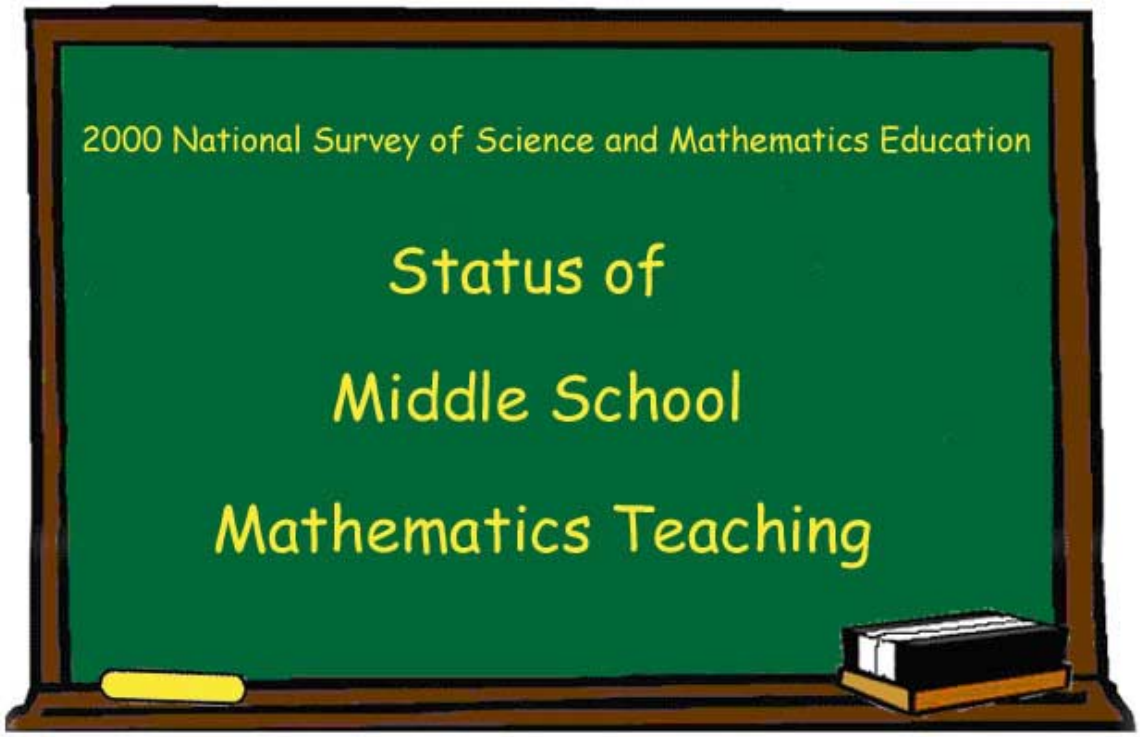

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Status of Middle School Mathematics Teaching

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 middle school (grades 6–8) mathematics instruction based on the responses of 634 middle school mathematics 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.

This report is organized by the following major topical areas:

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

Characteristics of the Middle School Mathematics Teaching Force

General Demographics

As can be seen in Table 1, over 70 percent of middle school mathematics teachers are female. Blacks, Hispanics, and other minority groups appear to be underrepresented in the middle school mathematics teaching force, representing roughly 15 percent of teachers. Forty-four percent of middle school mathematics teachers have received a Master's Degree.

The distribution of middle school mathematics teachers according to age is quite balanced, with roughly 25 percent of teachers constituting each of the age groups. However, the fact that nearly one-third of the teachers responding indicated having more than 20 years experience suggests that many middle school mathematics teachers may be retiring over the next 10 years.

Table 1
Characteristics of the
Middle School Mathematics Teaching Force

	Percent of Teachers	
Sex		
Male	28	(3.3)
Female	72	(3.3)
Race		
American Indian or Alaskan Native	1	(0.4)
Asian	1	(0.3)
Black or African-American	9	(2.6)
Hispanic or Latino	4	(1.5)
Native Hawaiian or Other Pacific Islander	0	(0.2)
White	85	(2.9)
Age		
$\leq$ 30 years	25	(3.2)
31–40 years	23	(2.8)
41–50 years	26	(3.0)
51+ years	26	(3.4)
Experience		
0–2 years	20	(3.2)
3–5 years	13	(2.1)
6–10 years	13	(1.8)
11–20 years	25	(3.1)
$\geq$ 21 years	29	(3.5)
Master's Degree		
Yes	44	(3.3)
No	56	(3.3)

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.

