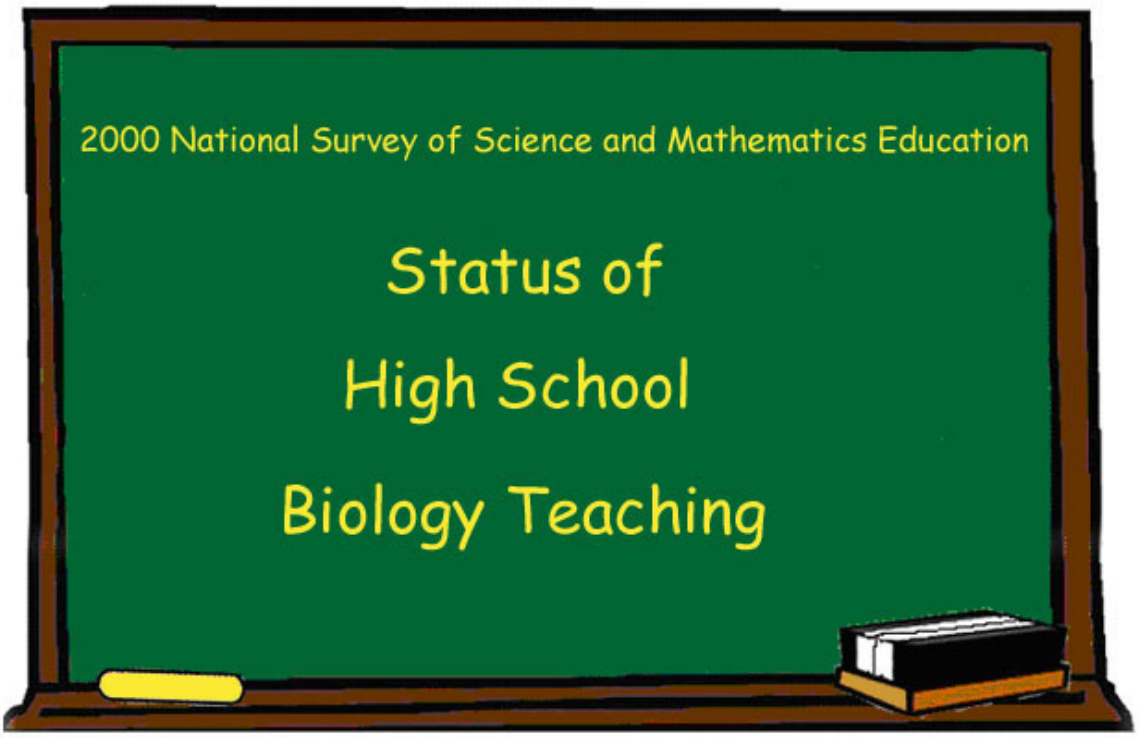

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Status of High School Biology Teaching

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.

This report describes the status of high school (grades 9–12) biology instruction based on the responses of 549 biology teachers.[1] For comparison purposes, many of the tables include data from teachers who do *not* teach biology (N=771); i.e., all other high school science teachers. These data include responses from high school chemistry, 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 generally point out only those differences which are substantial as well as statistically significant at the 0.05 level or beyond.

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

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

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

Characteristics of the Biology Teaching Force

General Demographics

Slightly more than half of all high school biology teachers in the United States are female, and 9 in 10 are white, as shown in Table 1. Roughly half (54 percent) have a masters degree. About half of the biology teaching force has more than ten years experience, and judging by the age of biology teachers, it appears that as many as one-third may be nearing retirement in the next ten years. This profile is very similar to that of teachers who teach sciences other than biology at the high school level.

Table 1
Characteristics of the
High School Biology Teaching Force

	Percent of Teachers			
	Biology		All Other Sciences	
Sex				
Male	47	(2.9)	53	(2.8)
Female	53	(2.9)	47	(2.8)
Race				
White	90	(1.6)	90	(1.7)
Black or African-American	5	(1.2)	4	(0.9)
Hispanic or Latino	3	(0.9)	3	(0.7)
American Indian or Alaskan Native	2	(0.8)	2	(0.5)
Asian	1	(0.3)	3	(1.1)
Native Hawaiian or Other Pacific Islander	0	(0.1)	0	(0.2)
Age				
≤ 30 yeears	19	(3.3)	21	(3.6)
31–40 years	23	(2.4)	23	(2.5)
41–50 years	28	(2.5)	30	(2.8)
51+ years	30	(2.6)	26	(2.2)
Experience				
0–2 years	14	(3.5)	18	(2.4)
3–5 years	16	(1.9)	15	(3.1)
6–10 years	19	(2.2)	17	(2.1)
11–20 years	21	(2.5)	20	(2.0)
≥ 21 years	30	(3.0)	29	(2.3)
Master's Degree				
Yes	54	(3.4)	59	(3.5)
No	46	(3.4)	41	(3.5)

Content Preparedness

In addition to having many years of experience, biology teachers generally appear to be well prepared in terms of the number of college-level life science courses they have taken. Ninety-one percent of the high school biology teachers have taken six or more courses in the discipline, suggesting the equivalent of at least a minor, and virtually all (98 percent) have taken at least three life science courses. (See Table 2.) It is also clear that biology teachers are generally better prepared in their own subject than they are in other science disciplines such as chemistry or physics.

