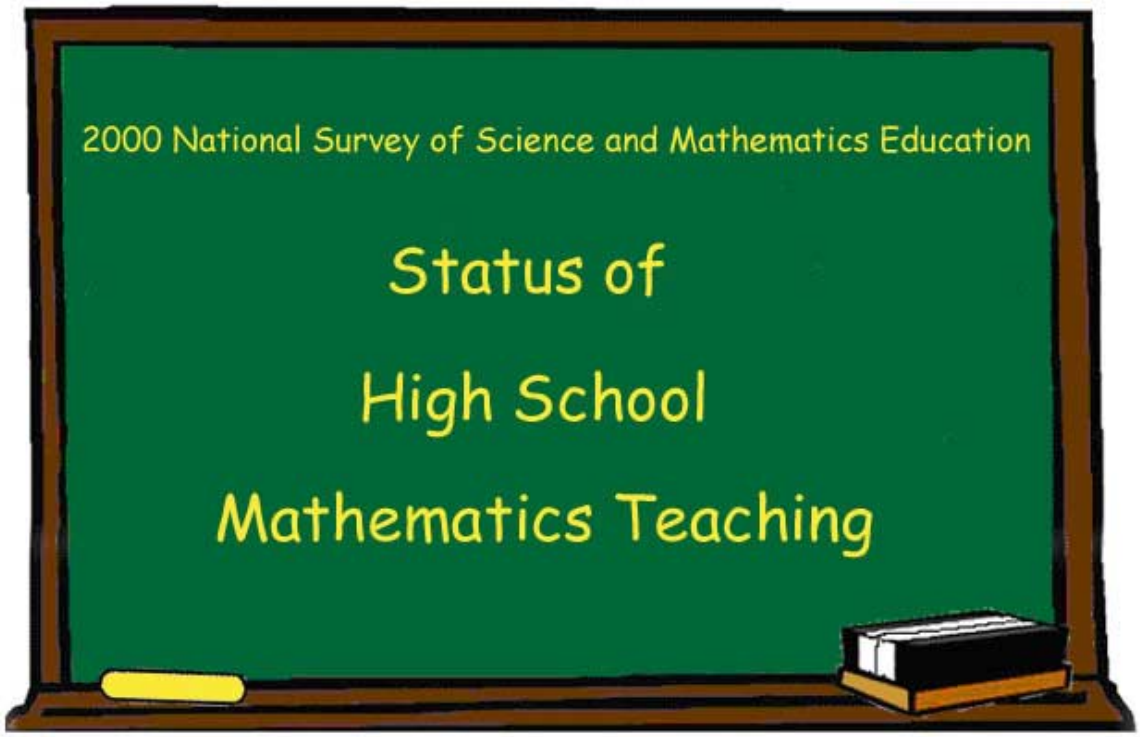

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Status of High School Mathematics Teaching

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) mathematics instruction based on the responses of 1,367 high school mathematics teachers.[1] 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.

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

- Characteristics of the high school mathematics teaching force in the United States;
- Professional development of high school mathematics teachers, both needs and participation;
- High school mathematics classes offered;

[1] A high school mathematics teacher is defined as someone who teaches at least one class of mathematics in grades 9–12.

- High school mathematics instruction, in terms of both objectives and class activities used; and
- Resources available for high school mathematics instruction.

Many tables in the report include a column that presents data for all high school mathematics teachers, as well as these data separated by the type of a randomly selected class. High school mathematics teachers whose selected class was an informal review course, such as Pre-Algebra, are compared to those whose selected class was a formal required course, such as Algebra I or Geometry. Finally, a fourth column in the tables presents data for teachers whose selected class was a formal advanced course, such as Calculus. Details on the way in which classes were divided for the purposes of comparison are included in the Appendix.

Characteristics of the High School Mathematics Teaching Force

General Demographics

As can be seen in Table 1, the high school mathematics teaching force has a larger number of females (55 percent) than males. Interestingly, data for high school teachers assigned exclusively to informal review courses are roughly the reverse, with 56 percent of the teachers being male. Demographic data also show that Blacks, Hispanics, and other minority groups are substantially underrepresented, collectively representing less than 10 percent of the high school mathematics teaching force.

The distribution of high school mathematics teachers according to age is skewed toward older teachers. Thirty percent of high school mathematics teachers are older than 50, suggesting that many may be retiring over the next 10 years. Ensuring an adequate number of teachers for advanced courses will need to be a priority for many districts. In looking at the data, it appears that these courses stand to lose the largest number of teachers to retirement in the next 10 years, with 40 percent having more than 20 years of teaching experience and 35 percent over 50 years old.

Overall 51 percent of high school mathematics teachers have received a Master's degree. However, a higher percentage of teachers of advanced courses (59 percent) have Master's degrees than teachers of informal or required mathematics courses. Taken together these data suggest that teachers of advanced mathematics courses are more qualified and more experienced than their colleagues teaching informal and required courses.

Table 1
Characteristics of the
High School Mathematics Teaching Force

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Sex								
Male	45	(2.0)	56	(4.5)	42	(3.1)	43	(3.4)
Female	55	(2.0)	44	(4.5)	58	(3.1)	57	(3.4)
Race								
White	91	(1.0)	90	(2.1)	89	(1.8)	94	(1.1)
Black or African-American	4	(0.8)	6	(1.8)	5	(1.5)	2	(0.7)
Hispanic or Latino	2	(0.4)	2	(0.8)	3	(0.7)	2	(0.5)
American Indian or Alaskan Native	1	(0.3)	2	(1.0)	0	(0.2)	1	(0.4)
Asian	1	(0.3)	1	(0.5)	1	(0.4)	2	(0.5)
Native Hawaiian or other Pacific Islander	0	(0.2)	1	(0.6)	0	(0.3)	0	(0.1)
Age								
≤ 30 years	16	(1.4)	16	(2.8)	20	(2.6)	13	(2.3)
31–40 years	24	(1.5)	24	(3.4)	25	(2.3)	24	(2.6)
41–50 years	29	(2.1)	28	(4.0)	30	(2.9)	27	(3.0)
50+ years	30	(1.7)	31	(4.0)	25	(2.6)	35	(2.7)
Experience								
0–2 years	13	(1.4)	13	(2.6)	16	(2.6)	9	(1.5)
3–5 years	15	(1.6)	15	(3.8)	18	(2.8)	12	(2.6)
6–10 years	15	(1.5)	14	(2.4)	15	(2.0)	13	(2.4)
11–20 years	24	(1.8)	26	(4.1)	22	(2.6)	26	(2.9)
≥ 21 years	34	(1.9)	32	(4.1)	29	(2.7)	40	(3.1)
Master's Degree								
Yes	51	(2.1)	46	(4.9)	46	(3.1)	59	(3.0)
No	49	(2.1)	54	(4.9)	54	(3.1)	41	(3.0)

Content Preparedness

Since it would be extremely difficult to gauge the extent to which a large national sample of teachers understands mathematics concepts (and knows how to help their students learn these concepts), proxy measures such as major or college courses taken in the field are typically used. An analysis of college courses taken by high school mathematics teachers shows that they are generally well prepared in mathematics content. Close to 60 percent of teachers reported having an undergraduate degree in mathematics, with another 22 percent having an undergraduate degree in mathematics education. (See Table 2.)

Table 2
Undergraduate Majors of
High School Mathematics Teachers†

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Mathematics	58	(2.2)	50	(5.0)	61	(3.0)	60	(3.2)
Mathematics Education	22	(2.0)	18	(3.4)	20	(2.4)	23	(3.2)
Other Education	10	(1.4)	19	(4.5)	8	(1.5)	8	(1.9)
Other Fields	10	(1.2)	12	(2.8)	11	(1.7)	9	(1.7)

† 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.

Data in Table 3 also help make the case for high school mathematics teachers being quite well prepared; 95 percent of teachers report having taken eight or more college courses in the field. This level of coursework suggests that nearly all high mathematics school teachers have the equivalent of at least a minor in mathematics.

