	6	(2.2)	0	(0.1)
Collect data using sensors or probes	41	(4.7)	25	(3.3)	27	(6.2)	6	(2.4)	0	(0.3)
Do laboratory simulations	45	(4.6)	29	(3.9)	22	(6.6)	4	(1.4)	0	—§
Solve problems using simulations	51	(5.0)	24	(3.7)	20	(6.7)	4	(1.3)	0	(0.2)
Do drill and practice	51	(5.5)	25	(3.6)	17	(6.6)	6	(2.4)	0	(0.2)
Play science learning games	59	(5.6)	31	(6.1)	7	(2.2)	2	(1.2)	0	—§
Take a test or quiz	67	(6.2)	16	(3.2)	6	(1.5)	11	(7.2)	0	(0.3)

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

Table 26
High School Chemistry Classes Where Teachers Report that Students Use Computers to do Particular Activities at Least Once a Week

	Percent of Classes			
	Chemistry		All Other Sciences	
Take a test or quiz	11	(7.1)	7	(1.2)
Retrieve or exchange data	7	(2.3)	8	(1.2)
Demonstrate scientific principles	7	(2.2)	6	(1.0)
Collect data using sensors or probes	7	(2.4)	5	(0.8)
Do drill and practice	7	(2.4)	4	(1.0)
Do laboratory simulations	4	(1.4)	7	(1.2)
Solve problems using simulations	4	(1.4)	4	(0.8)
Play science learning games	2	(1.2)	3	(0.9)

This infrequency of computer use is perplexing. One potential explanation is that teachers have not received the professional development they need in order to know how to integrate computers in their instruction. Data presented earlier in this report show that chemistry teachers identify instructional technology as an area where they are in particular need of professional development. (See Table 10.) While technology is a common emphasis in professional development activities, teacher participation is generally so low that the total amount of professional development time devoted to this area is quite small. (See Tables 11 and 13.)

Another potential explanation is a lack of access to computers; however, teachers in only 7 percent of chemistry classes reported that computers were needed for instruction, but that they were not available. (See Table 27.)

Table 27
Equipment Need, Availability, and Use in High School Chemistry Classes

	Percent of Classes					
	Not Needed		Needed, but Not Available		Used	
Overhead projector						
Chemistry	15	(7.9)	0	(0.3)	85	(7.9)
All Other Sciences	11	(2.6)	0	—[§]	89	(2.6)
Videotape player						
Chemistry	9	(2.2)	0	(0.1)	91	(2.2)
All Other Sciences	4	(1.0)	0	(0.1)	96	(1.0)
Videodisc player						
Chemistry	41	(4.9)	2	(0.8)	57	(5.0)
All Other Sciences	38	(2.5)	8	(1.5)	54	(2.8)
CD-ROM player						
Chemistry	38	(5.1)	6	(1.4)	55	(5.4)
All Other Sciences	35	(2.6)	8	(1.4)	57	(2.9)
Four-function calculator						
Chemistry	23	(3.8)	3	(1.3)	75	(4.0)
All Other Sciences	40	(2.6)	5	(1.2)	54	(2.7)
Fraction calculators						
Chemistry	57	(6.8)	4	(1.6)	39	(7.2)
All Other Sciences	73	(2.5)	3	(1.3)	24	(2.1)
Graphing calculators						
Chemistry	42	(5.8)	4	(1.5)	54	(6.0)
All Other Sciences	65	(2.5)	5	(1.1)	30	(2.3)
Scientific calculators						
Chemistry	11	(3.1)	2	(0.9)	87	(3.3)
All Other Sciences	46	(2.8)	5	(1.1)	49	(2.6)
Computers						
Chemistry	8	(2.0)	7	(2.4)	84	(3.0)
All Other Sciences	9	(1.5)	6	(1.0)	85	(1.9)
Computers with Internet connection						
Chemistry	15	(2.8)	12	(2.7)	74	(3.8)
All Other Sciences	14	(1.9)	7	(1.2)	79	(2.2)
Calculator/computer lab interfacing devices						
Chemistry	30	(5.0)	17	(3.0)	53	(5.9)
All Other Sciences	42	(3.0)	18	(2.5)	40	(2.6)
Running water						
Chemistry	0	—[§]	0	(0.1)	100	(0.1)
All Other Sciences	3	(0.8)	2	(0.6)	95	(1.0)
Electric outlet						
Chemistry	3	(2.3)	0	(0.1)	97	(2.3)
All Other Sciences	1	(0.5)	2	(0.7)	97	(0.8)
Gas for burners						
Chemistry	3	(1.3)	1	(0.9)	96	(1.5)
All Other Sciences	28	(2.5)	7	(1.2)	65	(2.6)
Hoods or air hose						
Chemistry	5	(2.1)	2	(1.0)	92	(2.4)
All Other Sciences	42	(2.4)	14	(1.7)	45	(2.8)

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

Resources Available for Chemistry Instruction

Chemistry teachers' apparent access to computers is similar to that for other instructional resources. Given a list of equipment and facilities, in only two instances did teachers in more than 10 percent of chemistry classes report needing a particular resource, but not having it. One of these was calculator/computer lab interfacing devices (17 percent reported needing but not having), and the other was computers with internet connections (12 percent). More than 95 percent of chemistry classrooms have electric outlets, a source of gas for burners, and running water. (See Table 27.)