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

	Percent of Teachers							
	Zero Semesters		1–2 Semesters		3–5 Semesters		6 or More Semesters	
Biology								
Life science	1	(0.5)	0	(0.2)	7	(1.5)	91	(1.6)
Chemistry	3	(0.7)	17	(2.1)	50	(3.1)	30	(2.6)
Science education	19	(3.4)	31	(2.9)	26	(2.1)	25	(2.3)
Physics/physical Science	10	(1.4)	51	(3.4)	24	(2.6)	16	(3.3)
Earth/space science	20	(3.3)	38	(2.4)	27	(2.3)	15	(1.9)
All Other Sciences								
Life science	13	(1.8)	25	(3.5)	18	(1.7)	44	(2.9)
Chemistry	3	(0.7)	18	(2.9)	29	(2.4)	50	(2.9)
Science education	21	(2.5)	32	(2.9)	22	(2.1)	25	(2.1)
Physics/physical Science	4	(1.0)	30	(2.9)	28	(2.6)	39	(2.8)
Earth/space science	26	(3.6)	27	(2.1)	26	(2.8)	22	(2.1)

† 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.

Biology classes are more likely than other high school science classes to be taught by teachers who have completed at least six courses in their field. Ninety-four percent of biology classes are taught by teachers who have completed this amount of coursework in their discipline, compared to 74 percent for chemistry, 64 percent for physics, and 58 percent for earth science. (See Table 3.)

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)	1	(0.8)	4	(1.6)
Chemistry	74	(4.2)	17	(3.3)	9	(2.8)
Physics	64	(5.8)	26	(5.4)	10	(3.7)
Earth science	58	(6.1)	34	(5.4)	8	(3.7)

The vast majority (94 percent) of biology teachers have completed a course in introductory biology/life science. Fewer have had more specialized courses, such as cell biology (68 percent) or entomology (28 percent), but at least three-fourths reported having taken courses in subjects that go beyond what they would be expected to teach at a high school level. For example, 84 percent have had coursework in genetics and evolution, and 80 percent have had coursework in botany. (See Table 4.) These topics may be included in high school biology curricula, but not at the level taught in the college courses taken by these teachers. As might be expected, a higher percentage of biology teachers than teachers of other subjects have completed college courses in these discipline-specific subjects.

In terms of coursework in pedagogy, 91 percent of high school biology teachers have had coursework in general methods of teaching, but fewer have had courses in methods of teaching science (77 percent) or supervised student teaching (72 percent). (See Table 4.) Furthermore, high school biology teachers are much more likely to have majored in science than in education. This is also true for other high school science teachers. (See Table 5).

Table 4
High School Biology Teachers
Completing Various College Courses

	Percent of Teachers			
	Biology		All Other Sciences	
General methods of teaching	91	(3.2)	89	(2.1)
Methods of teaching science	77	(3.3)	75	(3.5)
Supervised student teaching in science	72	(3.3)	67	(3.0)
Instructional uses of computers/other technologies	50	(2.7)	46	(3.3)
Introductory biology/life science	94	(1.4)	76	(2.6)
Genetics, evolution	84	(2.1)	40	(2.8)
Anatomy/Physiology	82	(2.3)	39	(2.6)
Botany, plant physiology	80	(3.3)	45	(3.0)
Zoology, animal behavior	73	(2.7)	40	(2.9)
Other life science	71	(2.6)	36	(3.0)
Ecology	69	(3.3)	37	(2.5)
Microbiology	69	(3.1)	35	(2.7)
Cell Biology	68	(2.8)	38	(2.8)
Entomology	28	(2.7)	11	(1.6)

Table 5
Undergraduate Majors of
High School Biology Teachers[†]

	Percent of Teachers			
	Biology		All Other Sciences	
Science	85	(2.4)	78	(2.9)
Science Education	3	(0.8)	9	(1.5)
Other Education	5	(1.4)	6	(2.7)
Other Fields	7	(1.5)	7	(1.4)

[†] These data should be interpreted with caution. When asked to specify the subject(s) of their degrees, approximately 10 percent of the teachers indicated they had undergraduate majors in three or more fields. These teachers were excluded from these analyses.

High school biology teachers' ratings of their own content preparedness indicate a high degree of confidence in their content knowledge, again reflecting their strong backgrounds in life science. The survey asked them to rate how qualified they felt to teach each of a number of fundamental topics in biology:

- Structure and function of human systems;
- Interactions of living things/ecology;
- Genetics and evolution;
- Animal behavior; and
- Plant biology.

More than three-fourths of biology teachers believed themselves to be "very well qualified" to teach genetics and evolution, ecology, and the structure and function of human systems. Fewer felt as qualified to teach plant biology or animal behavior, but even in these subjects only 5 percent or less felt "not well qualified." In all cases, more biology teachers than teachers of other sciences felt very well qualified to teach these topics. (See Table 6.)

Table 6
High School Biology Teachers' Perceptions of Their Qualifications to Teach Each of a Number of Subjects

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Biology						
Structure and function of human systems	1	(0.4)	19	(2.9)	80	(2.9)
Interactions of living things/ecology	1	(0.3)	19	(2.7)	81	(2.7)
Genetics and evolution	1	(0.7)	21	(2.8)	77	(2.9)
Animal behavior	5	(1.5)	27	(2.6)	68	(3.0)
Plant biology	3	(1.2)	31	(3.2)	66	(3.3)
All Other Sciences						
Structure and function of human systems	39	(3.0)	26	(2.3)	36	(2.9)
Interactions of living things/ecology	35	(3.0)	30	(2.6)	35	(2.4)
Genetics and evolution	39	(2.8)	27	(2.3)	34	(2.6)
Animal behavior	43	(3.0)	28	(2.6)	29	(2.3)
Plant biology	44	(3.0)	29	(2.9)	27	(2.5)

A similar question was asked of teachers in the various high school science disciplines, with topics appropriate to the discipline (e.g., chemistry teachers were asked how qualified they felt to teach structure of matter and chemical bonding, among other topics). Each discipline-specific series was combined into a composite variable using factor analysis. (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, biology teachers were second only to chemistry teachers in considering themselves well qualified, roughly equivalent to physics and earth science teachers. (See Table 7.)