Table 3
Number of Semesters† Completed by
High School Mathematics Teachers

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Fewer than 4 Semesters	2	(0.8)	7	(3.4)	0	(0.1)	2	(1.1)
4–7 Semesters	3	(0.7)	5	(1.8)	4	(1.3)	2	(0.9)
8–11 Semesters	13	(1.6)	8	(2.1)	16	(2.7)	12	(2.5)
More than 11 Semesters	82	(1.8)	80	(4.2)	80	(3.1)	84	(2.8)

† The highest number of courses a teacher could indicate for each of the four categories—calculus, statistics, advanced calculus, and "all other mathematics courses"—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 nine courses in a particular category.

Table 4 provides more specific data on the coursework high school mathematics teachers have had in college. Ninety-six percent have had coursework in calculus and more than 80 percent have taken courses in probability and statistics, geometry, and college algebra/ trigonometry, suggesting a high level of preparation in the traditional topics offered at the high school level.

However, teachers of informal mathematics are significantly less likely than their colleagues who teach advanced courses to have taken courses in the areas of calculus, real analysis, differential equations, abstract algebra, and linear algebra. These data suggest that students enrolled in informal mathematics courses are being taught by teachers with somewhat weaker content backgrounds. If teachers are to guide students in their exploration of mathematics concepts, they must themselves have a firm grasp of powerful mathematics concepts. Having

teachers take coursework in these important content areas is one way of equipping them to guide their students.

Table 4
High School Mathematics Teachers
Completing Various College Courses

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
General methods of teaching	90	(1.2)	93	(1.7)	90	(2.0)	88	(2.0)
Methods of teaching mathematics	77	(2.1)	75	(3.7)	78	(3.1)	78	(3.7)
Supervised student teaching in mathematics	70	(2.0)	61	(4.7)	72	(3.0)	71	(3.1)
Instructional uses of computers/other technologies	43	(2.2)	41	(4.5)	45	(3.0)	43	(3.6)
Mathematics for middle school teachers	26	(1.9)	33	(4.8)	25	(2.2)	25	(3.3)
Geometry for elementary/middle school teachers	17	(1.7)	21	(3.6)	18	(2.0)	15	(2.9)
Calculus	96	(0.8)	88	(3.2)	98	(0.7)	99	(0.8)
Probability and statistics	86	(1.7)	84	(4.0)	87	(2.7)	86	(2.5)
Geometry	83	(1.3)	78	(3.7)	82	(2.2)	86	(1.6)
Linear algebra	82	(1.7)	74	(4.2)	86	(2.2)	81	(3.2)
College algebra/trigonometry/ elementary functions	80	(1.5)	79	(3.5)	80	(2.7)	81	(2.5)
Advanced calculus	70	(2.0)	58	(4.5)	69	(3.3)	76	(3.0)
Computer science course	68	(2.0)	65	(4.4)	69	(2.7)	68	(3.3)
Differential equations	65	(1.9)	55	(4.2)	66	(3.1)	69	(2.9)
Abstract algebra	65	(2.0)	51	(4.7)	67	(2.9)	70	(3.3)
Computer programming	62	(2.0)	57	(4.4)	61	(3.1)	65	(3.4)
Other upper division mathematics	60	(2.0)	48	(4.7)	63	(2.8)	61	(3.2)
Number theory	56	(2.0)	53	(4.6)	59	(3.4)	55	(3.2)
History of mathematics	41	(2.0)	41	(4.4)	42	(2.9)	42	(3.2)
Real analysis	38	(2.1)	32	(4.3)	33	(2.8)	48	(3.3)
Discrete mathematics	38	(1.7)	34	(4.1)	37	(3.0)	41	(2.9)
Applications of mathematics/ problem solving	37	(1.8)	36	(4.0)	38	(3.0)	38	(3.5)
Other computer science	28	(2.1)	30	(4.4)	30	(3.0)	22	(2.9)

The National Council of Teachers of Mathematics (NCTM) has recommended that high school mathematics teachers have college coursework in abstract algebra, geometry, calculus, probability and statistics, applications of mathematics/problem solving, and history of mathematics (National Council of Teachers of Mathematics, 1998). As can be seen in Table 5, only 40 percent of high school mathematics teachers have had 5 or 6 of these courses; another 48 percent have had 3 or 4 of these courses.

Table 5
High School Mathematics Teachers Completing
NCTM-Recommended College Mathematics Courses

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
None	1	(0.7)	6	(3.3)	0	(0.1)	0	(0.4)
1–2 Courses	10	(1.4)	12	(2.9)	9	(1.8)	10	(2.7)
3–4 Courses	48	(2.1)	49	(4.6)	51	(3.0)	45	(3.5)
5–6 Courses	40	(2.0)	33	(4.5)	40	(3.1)	45	(3.2)

Knowing the extent of teachers' course backgrounds provides useful information about the preparation of the nation's high school mathematics teaching force. Also important are teachers' perceptions of their preparation—how well prepared teachers feel they are to teach the various content areas.

Overall, high school mathematics teachers reported feeling qualified to teach a number of mathematics topics at the secondary level. In fact, over 90 percent of them reported feeling at least adequately prepared to teach all but five areas. The five areas which large percentages of high school teachers reported feeling not well qualified to teach are mathematical structures (46 percent), topics from discrete mathematics (44 percent), calculus (39 percent), statistics (23 percent) and technology to support mathematics instruction (23 percent). (See Table 6.)

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

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Pre-algebra	0	(0.2)	5	(1.1)	94	(1.1)
Algebra	0	(0.2)	5	(1.1)	94	(1.2)
Computation	1	(0.2)	11	(1.4)	88	(1.5)
Estimation	1	(0.2)	14	(1.7)	85	(1.7)
Measurement	1	(0.2)	14	(1.7)	85	(1.8)
Patterns and relationships	1	(0.3)	24	(2.0)	75	(2.0)
Geometry and spatial sense	4	(0.7)	26	(2.1)	70	(2.2)
Numeration and number theory	6	(0.7)	30	(2.1)	65	(2.2)
Functions and pre-calculus concepts	6	(0.9)	33	(2.0)	61	(2.0)
Data collection and analysis	9	(1.1)	45	(2.5)	46	(2.5)
Probability	10	(1.3)	49	(1.8)	42	(2.0)
Technology	23	(1.9)	48	(2.2)	29	(2.2)
Statistics	23	(1.6)	51	(2.3)	26	(2.1)
Calculus	39	(1.9)	37	(2.0)	25	(1.8)
Topics from discrete mathematics	44	(1.9)	40	(1.7)	16	(1.5)
Mathematical structures	46	(2.0)	41	(1.8)	12	(1.4)

Pedagogical Preparedness

The National Council of Teachers of Mathematics originally published *Curriculum and Evaluation Standards for School Mathematics* in 1989. As one measure of the influence of the *Standards*, teachers in the 2000 National Survey of Science and Mathematics Education were asked the extent of their familiarity with the *Standards*. As can be seen in Table 7, 85 percent of high school mathematics teachers reported being at least somewhat familiar with the NCTM *Standards*. Roughly three-fourths of the teachers familiar with the *Standards* agree with their vision and indicated that they are implementing the recommendations found in the *Standards* documents at least to a moderate extent.

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

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Familiarity with NCTM *Standards*								
Not at all familiar	15	(1.5)	22	(4.2)	17	(2.6)	9	(1.5)
Somewhat familiar	31	(1.9)	31	(4.4)	31	(2.5)	30	(3.0)
Fairly familiar	36	(1.9)	33	(4.1)	34	(2.5)	40	(3.7)
Very familiar	18	(1.3)	14	(2.5)	19	(2.1)	21	(2.0)
Extent of agreement with NCTM *Standards* †								
Strongly Disagree	0	(0.2)	1	(0.5)	0	(0.2)	0	(0.3)
Disagree	7	(1.1)	9	(3.2)	7	(1.6)	5	(1.0)
No Opinion	19	(2.0)	24	(4.1)	19	(2.8)	18	(3.4)
Agree	66	(2.4)	62	(4.7)	66	(3.2)	68	(4.0)
Strongly Agree	8	(0.9)	5	(1.7)	8	(1.6)	9	(1.6)
Extent to which recommendations have been implemented †								
Not at all	3	(1.0)	6	(2.6)	2	(1.0)	3	(2.0)
To a minimal extent	24	(2.2)	17	(3.6)	27	(3.2)	22	(3.9)
To a moderate extent	57	(2.6)	61	(5.2)	58	(3.6)	55	(3.9)
To a great extent	17	(1.8)	16	(4.2)	14	(1.9)	20	(3.4)

† These analyses included only those teachers indicating they were at least somewhat familiar with the *Standards*.