Teachers in the vast majority of chemistry classes (96 percent) report using one or more textbooks/programs, with the three most commonly used chemistry texts being:

- *Addison-Wesley—Chemistry* (Addison/Wesley Longman, Inc./Scott Foresman)
- *Modern Chemistry* (Holt, Rinehart and Winston, Inc.)
- *Chemistry: Connections to Our Changing World* (Prentice Hall, Inc.)

As can be seen in Table 28, teachers in 80 percent of chemistry classes rated their textbook/program as good or better in quality. Despite these ratings, there does seem to be an issue with the amount of material in chemistry textbooks. Only 42 percent of chemistry classes address more than three-fourths of their textbook, 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 29.)

Table 28
High School Chemistry Teachers' Perceptions of Quality of Textbooks/Programs Used in High School Chemistry Classes†

	Percent of Classes	
	Chemistry	All Other Sciences
Very Poor	0 (0.3)	1 (0.4)
Poor	5 (1.4)	4 (0.9)
Fair	15 (2.4)	19 (2.1)
Good	38 (5.3)	38 (2.3)
Very Good	37 (4.3)	28 (2.5)
Excellent	4 (1.0)	9 (1.3)

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

Table 29
Percentage of High School Chemistry Textbook/Program Covered During the Course[†]

	Percent of Classes			
	Chemistry		All Other Sciences	
Less than 25 percent	1	(0.3)	4	(0.7)
25–49 percent	13	(2.2)	13	(1.6)
50–74 percent	45	(5.3)	36	(2.4)
75–90 percent	35	(4.1)	37	(2.7)
More than 90 percent	7	(1.4)	9	(1.4)

[†] Only classes using published textbooks/programs were included in these analyses.

Summary

The high school chemistry teacher workforce seems to be a fairly well prepared one; most chemistry students receive instruction from teachers who have had substantial course work in chemistry and who are confident in their content knowledge and in their ability to teach the content.

Chemistry teachers expressed a need for professional development in a number of ways, especially in using instructional technology. At the same time, they spend very little time in professional development where they might receive such assistance. Chemistry teachers also called for help in accommodating students with special needs, however very little of the professional development they do participate in is focused on this area.

The data strongly suggest a pattern of instruction that relies heavily on lecture/discussion, students working problems, and an occasional lab. Lecture/discussion accounts for far more instructional time than any other single activity (e.g., doing laboratory activities, non-laboratory small group work, individual student work). The use of demonstrations and the integration of computers into chemistry instruction are surprisingly infrequent; the latter is perhaps explained by teachers' lack of preparation. The image of high school chemistry instruction is quite similar to what these teachers likely experienced in their college chemistry courses, and may explain the pattern of instructional strategies.

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Appendix

Description of Composite Variables

To facilitate the reporting of large amounts of survey data, and because individual questionnaire items are potentially unreliable, HRI used factor analysis to identify survey questions that could be combined into "composites." Each composite represents an important construct related to science education.

Each composite is calculated by summing the responses to the items associated with that composite and then dividing by the total points possible. In order for the composites to be on a 100-point scale, the lowest response option on each scale was set to 0 and the others were adjusted accordingly; so for instance, an item with a scale ranging from 1 to 4 was re-coded to have a scale of 0 to 3. By doing this, someone who marks the lowest point on every item in a composite receives a composite score of 0 rather than some positive number. It also assures that 50 is the true mid-point. The denominator for each composite is determined by computing the maximum possible sum of responses for a series of items and dividing by 100; e.g., a 9-item composite where each item is on a scale of 0–3 would have a denominator of 0.27.

Composite definitions for the science teacher questionnaire are presented below along with the item numbers. Reliability information is based on the entire sample of K–12 science teachers.