Table 7
Content Preparedness Composite Scores of High School Science Teachers

	Mean Score	
Chemistry	90	(1.2)
Biology/life science	84	(1.4)
Physics	82	(3.1)
Earth science	81	(1.5)
Environmental science	73	(2.8)
Physical science	66	(3.3)
Integrated/general science	64	(1.4)

The overall picture of high school biology teachers is that they are relatively well qualified in their subject area; by and large, 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.

The study found that over 90 percent of biology students nationwide are taught by teachers who have either a major, minor, or certification in biology.[2]

Pedagogical Preparedness

The National Research Council (NRC) *National Science Education Standards*, while not specific to biology, provide a useful frame for interpreting data on biology teachers' pedagogical preparedness. Responding to an item about the NRC *Standards*, 61 percent of biology teachers indicated they were at least somewhat familiar with the document, and of these, 71 percent said they agreed with them. These percentages are similar to those from teachers of the other sciences. (See Table 8.)

Table 8
High School Biology Teachers' Familiarity with, Agreement with, and Implementation of the NRC *Standards*

	Percent of Teachers			
	Biology		All Other Sciences	
Familiarity with NRC *Standards*				
Not at all familiar	39	(3.3)	36	(2.7)
Somewhat familiar	32	(3.2)	36	(3.4)
Fairly familiar	19	(2.0)	17	(1.8)
Very familiar	9	(1.5)	11	(1.5)
Extent of agreement with NRC *Standards*†				
Strongly Disagree	1	(0.5)	0	—§
Disagree	6	(1.8)	8	(2.6)
No Opinion	22	(3.2)	22	(2.8)
Agree	67	(3.6)	63	(3.9)
Strongly Agree	4	(1.3)	7	(1.5)
Extent to which recommendations have been implemented†				
Not at all	4	(1.6)	5	(1.3)
To a minimal extent	28	(3.1)	28	(3.7)
To a moderate extent	57	(3.5)	56	(3.9)
To a great extent	12	(2.4)	11	(2.1)

† 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 also 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 of the strategies presented, biology teachers are more likely to feel prepared to use standards-based teaching practices and teach students from diverse backgrounds, than to feel prepared in

[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.

technology-related areas. These results are similar to those for teachers of the other sciences. (See Table 9.) In particular, relatively few biology or other science teachers indicated they felt well prepared to use the Internet for collaborative projects across classes or schools. (See Table 10.) With two exceptions (take students' prior understanding into account when planning curriculum and instruction, and recognize and respond to student cultural diversity), 80 percent or more of biology teachers rated themselves as being well prepared to implement a number of practices included in the "Standards-Based Teaching Practices" composite (Table 10); for example:

- Develop students' conceptual understanding of science;
- Make connections between science and other disciplines;
- Provide deeper coverage of fewer science concepts; and
- Lead a class of students using investigative strategies.

Table 9
Composite Scores of High School
Biology Teachers' Pedagogical Preparedness

	Mean Score			
	Biology		All Other Sciences	
Preparedness to use Standards-Based Teaching Practices	76	(1.0)	77	(1.0)
Preparedness to teach Students from Diverse Backgrounds	76	(1.3)	77	(1.0)
Preparedness to use Calculators/Computers	51	(2.2)	57	(1.5)
Preparedness to use the Internet	50	(2.0)	49	(1.9)

Table 10
High School Biology Teachers Considering Themselves Well Prepared† for Each of a Number of Tasks

	Percent of Teachers			
	Biology		All Other Sciences	
Listen/ask questions as students work in order to gauge their understanding	95	(1.2)	97	(1.0)
Encourage students' interest in science	94	(1.6)	95	(1.6)
Encourage participation of females in science	94	(1.3)	96	(0.9)
Manage a class of students engaged in hands-on/project-based work	92	(1.6)	91	(1.8)
Develop students' conceptual understanding of science	91	(1.5)	94	(1.1)
Make connections between science and other disciplines	91	(1.4)	88	(1.9)
Encourage participation of minorities in science	90	(1.8)	89	(1.9)
Provide deeper coverage of fewer science concepts	88	(1.7)	88	(1.5)
Have students work in cooperative learning groups	86	(2.0)	86	(2.1)
Use the textbook as a resource rather than the primary instructional tool	85	(2.2)	85	(1.9)
Teach groups that are heterogeneous in ability	83	(2.1)	77	(3.0)
Lead a class of students using investigative strategies	80	(2.6)	84	(1.9)
Take students' prior understanding into account when planning curriculum and instruction	74	(2.4)	79	(2.0)
Use the Internet in your science teaching for general reference	65	(3.0)	64	(3.1)
Use calculators/computers for drill and practice	60	(3.1)	75	(2.3)
Use calculators/computers to collect and/or analyze data	61	(2.9)	72	(2.3)
Recognize and respond to student cultural diversity	61	(3.0)	61	(2.8)
Use the Internet in your science teaching for data acquisition	58	(3.4)	55	(3.0)
Use computers to demonstrate scientific principles	47	(3.4)	55	(3.1)
Use calculators/computers for science learning games	46	(3.2)	50	(2.5)
Use computers for laboratory simulations	43	(3.5)	48	(3.0)
Involve parents in the science education of their children	40	(2.9)	48	(2.8)
Use the Internet in your science teaching for collaborative projects with classes/individuals in other schools	28	(2.9)	31	(2.8)
Teach students who have limited English proficiency	24	(3.0)	19	(1.8)

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

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 11. Learning how to use technology in science instruction was the area most likely to be rated by biology teachers as a moderate or substantial need. Teachers of other sciences also ranked this need the highest. The infusion of technology in classrooms and the push for its use have likely made teachers more aware of their needs in this area.