High school mathematics teachers were also asked how well prepared they felt to use various instructional strategies in their teaching. Table 8 provides details on their perceptions of their preparedness for these areas.

Note that 93 percent of the teachers considered themselves at least "fairly well prepared" to encourage female participation in mathematics. Similar percentages emerged as teachers reported their preparedness to encourage students' interest in mathematics, as well as their ability to listen and ask questions to gauge students' understanding. A high percentage of teachers also reported being at least fairly well prepared to develop students' conceptual understanding of mathematics (88 percent), encourage participation of minority students (86 percent), use calculators/computers for drill and practice (86 percent), and take students' prior understanding into account when planning curriculum and instruction (85 percent).

Table 8
High School Mathematics Teachers Considering Themselves Well Prepared† for Each of a Number of Tasks

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Encourage participation of females in mathematics	93	(0.9)	90	(3.2)	94	(1.0)	95	(1.3)
Listen/ask questions as students work in order to gauge their understanding	92	(1.1)	91	(2.5)	92	(1.8)	92	(1.7)
Encourage students' interest in mathematics	90	(1.2)	90	(3.1)	90	(1.7)	91	(1.9)
Develop students' conceptual understanding of mathematics	88	(1.7)	82	(4.2)	88	(2.2)	94	(1.6)
Encourage participation of minorities in mathematics	86	(1.4)	81	(4.0)	86	(1.9)	86	(2.0)
Use calculators/computers for drill and practice	86	(1.3)	80	(4.1)	86	(2.0)	89	(2.1)
Take students' prior understanding into account when planning curriculum and instruction	85	(1.5)	84	(4.2)	85	(2.3)	86	(2.0)
Have students work in cooperative learning groups	76	(1.6)	72	(4.0)	79	(2.6)	74	(3.0)
Provide deeper coverage of fewer mathematics concepts	76	(1.9)	69	(5.1)	78	(2.9)	77	(3.3)
Use calculators/computers to demonstrate mathematics principles	75	(1.8)	58	(5.0)	76	(2.9)	83	(2.3)
Teach groups that are heterogeneous in ability	72	(2.1)	72	(4.6)	73	(3.1)	72	(3.3)
Use the textbook as a resource rather than the primary instructional tool	71	(2.0)	69	(4.2)	72	(3.2)	71	(3.3)
Manage a class of students engaged in hands-on/ project-based work	69	(2.0)	70	(4.3)	71	(2.7)	66	(3.5)
Make connections between mathematics and other disciplines	68	(1.9)	68	(4.6)	69	(2.8)	67	(3.1)
Use calculators/computers to collect and/or analyze data	65	(2.0)	55	(4.9)	65	(3.0)	70	(2.9)
Lead a class of students using investigative strategies	62	(2.1)	54	(4.5)	65	(3.1)	62	(3.5)
Use calculators/computers for simulations and applications	58	(2.0)	48	(4.5)	57	(3.2)	62	(3.4)
Recognize and respond to student cultural diversity	55	(2.3)	50	(4.9)	56	(3.1)	56	(3.6)
Use calculators/computers for mathematics learning games	54	(2.2)	48	(4.4)	54	(3.2)	57	(3.6)
Involve parents in the mathematics education of their children	37	(2.0)	33	(4.6)	37	(3.2)	39	(2.9)
Use the Internet in your mathematics teaching for general reference	29	(1.9)	26	(3.5)	30	(3.2)	29	(3.2)
Use the Internet in your mathematics teaching for data acquisition	28	(1.8)	24	(3.2)	29	(3.0)	27	(3.2)
Teach students who have limited English proficiency	18	(1.5)	24	(3.9)	19	(2.6)	15	(1.9)
Use the Internet in your mathematics teaching for collaborative projects with classes/individuals in other schools	15	(1.4)	11	(2.3)	17	(2.7)	15	(2.8)

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

While there have been calls for increased technology use in America's classrooms, data from the 2000 National Survey of Science and Mathematics Education highlight the need for professional development opportunities for high school mathematics teachers if that goal is to be achieved, specifically in the area of Internet usage in the classroom. Although 86 percent of high school mathematics teachers reported feeling at least fairly well prepared to use calculators and computers for drill and practice, fewer than one-third of them reported feeling similarly prepared to have students use the Internet for general reference or data acquisition. Even fewer teachers reported feeling at least "fairly well prepared" to use the Internet for collaborative projects (15 percent).

It is important to note that teachers of informal mathematics courses are less likely to feel prepared in some areas than are their colleagues teaching advanced courses, particularly those areas that involve the use of calculators/computers in the classroom. For example, 83 percent of teachers of advanced mathematics courses reported being well prepared to use calculators and computers to demonstrate mathematics principles, while only 58 percent of teachers of informal mathematics courses felt similarly. Also, while 70 percent of teachers of advanced mathematics courses reported being well prepared to use calculators and computers to collect and/or analyze data, only 55 percent of teachers of informal courses said the same. Perhaps even more important was the fact that teachers of informal mathematics courses were less likely than their colleagues teaching advanced courses to report feeling prepared to develop students' conceptual understanding of mathematics.

As yet another lens on teachers' perceptions of pedagogical preparedness, composite variables were created from these individual strategies. (Composite definitions are included in the Appendix.) Mean scores on these composites highlight the fact that high school mathematics teachers are least likely to feel prepared in technology-related areas. In the area of "preparedness to use calculators and computers," mean scores for teachers of advanced courses are significantly higher than those for both teachers of informal courses and teachers of formal required courses. (See Table 9.)

Table 9
Composite Scores of High School Mathematics
Teachers' Pedagogical Preparedness for Various Activities

	Mean Score							
	All		Informal Review		Formal Required		Formal Advanced	
Preparedness to Use Standards-Based Teaching Practices	68	(0.7)	65	(1.7)	68	(1.2)	69	(1.3)
Preparedness to Teach Students from Diverse Backgrounds	72	(0.8)	69	(2.0)	72	(1.0)	74	(1.3)
Preparedness to Use Calculators/Computers	63	(1.0)	55	(2.1)	61	(1.6)	68	(1.7)
Preparedness to Use the Internet	30	(1.2)	26	(2.2)	31	(1.7)	30	(2.4)

Professional Development of High School Mathematics Teachers

A fairly large number of high school mathematics teachers expressed the need for professional development in various areas related to teaching mathematics. For example, 67 percent of high school mathematics teachers indicated they need professional development in the use of technology in mathematics instruction, a higher percentage than in any other category. Teachers of formal required courses were more likely to cite this area as a need (72 percent) than were their colleagues teaching advanced courses (59 percent).

Over half of all high school mathematics teachers indicated a need for more professional development in learning how to use inquiry/investigation-oriented strategies, as well as learning

how to teach mathematics in a class that includes students with special needs. Teachers of informal mathematics courses were more likely to report a need for professional development in how to use inquiry investigation-oriented strategies than were their colleagues teaching advanced courses. (See Table 10.)

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

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Learning how to use technology in mathematics instruction	67	(1.8)	69	(4.0)	72	(2.9)	59	(3.5)
Learning how to teach mathematics in a class that includes students with special needs	55	(2.3)	57	(4.3)	56	(3.8)	51	(3.8)
Learning how to use inquiry/investigation-oriented teaching strategies	53	(2.1)	61	(4.6)	56	(3.0)	47	(3.6)
Understanding student thinking in mathematics	40	(2.3)	39	(4.6)	43	(3.9)	36	(3.7)
Learning how to assess student learning in mathematics	32	(2.0)	39	(4.9)	35	(3.5)	25	(2.6)
Deepening my own mathematics content knowledge	32	(2.3)	37	(4.6)	29	(3.2)	31	(4.1)

In comparison to the professional development needs listed in Table 10 above, data on high school teachers' participation in professional development appears to be somewhat low. Nearly 60 percent of high school mathematics teachers have spent fewer than 35 hours on professional development over the previous three years. This equates to less than two days per year that high school mathematics teachers spent refining and strengthening their teaching skills.