Table A-1
Science Teacher Content Preparedness*

	Biology/ Life Science	Chem-istry	Earth Science	Environ-mental Science	Integrated/ General Science	Physical Science	Physics
Earth's features and physical processes			Q15a1a	Q15a1a	Q15a1a	Q15a1a	
The solar system and the universe			Q15a1b		Q15a1b	Q15a1b	
Climate and weather			Q15a1c	Q15a1c	Q15a1c	Q15a1c	
Structure and function of human systems	Q15a2a				Q15a2a		
Plant biology	Q15a2b				Q15a2b		
Animal behavior	Q15a2c				Q15a2c		
Interactions of living things/ecology	Q15a2d			Q15a2d	Q15a2d		
Genetics and evolution	Q15a2e				Q15a2e		
Structure of matter and chemical bonding		Q15a3a			Q15a3a	Q15a3a	
Properties and states of matter		Q15a3b			Q15a3b	Q15a3b	
Chemical reactions		Q15a3c			Q15a3c	Q15a3c	
Energy and chemical change		Q15a3d			Q15a3d	Q15a3d	
Forces and motion					Q15a4a	Q15a4a	Q15a4a
Energy					Q15a4b	Q15a4b	Q15a4b
Light and sound					Q15a4c	Q15a4c	Q15a4c
Electricity and magnetism					Q15a4d	Q15a4d	Q15a4d
Modern physics (e.g., special relativity)					Q15a4e	Q15a4e	Q15a4e
Pollution, acid rain, global warming				Q15a5a	Q15a5a		
Population, food supply, and production				Q15a5b	Q15a5b		
Formulating hypothesis, drawing conclusions, making generalizations	Q15a6a	Q15a6a	Q15a6a	Q15a6a	Q15a6a	Q15a6a	Q15a6a
Experimental design	Q15a6b	Q15a6b	Q15a6b	Q15a6b	Q15a6b	Q15a6b	Q15a6b
Describing, graphing, and interpreting data	Q15a6c	Q15a6c	Q15a6c	Q15a6c	Q15a6c	Q15a6c	Q15a6c
Number of Items in Composite	**8**	**7**	**6**	**8**	**22**	**15**	**8**
Reliability (Cronbach's Coefficient Alpha)	**0.87**	**0.87**	**0.76**	**0.79**	**0.87**	**0.89**	**0.88**

* Questions comprising these composites were asked of only those teachers in non-self-contained settings.

Table A-2
Science Teacher Preparedness to Use Standards-Based Teaching Practices

Take students' prior understanding into account when planning curriculum and instruction.	Q3a
Develop students' conceptual understanding of science	Q3b
Provide deeper coverage of fewer science concepts	Q3c
Make connections between science and other disciplines	Q3d
Lead a class of students using investigative strategies	Q3e
Manage a class of students engaged in hands-on/project-based work	Q3f
Have students work in cooperative learning groups	Q3g
Listen/ask questions as students work in order to gauge their understanding	Q3h
Use the textbook as a resource rather than the primary instructional tool	Q3i
Teach groups that are heterogeneous in ability	Q3j
Number of Items in Composite	**10**
Reliability (Cronbach's Coefficient Alpha)	**0.88**

Table A-3
Science Teacher Preparedness to Teach Students from Diverse Backgrounds

Recognize and respond to student cultural diversity	Q3l
Encourage students' interest in science	Q3m
Encourage participation of females in science	Q3n
Encourage participation of minorities in science	Q3o
Number of Items in Composite	**4**
Reliability (Cronbach's Coefficient Alpha)	**0.81**

Table A-4
Science Teacher Preparedness to Use Calculators/Computers

Use calculators/computers for drill and practice	Q3q
Use calculators/computers for science learning games	Q3r
Use calculators/computers to collect and/or analyze data	Q3s
Use computers to demonstrate scientific principles	Q3t
Use computers for laboratory simulations	Q3u
Number of Items in Composite	**5**
Reliability (Cronbach's Coefficient Alpha)	**0.89**

Table A-5
Science Teacher Preparedness to Use the Internet

Use the Internet in your science teaching for general reference	Q3v
Use the Internet in your science teaching for data acquisition	Q3w
Use the Internet in your science teaching for collaborative projects with classes/individuals in other schools	Q3x
Number of Items in Composite	**3**
Reliability (Cronbach's Coefficient Alpha)	**0.86**

Table A-6
Nature of Science Objectives

Learn to evaluate arguments based on scientific evidence	Q23f
Learn about the history and nature of science	Q23j
Learn how to communicate ideas in science effectively	Q23g
Learn about the applications of science in business and industry	Q23h
Learn about the relationship between science, technology, and society	Q23i
Number of Items in Composite	**5**
Reliability (Cronbach's Coefficient Alpha)	**0.84**

Table A-7
Science Content Objectives

Learn basic science concepts	Q23b
Learn important terms and facts of science	Q23c
Learn science process/inquiry skills	Q23d
Prepare for further study in science	Q23e
Number of Items in Composite	**4**
Reliability (Cronbach's Coefficient Alpha)	**0.60**