About one-half of biology teachers indicated they need professional development related to teaching through inquiry/investigation, and roughly 4 in 10 indicated a need for help in learning how to assess student learning, understanding student thinking, and deepening their own content knowledge. (See Table 11.)

Table 11
High School Biology Teachers Reporting They Perceived a Moderate or Substantial Need for Professional Development in the Preceding Three Years

	Percent of Teachers			
	Biology		All Other Sciences	
Learning how to use technology in science instruction	73	(3.6)	69	(2.4)
Learning how to teach science in a class that includes students with special needs	58	(3.2)	60	(2.8)
Learning how to use inquiry/investigation-oriented teaching strategies	51	(3.2)	53	(2.5)
Learning how to assess student learning in science	43	(2.9)	41	(3.0)
Understanding student thinking in science	42	(3.2)	51	(2.8)
Deepening my own science content knowledge	39	(3.0)	38	(2.9)

Learning to accommodate students with special needs was also commonly reported as an area in which teachers would like more professional development. It may be that the trend toward mainstreaming over the last decade accounts for teachers recognizing they need help accommodating students with special needs. These students are present in a substantial portion of high school biology classes: 40 percent of biology classes include students who are considered learning disabled, and 20 percent include students with limited English proficiency. (See Table 12.)

Table 12
High School Biology Classes with One or More Students with Particular Special Needs

	Percent of Classes			
	Biology		All Other Sciences	
Learning Disabled	40	(3.8)	35	(2.6)
Limited English Proficiency	20	(2.4)	16	(1.6)
Mentally Handicapped	2	(1.2)	4	(1.0)
Physically Handicapped	4	(1.2)	5	(0.8)

Professional Development of Biology Teachers

Biology teachers, like high school science teachers generally, report low levels of participation in professional development specific to science teaching. Fewer than half of biology teachers have spent more than 35 hours in science-related professional development in the previous three years. (See Table 13.)

Table 13
Time Spent on In-Service Education by High School Biology Teachers in the Preceding Three Years

	Percent of Teachers			
	Biology		All Other Sciences	
None	7	(1.7)	8	(1.1)
Less than 6 hours	7	(1.6)	10	(2.5)
6–15 hours	17	(2.2)	16	(1.9)
16–35 hours	23	(2.4)	22	(2.2)
More than 35 hours	46	(2.6)	44	(3.1)

As to how this time is spent, the workshop is by far the most common form of professional development (70 percent of high school biology teachers have attended one in the previous three years), followed by collaborating with teachers locally, either observing their classrooms (53 percent) or meeting regularly to discuss science teaching (52 percent). (See Table 14.) Forty percent report attending a state or national science teachers meeting in the previous three years, and the same percentage have taken a college/university science course that recently.

Table 14
High School Biology Teachers Participating in Various Professional Development Activities in Past Three Years

	Percent of Teachers			
	Biology		All Other Sciences	
Attended a workshop on science teaching	70	(3.5)	70	(2.6)
Observed other teachers teaching science as part of your own professional development (formal or informal)	53	(3.0)	59	(2.7)
Met with a local group of teachers to study/discuss science teaching issues on a regular basis	52	(3.4)	54	(2.7)
Taken a formal college/university science course	40	(3.1)	35	(2.6)
Attended a national or state science teacher association meeting	40	(2.7)	46	(3.1)
Taken a formal college/university course in the teaching of science	27	(2.8)	25	(2.5)
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	25	(2.5)	23	(2.6)
Collaborated on science teaching issues with a group of teachers at a distance using telecommunications	15	(1.9)	18	(2.1)

Teachers were asked to consider their professional development as a whole and characterize it in terms of different potential emphases. (See Table 15.) Half of all high school biology 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 most likely to be rated as a need and also most likely to be emphasized in professional development opportunities. It is not clear if technology-related activities are simply what are being offered most often, or if teachers are actively pursuing these types of opportunities. In either case, professional development in the area of technology does seem to be having an effect; a higher percentage of biology teachers (42 percent) reported that they had changed their teaching

practices as a result of technology-related professional development activities than for any other type of activity (Table 16).

Table 15
High School Biology Teachers Reporting that Their Professional Development Gave Heavy Emphasis† to Various Areas

	Percent of Teachers			
	Biology		All Other Sciences	
Learning how to use technology in science instruction	50	(3.9)	44	(3.2)
Learning how to use inquiry/investigation-oriented teaching strategies	39	(3.5)	32	(2.6)
Deepening my own science content knowledge	25	(2.7)	28	(3.1)
Learning how to assess student learning in science	23	(2.6)	25	(2.6)
Understanding student thinking in science	22	(2.7)	19	(1.9)
Learning how to teach science in a class that includes students with special needs	14	(3.8)	12	(1.7)

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

Table 16
High School Biology Teachers Indicating Their Professional Development Activities in the Preceding Three Years Caused Them to Change Their Teaching Practices†

	Percent of Teachers			
	Biology		All Other Sciences	
Learning how to use technology in science instruction	42	(2.7)	42	(3.3)
Learning how to use inquiry/investigation-oriented teaching strategies	31	(2.8)	24	(2.5)
Deepening my own science content knowledge	19	(2.7)	14	(2.1)
Understanding student thinking in science	15	(2.1)	20	(2.3)
Learning how to assess learning in science	13	(2.0)	19	(2.3)
Learning how to teach science in a class that includes students with special needs	13	(2.1)	14	(2.0)

† Includes only those teachers who reported at least some science-related professional development in the preceding three years.

In contrast, there seems to be a very poor match between needs and opportunities in terms of learning to accommodate students with special needs; 58 percent of high school biology teachers rated this area as a need, but only 14 percent indicated their professional development emphasized it, and only 13 percent indicated that their teaching had changed as a result of these professional development activities. (See Tables 11, 15, and 16.)