Table 11
Time High School Mathematics Teachers Spent on In-Service Education in Mathematics in the Preceding Three Years

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
None	7	(1.4)	6	(2.5)	5	(1.3)	9	(2.7)
Less than 6 hours	8	(1.4)	11	(4.1)	10	(2.6)	4	(0.8)
6–15 hours	18	(1.8)	22	(3.9)	14	(1.8)	20	(3.2)
16–35 hours	25	(1.8)	25	(4.5)	27	(2.8)	22	(2.2)
More than 35 hours	43	(2.2)	35	(3.9)	44	(3.4)	45	(3.3)

As to how this time is spent, the workshop is by far the most common form of professional development. Data in Table 12 show that 80 percent of high school mathematics teachers have attended a workshop on mathematics teaching in the previous three years. Observing other teachers teaching mathematics as part of their professional development, and meeting with other teachers to discuss mathematics teaching issues, were mentioned by roughly half of the teachers. Forty percent of the teachers reported attending a state or national mathematics teachers meeting, while 20 percent reported serving as a mentor or coach in mathematics teaching as part of a

formal arrangement. Teachers of informal mathematics courses were less likely to report serving as mentors or coaches than were their colleagues who teach advanced courses. Finally, taking a formal college-level course in mathematics or the teaching of mathematics and collaborating with a group of teachers using telecommunications was reported as recent professional development activities by fewer than 20 percent of the teachers.

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

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Attended a workshop on mathematics teaching	80	(2.0)	75	(4.3)	81	(2.8)	81	(3.1)
Observed other teachers teaching mathematics as part of your own professional development (formal or informal)	53	(2.1)	54	(4.7)	56	(3.4)	51	(3.5)
Met with a local group of teachers to study/discuss mathematics teaching issues on a regular basis	49	(2.1)	48	(4.4)	51	(3.2)	49	(3.2)
Attended a national or state mathematics teacher association meeting	40	(2.3)	33	(4.1)	43	(3.4)	41	(3.5)
Served as a mentor and/or peer coach in mathematics teaching, as part of a formal arrangement that is recognized or supported by the school or district	20	(1.4)	13	(2.9)	20	(2.2)	24	(2.9)
Taken a formal college/university mathematics course	18	(1.8)	17	(3.0)	17	(2.0)	19	(2.3)
Taken a formal college/university course in the teaching of mathematics	18	(1.4)	16	(3.2)	22	(2.5)	16	(1.9)
Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications	9	(1.4)	4	(1.4)	9	(1.7)	12	(2.7)

Data on high school teachers' most recent college coursework indicate that 45 percent of high school mathematics teachers have not taken a college/university mathematics course since 1990; 38 percent have not taken a course in either mathematics or how to teach mathematics since that time. (See Table 13.) Teachers of informal mathematics courses appear to have taken coursework more recently than have teachers of advanced courses. For example, 61 percent of teachers of informal mathematics courses have taken a mathematics course since 1990, compared to only 48 percent of teachers of advanced mathematics courses. These data may be a result of teachers of informal mathematics courses being newer to the profession (Table 1), with on the average less time passing since their enrollment at a college or university. However, the data may also be an indication that informal mathematics teachers not only feel a greater need for participating in professional development, but make more of an attempt to upgrade their skills.

Table 13
High School Mathematics Teachers' Most Recent College Coursework in Field

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Mathematics								
1996–2000	30	(2.2)	32	(3.7)	31	(3.1)	27	(3.3)
1990–1995	25	(1.8)	29	(4.3)	28	(2.8)	21	(2.1)
Prior to 1990	45	(1.8)	39	(4.2)	41	(2.8)	52	(3.3)
The Teaching of Mathematics								
1996–2000	28	(1.8)	24	(3.6)	30	(2.7)	29	(3.6)
1990–1995	21	(1.4)	27	(4.5)	22	(2.3)	15	(2.0)
Prior to 1990	38	(2.1)	30	(4.2)	35	(2.8)	45	(3.5)
Never	13	(1.6)	19	(4.2)	13	(2.1)	11	(1.9)
Mathematics or the Teaching of Mathematics								
1996–2000	38	(2.2)	38	(3.9)	40	(2.9)	35	(3.5)
1990–1995	24	(1.7)	31	(4.7)	25	(2.4)	20	(2.3)
Prior to 1990	38	(2.0)	31	(4.0)	35	(2.8)	45	(3.5)

High school mathematics teachers were asked to consider their professional development as a whole and characterize it in terms of different potential emphases. (See Table 14.) Nearly half indicated that their professional development experiences emphasized learning how to use technology in mathematics instruction. However, teachers of informal mathematics courses were less likely to report heavy emphasis being put on technology professional development than were teachers of formal courses, both required and advanced.

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 one of the most likely to receive heavy emphases during their professional development opportunities. It is not clear if these data are simply a result of the professional development being offered or if teachers are more actively pursuing technology-focused opportunities.

Table 14
High School Mathematics Teachers Reporting that Their Professional Development Gave Heavy Emphasis to Various Areas[†]

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Learning how to use technology in mathematics instruction	47	(2.1)	31	(3.8)	48	(3.4)	53	(3.5)
Learning how to use inquiry/investigation-oriented teaching strategies	27	(1.6)	24	(4.0)	31	(2.8)	26	(2.9)
Understanding student thinking in mathematics	23	(1.9)	21	(3.8)	24	(2.7)	23	(3.1)
Learning how to assess student learning in mathematics	22	(1.8)	15	(2.5)	25	(3.1)	24	(3.0)
Deepening my own mathematics content knowledge	16	(1.5)	14	(2.6)	15	(2.4)	20	(2.8)
Learning how to teach mathematics in a class that includes students with special needs	10	(1.3)	11	(2.2)	10	(1.3)	10	(3.1)

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

Similarly, deepening mathematics content knowledge was mentioned by only 16 percent of responding teachers as receiving a high emphasis, and this area was among the least likely to be identified as a substantial professional need in Table 10. In contrast, there seems to be a very poor match between needs and opportunities in terms of learning to accommodate students with special needs; this was one of the most highly rated needs (55 percent), but only 10 percent of high school mathematics teachers indicated their professional development emphasized this area.

Table 15 suggests that participation in the various professional development offerings has not had a major effect on teachers' practice. Only 40 percent of high school mathematics teachers reported changing their practice as a result of their attendance in professional development that emphasized technology, with teachers of informal courses being least likely to report a change (28 percent). Results for professional development in other areas are even lower, with fewer than one-fourth of the teachers reporting a change of practice as a result of professional development in various areas.

Table 15
High School Mathematics Teachers Reporting that Their Professional Development Activities Caused Them to Change Their Teaching Practices[†]

	Percent of Teachers							
	All		Informal Review		Formal Required		Formal Advanced	
Learning how to use technology in mathematics instruction	40	(1.9)	28	(3.9)	40	(2.9)	45	(3.5)
Learning how to use inquiry/investigation-oriented teaching strategies	24	(1.8)	14	(2.7)	29	(2.8)	24	(3.3)
Learning how to assess student learning in mathematics	15	(1.4)	14	(3.5)	15	(2.2)	17	(2.2)
Understanding student thinking in mathematics	15	(1.7)	10	(2.3)	17	(2.1)	15	(3.3)
Learning how to teach mathematics in a class that includes students with special needs	13	(1.3)	14	(3.7)	12	(1.9)	14	(2.3)
Deepening my own mathematics content knowledge	13	(1.8)	13	(4.4)	8	(1.6)	18	(3.2)

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

High School Mathematics Classes Offered

The typical high school mathematics classroom has about 21 students. Only 18 percent of students in upper-level, advanced courses are non-Asian minorities, compared to 35 percent in informal courses.

Table 16
Female and Non-Asian Minority
Students in High School Mathematics Classes

	Percent of Students							
	All		Informal Review		Formal Required		Formal Advanced	
Female	52	(0.6)	46	(1.4)	53	(0.9)	53	(0.9)
Non-Asian	26	(1.5)	35	(2.9)	29	(2.0)	18	(1.5)

Table 17 shows that nearly all high schools offer formal mathematics courses equivalent to Algebra 1, Geometry, and Algebra 2, and 89 percent of the schools including grade 10, 11, or 12 offer a formal Algebra 3/Pre-Calculus course. Other formal courses are substantially less common. For example, only 43 percent of schools with grades 10, 11, or 12 offer a course in calculus, and only 23 percent offer a course in probability and statistics.

Table 17
Schools Offering Various Mathematics
Courses, Grade 9 and Grade 10, 11, or 12

	Percent of Schools			
	Schools Including Grade 9		Schools Including Grade 10, 11, or 12	
Review Mathematics				
Level 1 (e.g., Remedial Mathematics)	28	(2.6)	28	(2.5)
Level 2 (e.g., Consumer Mathematics)	26	(2.6)	27	(2.5)
Level 3 (e.g., General Mathematics 3)	16	(2.3)	17	(2.4)
Level 4 (e.g., General Mathematics 4)	9	(1.7)	10	(1.8)
Informal Mathematics				
Level 1 (e.g., Pre-Algebra)	51	(3.6)	50	(3.5)
Level 2 (e.g., Basic Geometry)	21	(2.7)	23	(2.7)
Level 3 (e.g., after Pre-Algebra, but not Algebra 1)	17	(2.1)	17	(2.1)
Formal Mathematics				
Level 1 (e.g., Algebra 1 or Integrated Math 1)	98	(0.9)	98	(0.8)
Level 2 (e.g., Geometry or Integrated Math 2)	93	(2.2)	94	(2.2)
Level 3 (e.g., Algebra 2 or Integrated Math 3)	93	(2.2)	96	(2.0)
Level 4 (e.g., Algebra 3 or Pre-Calculus)	84	(3.1)	89	(2.9)
Level 5 (e.g., Calculus)	41	(3.5)	43	(3.5)
Level 5, AP	33	(3.0)	36	(3.2)
Other Mathematics Courses				
Probability and Statistics	21	(2.6)	23	(2.7)
Mathematics integrated with other subjects	4	(0.8)	4	(0.8)

High School Mathematics Instruction

This section draws on teachers' descriptions of what transpires in high school mathematics classrooms in the United States, in terms of both instructional objectives and classroom activities.

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate each in terms of the emphasis received in their randomly selected class. As can be seen in Table 18, 85 percent of high school mathematics teachers place a heavy emphasis on learning mathematical concepts; roughly three-fourths of them reported teaching classes with heavy emphases on learning how to solve problems and learning how to reason mathematically. In contrast, only 56 percent place heavy emphasis on helping students learn how mathematics ideas connect with one another, while even fewer (32 percent) emphasize learning to explain ideas in mathematics. Among the instructional objectives least likely to be reported as receiving heavy emphasis were applying mathematics in business and industry and learning about the history and nature of mathematics.

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

	Percent of Classes							
	All		Informal Review		Formal Required		Formal Advanced	
Learn mathematical concepts	85	(1.4)	72	(3.6)	89	(1.8)	88	(2.1)
Learn how to solve problems	74	(1.8)	72	(3.6)	76	(2.5)	72	(3.4)
Learn how to reason mathematically	72	(1.9)	63	(4.2)	74	(2.5)	73	(3.3)
Prepare for further study in mathematics	61	(1.9)	35	(3.9)	60	(3.0)	76	(2.4)
Learn mathematical algorithms/procedures	57	(2.0)	45	(4.1)	56	(3.4)	65	(3.1)
Learn how mathematics ideas connect with one another	56	(1.6)	38	(3.6)	56	(2.8)	64	(2.6)
Develop students' computational skills	38	(1.8)	59	(4.4)	39	(2.8)	28	(2.4)
Understand the logical structure of mathematics	37	(1.6)	16	(2.8)	40	(3.0)	45	(3.3)
Learn to explain ideas in mathematics effectively	32	(1.9)	23	(3.5)	34	(3.0)	35	(2.9)
Prepare for standardized tests	28	(1.9)	33	(4.2)	33	(3.0)	19	(2.2)
Increase students' interest in mathematics	28	(1.7)	26	(3.7)	27	(2.8)	30	(2.5)
Learn to perform computations with speed and accuracy	20	(1.5)	22	(3.8)	20	(2.3)	20	(2.2)
Learn how to apply mathematics in business and industry	16	(1.3)	28	(3.6)	14	(1.9)	15	(1.8)
Learn about the history and nature of mathematics	3	(0.5)	2	(0.9)	2	(0.8)	4	(0.9)

Substantial differences exist when looking at these data according to teaching assignments. When compared to their colleagues teaching required and advanced mathematics courses, teachers of informal mathematics courses were less likely to report placing heavy emphasis on learning mathematical concepts, learning how to connect mathematics ideas, preparing students for further study in the subject and learning how to explain ideas in mathematics. They were more likely to report placing heavy emphasis on developing students' computational skills and preparing for standardized tests.

Composite variables were created from the list of objectives in Table 18 and are presented in Table 19. The three composites are shown here with the objectives that comprise them:

Mathematics Reasoning
- Learn mathematical concepts
- Learn how to solve problems
- Learn how to reason mathematically
- Learn how mathematics ideas connect with one another

Basic Mathematics Skills
- Develop students' computational skills
- Learn to perform computations with speed and accuracy
- Prepare for standardized tests

Nature of Mathematics
- Understand the logical structure of mathematics
- Learn about the history and nature of mathematics
- Learn to explain ideas in mathematics effectively
- Learn how to apply mathematics in business and industry

Mathematics reasoning objectives were much more likely to receive heavy emphasis, although the mean score for informal courses in this area was lower than the mean scores for both required and advanced classes. In addition, as would be expected, mean scores indicate that teachers of both informal and required mathematics courses are more likely to emphasize basic mathematics skills than are their colleagues teaching more advanced courses.

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

	Mean Scores							
	All		Informal Review		Formal Required		Formal Advanced	
Mathematical Reasoning	90	(0.5)	85	(1.0)	91	(0.7)	91	(0.6)
Basic Mathematics Skills	65	(0.9)	70	(1.5)	67	(1.3)	60	(1.6)
Nature of Mathematics	60	(0.7)	54	(1.4)	60	(1.0)	63	(1.4)

Class Activities

The 2000 National Survey of Science and Mathematics Education provides three sources of information about how mathematics is taught at the high school level. One series of items listed a number of instructional strategies and asked 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 that 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 high school mathematics instruction from these three items are presented in Tables 20–23. Although teachers reported placing heavy emphasis on mathematical reasoning and conceptual understanding, the predominant instructional strategies teachers report using involve students listening and taking notes during presentations, answering textbook or worksheet questions, and reviewing homework and worksheet assignments. For example, data in Table 20 show that teachers reported incorporating these activities at least once a week in over 90 percent of the high school classrooms. Additionally, teachers reported having students follow specific

instructions in an activity, as well as having them practice routine computations and algorithms, at least once a week in over 70 percent of the classes. Such high percentages for these instructional strategies may be an indication that teachers are heavily relying on rote computational practice and drills to achieve their goals of strengthening students' conceptual understanding and reasoning abilities in mathematics, although such strategies may not be best suited for those purposes.

Activities that focused on strengthening students' ability to effectively communicate mathematical ideas or carry out mathematical investigations were reported as happening less frequently. As seen in Table 20, in over 50 percent of the high school mathematics classes, teachers reported never having their students write reflections, while having students make formal presentations was reported as happening no more than a few times a year in over 70 percent of the classrooms. Similarly, rarely did students design their own investigations or work on extended projects. Apparently, working in groups is one of the only opportunities for students to communicate about mathematics, with teachers reporting incorporating this strategy in roughly 60 percent of the classrooms at least once a week.