Biology Classes Offered

Of the high schools (schools including grades 10, 11, or 12, and no grade lower than 9) in the United States, 96 percent offer at least one 1st year biology course. (See Table 17.) A 2nd year course in biology is offered at 82 percent of schools, with 39 percent offering Advanced Placement (AP) biology. Regarding 2nd year courses, there are some disparities between the percent of high schools offering courses, and the percentage of high school students with access to the courses. This is almost certainly due to the fact that larger schools are more likely than small ones to offer advanced biology courses, and that small schools outnumber large schools in the US.

Table 17
Availability of Biology
Courses at the High School† Level

	Percent of Schools Offering Course		Percent of Students with Access to Course	
1st Year	94	(1.8)	96	(1.0)
1st Year, Applied	33	(3.3)	36	(2.7)
Any 1st Year	96	(1.5)	96	(1.0)
2nd Year, AP	39	(2.7)	49	(2.6)
2nd Year, Advanced	56	(3.3)	60	(2.8)
Any 2nd Year	82	(2.4)	86	(1.7)

† 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 high school science classes offered in the nation, biology ranks first, at 36 percent. Chemistry (1st year or advanced) accounts for 22 percent, followed by physics at 12 percent. (See Table 18.)

Table 18
Most Commonly Offered
High School 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 1st year biology class has approximately 23 students. (See Table 19.) Fifty-two percent of 1st year biology students are female, compared to 56 percent in 1st year chemistry and 46 percent in 1st year physics. About a quarter of the high school biology students are non-Asian minorities.

Table 19
Average Number of Students
in High School Biology Classes

	Number of Students	
1st year Biology	23	(1.0)
Advanced Biology	20	(1.2)
All Other Sciences	21	(0.4)

Table 20
Female and Non-Asian Minority
Students in High School Science Classes

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

Regarding the ability level of high school biology students, teachers in 17 percent of high school biology classes describe their classes as homogeneous and high in ability, one-third as homogeneous and average, and 41 percent as heterogeneous. Only 9 percent of biology classes were categorized as "low ability." (See Table 21.) High school biology classes are significantly less likely than chemistry or physics classes to include students considered homogeneous and high in ability.

Table 21
Ability Grouping in Selected
High School 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)

Biology 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 biology and other science classes may have been asked about any of those classes. Accordingly, the number of biology classes included in the analyses reported below (430) is less than the 549 responding teachers of biology. The generally larger standard errors are a reflection of the reduced sample size. The data reported in the "All Other Sciences" column are based on 888 non-chemistry high school science classes.

The next two sections draw on teachers' descriptions of what transpires in biology 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 they receive in the randomly selected class. As can be seen in Table 22, teachers report that the vast majority of biology classes include a heavy emphasis on learning basic science concepts (81 percent), followed by learning science process/inquiry skills (64 percent). Slightly more than half of high school biology classes have a strong focus on learning important terms and facts of science. These relative emphases are similar to those of high school science classes overall.

Table 22
High School Biology Classes with
Heavy Emphasis On Various Instructional Objectives

	Percent of Classes			
	Biology		All Other Sciences	
Learn basic science concepts	81	(2.4)	80	(1.6)
Learn science process/inquiry skills	64	(3.9)	66	(2.3)
Learn important terms and facts of science	56	(3.7)	48	(3.0)
Increase students' interest in science	46	(3.8)	44	(2.6)
Prepare for further study in science	45	(3.6)	51	(2.6)
Learn how to communicate ideas in science effectively	39	(3.7)	39	(2.6)
Learn about the relationship between science, technology, and society	27	(2.8)	31	(2.4)
Learn to evaluate arguments based on scientific evidence	23	(2.4)	31	(2.4)
Prepare for standardized tests	22	(2.3)	21	(2.0)
Learn about the applications of science in business and industry	14	(2.1)	25	(3.0)
Learn about the history and nature of science	12	(1.9)	11	(1.3)

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

- Learning how to communicate ideas in science effectively;
- Learning about the relationship between science, technology, and society;
- Learning to evaluate arguments based on scientific evidence;

- 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 22. 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 23, Science Content objectives are much more likely than Nature of Science objectives to receive heavy emphasis in biology instruction, which is the same as the pattern for all other sciences.

Table 23
Mean Composite Scores Related to
High School Biology Class Objectives

	Mean Score			
	Biology		All Other Sciences	
Science Content	85	(0.9)	85	(0.6)
Nature of Science	66	(0.9)	66	(1.0)

Class Activities

The 2000 National Survey of Science and Mathematics Education provides three sources of information about how biology is taught at the high school level. One series of items listed various instructional strategies and asked biology 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 biology instruction from these three items are presented in Tables 24–27.

Each source paints the same picture of biology instruction; the predominant instructional strategies are lecture/discussion and short-term investigations.

Table 24
High School Biology Classes Where Teachers Report that Students Take Part in Various Instructional Activities