Roughly 80 percent of high school mathematics classes reported using calculators and computers for learning or practicing skills at least once a week, while lower percentages reported using calculators or computers to develop conceptual understanding (61 percent) or as general tools in the classroom (38 percent).

Table 20
High School Mathematics 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	
Review homework/worksheet assignments	0	(0.1)	1	(0.3)	5	(1.1)	24	(1.6)	69	(1.9)
Answer textbook or worksheet questions	0	(0.1)	1	(0.4)	4	(0.9)	29	(1.7)	65	(1.9)
Listen and take notes during presentation by teacher	0	(0.1)	2	(0.5)	5	(1.1)	33	(1.8)	59	(1.9)
Use calculators or computers for learning or practicing skills	3	(0.8)	4	(0.8)	12	(1.1)	32	(1.7)	49	(2.0)
Practice routine computations/algorithms	1	(0.3)	5	(0.6)	18	(1.3)	45	(2.0)	30	(1.9)
Use calculators or computers to develop conceptual understanding	4	(0.9)	12	(1.3)	23	(1.5)	32	(1.7)	29	(1.8)
Follow specific instructions in an activity or investigation	1	(0.2)	5	(0.7)	23	(1.7)	43	(2.0)	28	(2.0)
Use mathematical concepts to interpret and solve applied problems	1	(0.3)	8	(0.8)	23	(1.4)	48	(1.9)	21	(1.5)
Work in groups	1	(0.3)	7	(1.2)	30	(1.7)	43	(1.9)	19	(1.6)
Use calculators or computers as a tool	19	(1.6)	21	(1.4)	22	(1.4)	21	(1.7)	17	(1.6)
Read from a mathematics textbook in class	11	(1.2)	27	(2.0)	28	(1.6)	23	(1.5)	11	(1.3)
Record, represent, and/or analyze data	5	(0.9)	24	(1.5)	38	(1.7)	26	(1.8)	6	(0.8)
Engage in mathematical activities using concrete materials	5	(0.8)	26	(1.9)	44	(1.9)	20	(1.4)	5	(0.5)
Design their *own* activity or investigation	26	(1.8)	45	(2.0)	23	(1.6)	4	(0.6)	2	(0.8)
Read other mathematics-related materials in class	29	(1.9)	44	(1.9)	20	(1.4)	5	(0.7)	1	(0.4)
Write reflections (e.g. in a journal)	56	(2.0)	27	(1.5)	11	(1.3)	5	(0.8)	1	(0.5)
Make formal presentations to the rest of the class	31	(1.9)	43	(2.1)	18	(1.5)	6	(0.9)	1	(0.2)
Work on extended mathematics investigations or projects	37	(1.9)	43	(1.9)	16	(1.3)	3	(0.6)	1	(0.2)

In addition to reporting on the frequency of using different instructional strategies in high school mathematics classrooms, teachers indicated which activities occurred in their most recent mathematics lessons. (See Table 21.) Students listened to lectures and participated in discussions in nearly 90 percent of the most recently taught lessons, and roughly 80 percent of the classes involved students completing textbook/worksheet problems and using calculators. There were significant differences between informal mathematics classes and advanced classes, with advanced classes more likely to involve calculator use and less likely to have students working on textbook and worksheet problems.

Table 21
High School Mathematics Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes							
	All		Informal Review		Formal Required		Formal Advanced	
Discussion	90	(1.0)	85	(3.3)	90	(1.6)	92	(1.3)
Lecture	89	(1.1)	90	(2.4)	86	(2.1)	91	(1.4)
Students completing textbook/worksheet problems	81	(1.7)	88	(2.5)	84	(2.0)	74	(1.3)
Students using calculators	79	(1.5)	72	(3.4)	73	(2.7)	89	(1.5)
Students working in small groups	54	(1.9)	47	(3.8)	58	(2.9)	53	(3.2)
Students doing hands-on/manipulative activities	19	(1.4)	17	(3.0)	20	(2.4)	17	(2.6)
Students reading about mathematics	16	(1.5)	11	(2.5)	15	(2.0)	18	(2.6)
Test or quiz	15	(1.2)	19	(3.4)	15	(1.9)	13	(1.9)
Students using computers	3	(0.7)	5	(2.1)	3	(0.8)	1	(0.7)
Students using other technologies	1	(0.2)	1	(0.8)	0	(0.2)	1	(0.4)
None of the above	0	(0.3)	0	—[§]	1	(0.6)	0	(0.1)

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

The mean composite scores in Table 22 show the prevalence of traditional teaching practices (e.g., lecture, worksheets, reviewing homework). In each type of course, these practices were more common than any others.

Disparities between different types of mathematics classes in the extent to which calculators and computers are used in instruction are captured in two of the composite variables shown in Table 22—Use of Calculators/Computers for Developing Concepts and Skills, and Use of Calculators/Computers for Investigation. In both instances, use of such technology was more common in advanced courses than in either informal review or formal required courses. These same data indicate that calculators and computers are much more likely to be used to develop concepts and skills (e.g., to demonstrate mathematical principles, to do drill and practice) than as tools for investigations (e.g., to collect data, to record or analyze data).

Table 22
Class Mean Scores for High School Mathematics Teaching Practice Composite Variables

	Mean Score							
	All		Informal Review		Formal Required		Formal Advanced	
Use of Traditional Teaching Practices	82	(0.5)	80	(1.2)	83	(0.7)	82	(0.6)
Use of Strategies to Develop Students' Ability to Communicate Ideas	69	(0.6)	68	(1.4)	70	(0.9)	70	(1.0)
Use of Calculators/Computers for Developing Concepts and Skills	68	(0.9)	61	(2.0)	63	(1.6)	76	(0.9)
Use of Calculators/Computers for Investigation	31	(0.7)	28	(1.9)	29	(1.2)	34	(1.0)

Based on teacher reports of the amount of time spent on various activities (Table 23), very little time appears to be available for students to collaborate and work together to strengthen their mathematics skills. The combination of whole class lecture/discussion and individual student activities (such as completing textbook problems) accounted for 62 percent of the time in a typical high school mathematics lesson; an additional 12 percent of instructional time is spent on non-instructional activities.

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

	Average Percent							
	All		Informal Review		Formal Required		Formal Advanced	
Whole class lecture/discussion	42	(0.9)	35	(1.7)	41	(1.3)	47	(1.5)
Individual students reading textbooks, completing worksheets, etc.	20	(0.8)	29	(2.2)	22	(1.3)	15	(1.0)
Non-manipulative small group work	15	(0.8)	13	(2.2)	14	(1.2)	15	(1.2)
Daily routines, interruptions, and other non-instructional activities	12	(0.3)	12	(0.6)	12	(0.4)	11	(0.6)
Working with hands-on/manipulative materials	5	(0.4)	5	(1.3)	5	(0.7)	4	(0.6)
Other activities	6	(0.6)	6	(1.1)	6	(0.7)	7	(0.8)

Resources Available for High School Mathematics Instruction

Mathematics teaching is likely to be affected by the quality and availability of instructional resources. The 2000 National Survey of Science and Mathematics Education included a series of items on mathematics textbooks/programs—which ones were being used, how much of the textbook was covered, and teachers' perceptions of textbook quality. Teachers were also asked about the availability and use of a number of other instructional resources, including various types of calculators, computers, and Internet capabilities. These results are presented in this section.

Textbook Usage

Teachers in the vast majority of high school mathematics classes report using one or more commercially-published textbook/program in their instruction. Of these teachers, nearly 80 percent of them reported using a single mathematics textbook or program. Textbooks published by Prentice Hall, Inc., McGraw-Hill/Merrill Co., and Houghton Mifflin Company and subsidiaries account for 63 percent of high school mathematics textbook usage; the most commonly used textbooks are shown by course in Table 24.