	Percent of Classes									
	Never		A few times a year		Once or twice a month		Once or twice a week		All or almost all lessons	
Listen and take notes during presentation by teacher	0	(0.2)	2	(0.8)	12	(2.0)	53	(3.6)	34	(4.0)
Work in groups	0	(0.2)	2	(1.2)	22	(4.1)	60	(3.7)	15	(2.0)
Follow specific instructions in an activity or investigation	0	(0.3)	2	(0.7)	24	(4.3)	59	(4.2)	16	(2.0)
Do hands-on/laboratory science activities or investigations	1	(0.3)	3	(1.3)	24	(4.0)	64	(3.7)	10	(1.6)
Read from a science textbook in class	13	(2.4)	29	(3.2)	28	(3.0)	20	(2.6)	10	(4.3)
Answer textbook or worksheet questions	1	(0.6)	9	(1.7)	26	(3.3)	55	(3.6)	9	(1.8)
Record, represent, and/or analyze data	1	(0.8)	9	(1.8)	40	(3.7)	43	(3.5)	7	(1.3)
Write reflections	31	(2.9)	33	(3.9)	21	(2.8)	9	(1.7)	7	(1.6)
Watch a science demonstration	1	(0.4)	10	(1.6)	56	(3.5)	29	(3.0)	5	(1.1)
Read other science-related materials in class	6	(1.8)	28	(2.8)	44	(3.6)	17	(2.8)	5	(3.9)
Watch audiovisual presentations	1	(0.4)	18	(2.6)	57	(3.7)	21	(2.8)	3	(0.8)
Prepare written science reports	5	(1.3)	27	(2.8)	43	(3.3)	23	(3.9)	2	(0.8)
Use computers as a tool	21	(2.9)	33	(3.3)	30	(3.4)	14	(4.1)	1	(0.4)
Use mathematics as a tool in problem-solving	10	(2.0)	29	(2.7)	39	(3.6)	22	(4.2)	1	(0.5)
Design or implement their *own* investigation	8	(1.5)	43	(4.1)	42	(3.5)	7	(1.0)	1	(0.4)
Work on extended science investigations or projects	12	(2.2)	52	(3.6)	29	(4.1)	6	(1.5)	1	(0.4)
Participate in field work	23	(2.7)	45	(3.9)	29	(4.4)	3	(1.0)	0	(0.3)
Make formal presentations to the rest of the class	15	(2.3)	47	(3.7)	34	(4.1)	4	(1.2)	0	(0.3)
Take field trips	43	(3.5)	48	(3.8)	7	(1.5)	2	(0.9)	0	(0.3)

Table 25
High School Biology Classes Where Teachers Report that Students Take Part in Various Instructional Activities at Least Once a Week

	Percent of Classes			
	Biology		All Other Sciences	
Listen and take notes during presentation by teacher	86	(2.0)	86	(1.8)
Work in groups	76	(4.0)	83	(1.8)
Follow specific instructions in an activity or investigation	74	(4.2)	70	(2.9)
Do hands-on/laboratory science activities or investigations	73	(3.9)	70	(3.1)
Answer textbook or worksheet questions	65	(3.6)	77	(2.1)
Record, represent, and/or analyze data	50	(3.6)	59	(3.2)
Watch a science demonstration	33	(3.2)	50	(2.7)
Read from a science textbook in class	30	(4.1)	27	(2.2)
Prepare written science reports	26	(3.9)	25	(2.0)
Watch audiovisual presentations	24	(3.0)	20	(1.8)
Use mathematics as a tool in problem-solving	22	(4.1)	71	(2.3)
Read other science-related materials in class	22	(4.2)	18	(1.8)
Write reflections	16	(2.1)	15	(1.9)
Use computers as a tool	15	(4.1)	18	(2.2)
Design or implement their *own* investigation	8	(1.1)	10	(1.7)
Work on extended science investigations or projects	7	(1.5)	8	(1.4)
Make formal presentations to the rest of the class	5	(1.2)	6	(1.1)
Participate in field work	3	(1.1)	5	(1.1)
Take field trips	2	(1.0)	2	(0.7)

Table 26
High School Biology Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes			
	Biology		All Other Sciences	
Discussion	81	(2.3)	81	(1.8)
Lecture	72	(3.1)	72	(2.5)
Students working in small groups	47	(3.3)	56	(2.6)
Students doing hands-on/laboratory activities	48	(3.2)	39	(2.5)
Students completing textbook/worksheet problems	46	(3.7)	55	(2.5)
Students reading about science	27	(4.0)	24	(2.2)
Test or quiz	13	(1.8)	12	(1.5)
Students using other technologies	10	(2.0)	10	(1.5)
Students using computers	8	(2.0)	7	(1.1)
Students using calculators	4	(1.0)	42	(2.5)
None of the above	2	(0.8)	2	(0.5)

Table 27
Average Percentage of High School Biology Class Time Spent on Different Types of Activities

	Average Percent			
	Biology		All Other Sciences	
Whole class lecture/discussion	36	(1.9)	37	(1.2)
Working with hands-on, manipulative, or laboratory materials	26	(2.0)	19	(1.6)
Individual students reading textbooks, completing worksheets, etc.	12	(0.8)	16	(1.3)
Daily routines, interruptions, and other non-instructional activities	11	(0.5)	11	(0.3)
Non-laboratory small group work	8	(1.0)	11	(1.0)
Other activities	7	(0.9)	7	(0.7)

Lecture/Discussion

In terms of lecture, teachers in 86 percent of biology classes report their students listening and taking notes at least once a week. This is typical of high school science classes overall. (See Tables 24 and 25.) Furthermore, in 72 percent of most recent biology lessons teachers reported lecturing, and in 81 percent, discussion occurred. (See Table 26.) On the average, more instructional time is devoted to lecture/discussion than any other activity, both for biology and for the other sciences. (See Table 27.)

Laboratory Activities

In 73 percent of high school biology classes, teachers report students doing a laboratory or investigation at least weekly (Table 25); just under half indicated that this happened in the most recent lesson. (See Table 26.) Across all biology lessons, 26 percent of instructional time is spent "working with hands-on, manipulative, or laboratory materials," coming in second behind the 36 percent of class time spent on whole class lecture/discussion (Table 27). Biology classes seem to spend more time than other science classes on laboratory or other hands-on work, as reflected by the average percentage of time spent on each activity type (Table 27). However, while investigations are a major part of high school biology classes, these investigations appear to be primarily short-term lab activities rather than long-term projects. Only about a third of biology classes work on extended projects more than a few times in a year (Table 24). In this sense, biology classes are very similar to high school science classes overall.