Table 24
Most Commonly Used
High School Mathematics Textbooks, by Course

	Publisher	Title
Algebra I	Prentice Hall, Inc.	*Algebra Tools for a Changing World*
	McGraw-Hill/Merrill Co.	*Algebra 1*
	Houghton Mifflin Company/McDougal Littell/ D.C. Heath	*Algebra 1: An Integrated Approach*
Geometry	Houghton Mifflin Company/McDougal Littell/ D.C. Heath	*Geometry: An Integrated Approach*
	Prentice Hall, Inc.	*Geometry Tools for a Changing World*
	Houghton Mifflin Company/McDougal Littell/ D.C. Heath	*Geometry*
	McGraw-Hill/Merrill Co.	*Geometry*
	Key Curriculum Press	*Discovering Geometry*
Algebra II	Prentice Hall, Inc.	*Advanced Mathematics: A Pre-Calculus Approach*
	Houghton Mifflin Company/McDougal Littell/ D.C. Heath	*Algebra 2: An Integrated Approach*
	McGraw-Hill/Merrill Co.	*Algebra 2 with Trig: Applications and Connections*
	McGraw-Hill/Merrill Co.	*Algebra 2*
Algebra III	McGraw-Hill/Merrill Co.	*Advanced Mathematical Concepts: Pre-Calculus with Applications*
	Prentice Hall, Inc.	*Advanced Mathematics: A Pre-Calculus Approach*

Teachers were asked to rate the quality of the textbooks they used. As can be seen in Table 25, overall, 42 percent of high school mathematics teachers rated their textbooks very good or excellent, including 49 percent of the advanced classes but only 28 percent of the informal review classes. According to teachers, the typical high school mathematics class covers at least 75 percent of the textbook. (See Table 26.)

Table 25
High School Mathematics Teachers' Perceptions of
Quality of Textbooks/Programs Used in Mathematics' Classes

	Percent of Classes							
	All		Informal Review		Formal Required		Formal Advanced	
Very Poor	1	(0.2)	1	(0.5)	1	(0.3)	0	(0.2)
Poor	3	(0.6)	5	(1.8)	3	(1.0)	3	(0.8)
Fair	19	(1.7)	29	(4.2)	20	(2.7)	14	(1.9)
Good	35	(2.2)	37	(4.3)	36	(3.0)	33	(3.4)
Very Good	34	(2.0)	26	(3.8)	33	(3.0)	39	(2.8)
Excellent	8	(1.0)	2	(0.9)	8	(1.6)	10	(1.6)

Table 26
Percentage of High school Mathematics Textbooks/Programs Covered During the Course

	Percent of Classes							
	All		Informal Review		Formal Required		Formal Advanced	
Less than 25 percent	1	(0.2)	1	(0.8)	0	(0.3)	1	(0.3)
25–49 percent	6	(0.7)	9	(2.4)	3	(0.9)	7	(1.2)
50–74 percent	28	(1.9)	25	(3.8)	23	(2.8)	36	(2.8)
75–90 percent	46	(2.1)	49	(4.1)	48	(3.5)	43	(3.2)
More than 90 percent	19	(1.5)	16	(3.0)	25	(2.7)	13	(1.8)

Facilities and Equipment

High school mathematics teachers were given a list of equipment and asked to indicate whether each type of equipment is used in the randomly selected class. Table 27 shows the percentage of high school mathematics classes reporting at least some use of each type of equipment, as well as the percentages of classes where each is "needed, but not available" or "not needed."

High school mathematics teachers apparently consider their classrooms to be well equipped; in most cases fewer than 5 percent of teachers expressed a need for a particular kind of equipment for their classes and indicated it was not available to them. The only exception was in the category of "calculator/computer lab interfacing devices" where 10 percent of high school mathematics classes needed the equipment, but it was not available.

Note that the overhead projector is one of the most popular pieces of equipment in the high school mathematics classroom, with 88 percent of classes using it as an instructional tool. Overall, graphing and scientific calculators are more likely to be used than are four-function and fraction calculators, although there are substantial differences in how calculators are used in different types of classes. For example, four-function and fraction calculators were reported as being used to a greater extent in informal review courses and required courses than in advanced courses. Graphing calculators, on the other hand, were least likely to be used in informal review courses (45 percent) and most likely to be used in advanced courses (94 percent).

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

	Percent of Classes							
	All		Informal Review		Formal Required		Formal Advanced	
Overhead projector								
Not needed	12	(1.4)	17	(3.4)	12	(2.4)	9	(2.0)
Needed, but not available	0	(0.3)	1	(1.4)	0	—[§]	0	(0.1)
Used	88	(1.4)	82	(3.3)	88	(2.4)	91	(2.1)
Videotape player								
Not needed	57	(2.0)	57	(4.6)	54	(3.3)	59	(3.6)
Needed, but not available	0	(0.1)	0	(0.1)	0	(0.3)	0	(0.1)
Used	43	(2.0)	43	(4.6)	46	(3.3)	41	(3.6)
Videodisc player								
Not needed	94	(1.2)	96	(1.5)	96	(1.2)	91	(2.7)
Needed, but not available	3	(0.7)	2	(1.1)	2	(1.1)	3	(1.3)
Used	3	(1.0)	2	(1.0)	2	(0.5)	6	(2.4)
CD-ROM player								
Not needed	76	(2.2)	77	(4.1)	74	(3.5)	76	(2.9)
Needed, but not available	3	(0.8)	3	(1.2)	4	(1.7)	3	(0.8)
Used	21	(2.2)	20	(4.0)	22	(3.5)	21	(2.9)
Four-function calculator								
Not needed	34	(1.9)	26	(4.4)	28	(2.9)	45	(3.8)
Needed, but not available	1	(0.3)	2	(1.0)	1	(0.4)	1	(0.5)
Used	65	(1.9)	72	(4.4)	71	(2.9)	54	(3.8)
Fraction calculators								
Not needed	39	(2.0)	28	(4.5)	35	(3.0)	50	(3.6)
Needed, but not available	1	(0.3)	2	(0.7)	1	(0.6)	0	(0.2)
Used	60	(2.0)	71	(4.5)	64	(3.0)	50	(3.6)
Graphing calculators								
Not needed	20	(1.7)	54	(4.6)	21	(2.8)	4	(1.8)
Needed, but not available	2	(0.8)	1	(0.5)	3	(1.1)	2	(1.1)
Used	78	(1.9)	45	(4.5)	76	(2.9)	94	(2.2)
Scientific calculators								
Not needed	22	(1.6)	26	(4.4)	20	(2.6)	22	(2.4)
Needed, but not available	1	(0.3)	1	(1.0)	1	(0.4)	0	(0.2)
Used	77	(1.6)	73	(4.2)	79	(2.6)	78	(2.4)
Computers								
Not needed	35	(2.3)	39	(5.5)	33	(3.0)	35	(3.8)
Needed, but not available	5	(0.9)	7	(2.1)	5	(1.3)	5	(1.2)
Used	60	(2.3)	54	(5.4)	62	(3.1)	60	(3.8)
Calculator/computer lab interfacing devices								
Not needed	58	(2.3)	69	(4.3)	57	(3.0)	54	(4.2)
Needed, but not available	10	(1.0)	8	(2.5)	9	(1.7)	11	(2.0)
Used	32	(2.0)	23	(3.4)	34	(3.0)	35	(3.8)
Computers with Internet connection								
Not needed	54	(2.4)	62	(5.1)	53	(3.8)	53	(3.5)
Needed, but not available	5	(0.8)	5	(1.9)	4	(1.1)	6	(1.2)
Used	41	(2.3)	33	(4.8)	43	(3.6)	41	(3.3)

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

Summary

Overall, the high school mathematics teacher workforce has a higher percentage of females than males and lacks minority representation equal to that of the population of students served. The age distribution and experience levels of high school mathematics teachers suggest that many may be retiring within the next ten years.

Most high school mathematics teachers have had substantial coursework in their field. For example, nearly 60 percent of the teachers reported having an undergraduate degree in mathematics, with an additional 22 percent having an undergraduate degree in mathematics education. Further, close to 95 percent of high school mathematics teachers have taken coursework that roughly equates to a minor in the field of mathematics. However, data on content preparation for teachers of informal mathematics courses show somewhat weaker content backgrounds. In comparison to teachers of required and advanced elective mathematics courses, teachers of informal courses were less likely to have taken coursework in a number of areas.