Other Frequent Activities

From the three data sources described above, it is clear that some other activities are frequent in addition to lecture/discussion and laboratory activities. Students working together in small groups is quite common. (See Tables 24–27.) This may be a reflection of the amount of time spent doing investigations, although other high school science classes also work in groups quite frequently, despite spending somewhat less time on average doing laboratory activities. (See Table 25.) Answering textbook or worksheet questions is also a frequent activity.

It is surprising that 11 percent of time in biology classes is devoted to non-instructional activities. (See Table 27.) Over a year, this amounts to a loss of nearly four weeks of instructional time. The amount of non-instructional time, however, is no different than in high school science classes in the other science disciplines.

In most biology classes (88 percent), teachers assign more than one-half hour of homework per week. Just over half of the high school biology teachers surveyed (54 percent) reported assigning 30–90 minutes of homework per week in the randomly selected class, and only about 1 in 5 assign more than two hours. (See Table 28.) Teachers of the other sciences assign similar quantities of homework.

Table 28
Amount of Homework Assigned
in High School Biology Classes per Week

	Percent of Classes			
	Biology		All Other Sciences	
0–30 minutes	12	(2.1)	10	(1.2)
31–60 minutes	27	(3.1)	27	(2.3)
61–90 minutes	27	(2.9)	24	(1.9)
91–120 minutes	13	(2.0)	17	(1.7)
2–3 hours	13	(2.0)	15	(2.7)
More than 3 hours	9	(3.8)	7	(1.1)

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 posing the question and designing the experimental procedure. In only about half of the high school biology classes do teachers report that students design their own investigations at least monthly. (See Table 24.) This may represent a concern over the safety of students using lab materials for activities that have not been thoroughly tested. These same considerations could also explain the relative prevalence of students following specific instructions in an activity or investigation. (See Table 24.)

Less easily explained is the fact that in only one-third of the high school biology classes do teachers report doing demonstrations at least weekly, especially when demonstrations can be a way of compensating for equipment shortages or safety considerations. In contrast, about half of the other high school science classes do demonstrations at least once a week. (See Table 25).

Given the importance of field work to the discipline of biology, it is disappointing that about one-fourth of high school biology classes never include participation in field work. Moreover, 43 percent of classes never take field trips, which further limits students' opportunities to experience "real-world" biology. (See Table 24).

Finally, the frequency of computer use is surprisingly low. Fewer than 1 in 10 biology classes incorporated computer use during the most recent lesson. (See Table 26.) As can be seen in Table 29, only 36 percent of high school science classes ever use computers to collect data with sensors or probes and only 50 percent ever use computer simulations to solve problems.

Table 29
High School Biology Classes Where Teachers Report that Students Use Computers to do Particular Activities

	Percent of Classes									
	Never		A few times a year		Once or twice a month		Once or twice a week		All or almost all lessons	
Demonstrate scientific principles	40	(3.3)	30	(3.1)	25	(3.9)	5	(1.2)	1	(0.6)
Do laboratory simulations	41	(3.5)	34	(3.4)	20	(4.0)	5	(1.3)	1	(0.4)
Retrieve or exchange data	45	(3.7)	26	(2.7)	24	(4.0)	4	(1.2)	1	(0.5)
Solve problems using simulations	50	(3.9)	25	(2.9)	21	(4.3)	3	(0.7)	0	(0.3)
Do drill and practice	52	(3.8)	24	(2.7)	20	(4.0)	4	(1.2)	1	(0.4)
Play science learning games	56	(3.7)	28	(3.2)	11	(3.7)	5	(1.3)	0	(0.3)
Collect data using sensors or probes	64	(4.1)	24	(2.9)	10	(3.9)	2	(0.7)	1	(0.4)
Take a test or quiz	66	(4.2)	19	(4.0)	6	(1.4)	8	(1.8)	1	(0.6)

Table 30
High School Biology Classes Where Teachers Report that Students Use Computers to do Particular Activities at Least Once a Week

	Percent of Classes			
	Biology		All Other Sciences	
Demonstrate scientific principles	6	(1.3)	7	(1.2)
Do laboratory simulations	6	(1.3)	7	(1.4)
Retrieve or exchange data	5	(1.2)	9	(1.5)
Solve problems using simulations	3	(0.7)	6	(1.1)
Do drill and practice	4	(1.2)	6	(1.3)
Play science learning games	5	(1.3)	2	(0.9)
Collect data using sensors or probes	2	(0.7)	8	(1.3)
Take a test or quiz	9	(1.9)	8	(2.6)

The 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 biology teachers identify instructional technology as an area where they are in particular need of professional development. (See Table 11.) At the same time, other survey data show that teachers participate in very little professional development that is focused on science instruction, so even though many of those experiences emphasized technology use, the total amount of professional development time devoted to this area was low. (See Tables 13 and 15.)

Another potential explanation is a lack of access to computers; however, teachers in only 5 percent of high school biology classes reported that computers were needed for instruction, but that they were not available. (See Table 31.) This, too, could reflect the lack of professional development, as teachers may not understand the potential uses of technology in education, and therefore not perceive a need for the equipment. The vast majority of biology classes (85 percent) use computers at least once during the year. (See Table 31). Frequency of use, however, is clearly very low.