In the area of pedagogical preparedness, more than half of high school mathematics teachers reported being at least fairly familiar with the NCTM *Standards*, and roughly 75 percent of those that were familiar with the *Standards* agreed with their vision and indicated that they were implementing them in their classrooms. High percentages of the teachers reported feeling well prepared to encourage students' interest in mathematics, particularly female students. Areas of lower preparedness included being able to incorporate instructional strategies that involved the use of the Internet and to teach students who have limited English proficiency. Although data were fairly consistent across teaching assignments, there were a few differences between teachers of advanced mathematics courses and their colleagues teaching informal mathematics courses. Teachers of informal mathematics courses were less likely to report feeling well prepared for developing students' conceptual understanding and for using calculators/computers for various purposes.

Data on high school mathematics teachers' professional development needs and participation indicate a need for many of them to retool; nearly 60 percent of these teachers have spent less than 35 hours on professional development over the previous three years.

High school mathematics teachers reported placing heavy emphasis on mathematics concepts and reasoning. However, the typical high school mathematics class spends the highest percentages of time solving worksheet or textbook problems, reviewing homework and worksheet assignments, and practicing routine computation and algorithms, which do not seem to strongly support the development of mathematics concepts and reasoning. In addition, instructional activities that focus on strengthening students' ability to effectively communicate mathematical ideas or carry out investigations are used infrequently.

When looking at mathematics instruction across teaching assignments, there are numerous differences between the way informal mathematics courses and advanced courses are taught. Disturbingly, teachers of informal review courses were less likely to report emphasizing mathematical reasoning, less likely to report focusing on the nature of mathematics, less likely to

incorporate calculators and computers in their instruction, and less likely to focus on preparing their students for further study in mathematics. Instead, teachers of informal mathematics reported placing a higher emphasis on developing students' computational skills, preparing students for standardized tests, and focusing on basic mathematics skills. These data expose a very different learning experience for students enrolled in informal review courses, with instruction geared much more toward rote skills and very little preparation for a future career in any field related to mathematics.

Overall, high school mathematics teachers seem satisfied with their textbooks and reported needing very little in the way of instructional equipment. Overhead projectors were reported as being heavily used as instructional tools, and calculator usage varied depending on the type of course. Teachers of informal review courses were less likely to report needing graphing calculators and reported using four-function and fraction calculators more than did their colleagues teaching advanced courses.

References

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 1989.

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 High School Mathematics Categories

Informal Review

- Algebra 1A (1st of a two-year sequence for Algebra 1)
- Applied Math
- Basic Geometry
- Basic Math
- Business Math
- Career Math
- Comprehensive Math
- Consumer Math
- Developmental Math
- General Math
- High School Arithmetic
- Informal Geometry
- Introductory Algebra
- Practical Geometry
- Pre-Algebra
- Remedial Math
- Technical Math
- Vocational Math

Formal Required

- Algebra 1B (2nd of a two-year sequence for Algebra 1)
- Algebra 1
- Beginning
- Elementary
- Geometry
- Integrated Math 1
- Integrated Math 2
- Math B
- Math C
- Plane Geometry
- Solid Geometry
- Unified Math I
- Unified Math II

Formal Advanced

- Abstract Algebra
- Advanced Placement Calculus (AB, BC)
- Advanced Placement Statistics
- Algebra 2
- Algebra 3
- Algebra and Trigonometry
- Analytic/Advanced Geometry
- Calculus
- College Algebra
- College Prep Senior Math
- Differential Equations
- Discrete Math
- Elementary Functions
- Finite Math
- Integrated Math 3
- Intermediate Algebra
- Introduction to College Math
- Linear Algebra
- Math IV
- Multivariate Calculus
- Number Theory
- Numerical Analysis
- Pre-Calculus
- Probability
- Statistics
- Theory of Equations
- Trigonometry
- Unified Math III
- Vectors/Matrix Algebra

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

Table A-1
Mathematics 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 mathematics	Q3b
Provide deeper coverage of fewer mathematics concepts	Q3c
Make connections between mathematics 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)	**0.86**

Table A-2
Mathematics Teacher Preparedness to
Teach Students from Diverse Backgrounds

Recognize and respond to student cultural diversity	Q3l
Encourage students' interest in mathematics	Q3m
Encourage participation of females in mathematics	Q3n
Encourage participation of minorities in mathematics	Q3o
Number of Items in Composite	**4**
Reliability (Cronbach's Coefficient Alpha)	**0.80**

Table A-3
Mathematics Teacher Preparedness to Use Calculators/Computers

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

Table A-4
Mathematics Teacher Preparedness to Use the Internet

Use the Internet in your mathematics teaching for general reference	Q3v
Use the Internet in your mathematics teaching for data acquisition	Q3w
Use the Internet in your mathematics teaching for collaborative projects with classes/individuals in other schools	Q3x
Number of Items in Composite	**3**
Reliability (Cronbach's Coefficient Alpha)	**0.90**

Table A-5
Nature of Mathematics Objectives

Understand the logical structure of mathematics	Q23i
Learn about the history and nature of mathematics	Q23j
Learn how to explain ideas in mathematics effectively	Q23k
Learn how to apply mathematics in business and industry	Q23l
Number of Items in Composite	**4**
Reliability (Cronbach's Coefficient Alpha)	**0.73**

Table A-6
Basic Mathematics Skills Objectives

Develop students' computational skills	Q23d
Learn to perform computations with speed and accuracy	Q23m
Prepare for standardized tests	Q23n
Number of Items in Composite	**3**
Reliability (Cronbach's Coefficient Alpha)	**0.69**

Table A-7
Mathematics Reasoning Objectives

Learn mathematical concepts	Q23b
Learn how to solve problems	Q23e
Learn to reason mathematically	Q23f
Learn how mathematics ideas connect with one another	Q23g
Number of Items in Composite	**4**
Reliability (Cronbach's Coefficient Alpha)	**0.75**

Table A-8
Use of Traditional Teaching Practices

Introduce content through formal presentations	Q24a
Assign science/mathematics homework	Q24j
Listen and take notes during presentation by teacher	Q25a
Read from a science/mathematics textbook in class	Q25c
Practice routine computations/algorithms	Q25f
Review homework/worksheet assignments	Q25g
Answer textbook or worksheet questions	Q25k
Review student homework	Q27f
Number of Items in Composite	**8**
Reliability (Cronbach's Coefficient Alpha)	**0.74**

Table A-9
Use of Strategies to Develop Students' Abilities to Communicate Ideas

Pose open-ended questions	Q24b
Engage the whole class in discussions	
Require student to explain their reasoning when giving an answer	Q24d
Ask students to explain concepts to one another	Q24e
Ask students to consider alternative methods for solutions	Q24f
Ask students to use multiple representations (e.g., numeric, graphic, geometric, etc.)	Q24g
Help students see connections between science/mathematics and other disciplines	Q24h
Number of Items in Composite	**6**
Reliability (Cronbach's Coefficient Alpha)	**0.77**

Table A-10
Use of Calculators/Computers for Investigations

Record, represent, and/or analyze data	Q25l
Use calculators or computers as a tool (e.g., spreadsheets, data analysis)	Q25r
Do simulations	Q26d
Collect data using sensors or probes	Q26e
Retrieve or exchange data	Q26f
Solve problems using simulations	Q26g
Number of Items in Composite	**6**
Reliability (Cronbach's Coefficient Alpha)	**0.85**

Table A-11
Use of Calculators/Computers for Developing Concepts and Skills

Use calculators or computers for learning or practicing skills	Q25p
Use calculators or computers to develop conceptual understanding	Q25q
Do drill and practice	Q26a
Demonstrate mathematics principles	Q26b
Take a test or quiz	Q26h
Use graphing calculators	Q28g3
Number of Items in Composite	**6**
Reliability (Cronbach's Coefficient Alpha)	**0.86**