Table 31
Equipment Need, Availability, and Use in High School Biology Classes

	Percent of Classes					
	Not Needed		Needed, but Not Available		Used	
Overhead projector						
Biology	11	(4.4)	0	(0.0)	89	(4.4)
All Other Sciences	12	(3.4)	0	(0.1)	88	(3.4)
Videotape player						
Biology	4	(1.5)	0	(0.2)	96	(1.5)
All Other Sciences	6	(1.0)	0	(0.2)	94	(1.1)
Videodisc player						
Biology	39	(4.3)	4	(1.3)	57	(4.2)
All Other Sciences	38	(2.4)	8	(1.8)	54	(2.7)
CD-ROM player						
Biology	30	(3.8)	6	(1.3)	64	(4.0)
All Other Sciences	40	(2.9)	9	(1.5)	52	(2.9)
Four-function calculator						
Biology	51	(4.2)	5	(1.7)	44	(4.4)
All Other Sciences	28	(2.1)	4	(1.2)	68	(2.3)
Fraction calculators						
Biology	76	(3.4)	4	(1.5)	20	(3.1)
All Other Sciences	65	(3.3)	4	(1.1)	32	(3.4)
Graphing calculators						
Biology	73	(3.3)	5	(1.5)	22	(3.0)
All Other Sciences	51	(3.2)	5	(1.0)	44	(3.2)
Scientific calculators						
Biology	59	(3.9)	5	(1.7)	36	(3.8)
All Other Sciences	25	(2.2)	3	(0.9)	72	(2.2)
Computers						
Biology	10	(2.2)	5	(1.2)	85	(2.6)
All Other Sciences	9	(1.3)	7	(1.4)	84	(1.9)
Computers with Internet connection						
Biology	12	(2.4)	6	(1.3)	83	(2.8)
All Other Sciences	16	(1.8)	10	(1.7)	74	(2.4)
Calculator/computer lab interfacing devises						
Biology	49	(4.4)	16	(3.1)	35	(3.9)
All Other Sciences	34	(2.9)	19	(2.6)	48	(3.5)
Running water						
Biology	0	(0.4)	2	(0.8)	98	(1.0)
All Other Sciences	4	(1.0)	2	(0.5)	95	(1.1)
Electric outlet						
Biology	0	(0.3)	1	(0.4)	99	(0.6)
All Other Sciences	3	(1.0)	2	(0.8)	96	(1.3)
Gas for burners						
Biology	24	(3.2)	5	(1.6)	71	(3.5)
All Other Sciences	21	(2.3)	6	(1.2)	73	(2.5)
Hoods or air hose						
Biology	41	(3.7)	12	(2.2)	47	(4.4)
All Other Sciences	28	(2.3)	10	(1.6)	61	(2.5)

Resources Available for Biology Instruction

Biology 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 high school biology classes report needing a particular resource and not having it. One of these was calculator/computer lab interfacing devices (16 percent reported needing, but not available), and the other was hoods or air hoses (12 percent). Nearly all biology classrooms have electric outlets, running water, and videotape players. (See Table 31.)

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

- *Modern Biology* (Holt, Rinehart and Winston, Inc.);
- *Biology–The Dynamics of Life* (McGraw-Hill/Merrill Co.); and
- *Prentice Hall Biology* (Prentice Hall, Inc.).

As can be seen in Table 32, teachers in 77 percent of biology classes rated their textbook as good or better in quality. Despite these ratings, there does seem to be an issue with the amount of material in biology textbooks. Only 45 percent of biology classes address more than three-fourths of their textbook, which may be a reflection of publishers' efforts to meet as many state and district textbook adoption criteria as possible by including all of the content anyone might seek. (See Table 33.)

Table 32
High School Biology Teachers' Perceptions of Quality of Textbooks/Programs Used in Science Classes

	Percent of Classes			
	Biology		All Other Sciences	
Very poor	1	(0.7)	1	(0.3)
Poor	3	(1.0)	6	(1.1)
Fair	18	(4.1)	18	(1.5)
Good	39	(3.7)	37	(2.7)
Very good	29	(3.8)	31	(2.4)
Excellent	9	(1.8)	7	(1.3)

Table 33
Percentage of High School Biology Textbooks/Programs Covered During the Course

	Percent of Classes			
	Biology		All Other Sciences	
Less than 25 percent	4	(1.0)	2	(0.8)
25–49 percent	14	(2.3)	13	(1.4)
50–74 percent	37	(3.4)	39	(2.5)
75–90 percent	37	(4.2)	36	(2.1)
More than 90 percent	8	(1.6)	10	(1.3)

Summary

The high school biology teaching force seems to be well prepared. Most students in biology classes are being taught by teachers with a strong science background and high confidence in their content knowledge.

Biology teachers' background in education is less strong. Many recognize a need for more professional development, particularly in the areas of technology use and the teaching of special needs students. Technology is the most common focus of their professional development, yet biology teachers still use computers infrequently and do not report a need for more access to technology. Teaching special needs students is one of the rarest topics for professional development, although a substantial number of classes include special needs students who have been "mainstreamed."

A majority of the high school biology teachers report understanding the *National Science Education Standards,* and feeling prepared to use standards-based teaching practices; however, many report infrequently using several practices that are *Standards*-aligned. Investigations are second only to lecture/discussion in terms of how class time is spent, but data indicate that these tend to be short-term labs rather than extended projects.

References

National Research Council. *National Science Education Standards*. Washington, DC: National Research Council, 1996.

Weiss, I.R., Banilower, E.R., McMahon, K.C., and Smith, P.S. *Report of the 2000 National Survey of Science and Mathematics Education.* Chapel Hill, NC: Horizon Research, Inc., 2001.

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**

Table A-8
Use of Strategies to Develop Students' Abilities to Communicate Ideas

Pose open-ended questions	Q24b
Engage the whole class in discussions	Q24c
Require students to supply evidence to support their claims	Q24d
Ask students to explain concepts to one another	Q24e
Ask students to consider alternative explanations	Q24f
Help students see connections between science/mathematics and other disciplines	Q24h
Number of Items in Composite	**6**
Reliability (Cronbach's Coefficient Alpha)	**0.79**