Roughly three-fourths of middle school mathematics teachers received their undergraduate degrees in areas other than mathematics or mathematics education. (See Table 2.) However, data in Table 3 indicate that nearly two-thirds of them (63 percent) have taken eight or more courses in the field, suggesting the equivalent of at least a minor. This percentage of teachers represents roughly 75 percent of the middle school classes in the survey, suggesting that nearly 3 out of every 4 middle school classrooms are taught by teachers with at least a minor in mathematics or mathematics education.

Table 2
Undergraduate Majors of
Middle School Mathematics Teachers†

	Percent of Teachers	
Mathematics	16	(1.7)
Mathematics Education	10	(1.4)
Other Education	65	(3.1)
Other Fields	9	(1.9)

† 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.

Table 3
Number of Semesters† of College Coursework in Mathematics
Taken by Middle School Mathematics Teachers, by Teachers and Classes

	Percent of Teachers		Percent of Classes	
Fewer than 4 Semesters	9	(2.5)	4	(1.2)
4–7 Semesters	28	(3.8)	22	(3.1)
8–11 Semesters	26	(3.4)	27	(3.2)
More than 11 Semesters	37	(3.4)	47	(3.2)

† 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 middle school mathematics teachers report taking in college. Data indicate that the vast majority of teachers have had college coursework in general teaching methods (92 percent) and methods of teaching mathematics (78 percent). A closer look at the courses teachers reported taking in college reveals some gaps in their preparation, in areas recommended by the National Council of Teachers of Mathematics (NCTM). NCTM's standards documents have always called for the introduction of challenging mathematics content to all students. If teachers are to guide students in their exploration of mathematics concepts, they must themselves have a firm grasp of powerful mathematics concepts.

Table 4
Middle School Mathematics Teachers
Completing Various College Courses

	Percent of Teachers	
General methods of teaching	92	(2.1)
Methods of teaching mathematics	78	(3.5)
Supervised student teaching in mathematics	47	(3.8)
Mathematics for middle school teachers	45	(3.5)
Instructional uses of computers/other technologies	43	(3.5)
Geometry for elementary/middle school teachers	36	(3.2)
College algebra/trigonometry/elementary functions	66	(3.5)
Probability and statistics	56	(4.1)
Geometry	47	(3.9)
Computer programming or other computer science	45	(3.6)
Calculus	43	(3.1)
Computer programming	32	(2.9)
Linear algebra	28	(3.1)
Number theory	27	(3.3)
Applications of mathematics/problem solving	27	(2.6)
Other upper division mathematics	25	(2.5)
Other computer science	23	(3.3)
Abstract algebra	22	(2.3)
Advanced calculus	21	(2.1)
Differential equations	19	(2.1)
History of mathematics	16	(2.1)
Discrete mathematics	12	(1.5)
Real analysis	11	(1.9)
Engineering (any)	6	(1.4)

NCTM has recommended that middle 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 Table 4 shows, the percentages of middle school teachers having completed courses in these areas range from 56 percent for probability and statistics to 16 percent for history of mathematics. Further, data in Table 5 indicate that roughly 1 out of every 4 middle school mathematics teachers has not had any of the six recommended mathematics courses, while only 11 percent have had coursework in five or six of the recommended areas. These data may be the result of the way many undergraduate teacher preparation programs are designed. For example, while only 16 percent of the teachers reported taking a course in the history of mathematics, many more teachers may have had content in the area as part of a course with a broader purpose. Nevertheless, these data raise concerns about the overall capacity of the middle school mathematics teaching force to teach rigorous and relevant mathematics content.

Table 5
Middle School Teachers Completing a Number of NCTM-Recommended Mathematics Courses in College

	Percent of Teachers	
None	24	(3.0)
1–2 Courses	37	(3.8)
3–4 Courses	28	(2.8)
5–6 Courses	11	(1.4)

Knowing the extent of teachers' course backgrounds provides useful information about the preparation of the nation's middle 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, middle school mathematics teachers feel prepared to teach the traditional content and skills that are part of the curriculum. For example, the vast majority of middle school teachers reported being at least adequately prepared to teach topics such as numeration and number theory, computation, estimation, and measurement. (See Table 6.)

More than 40 percent of middle school mathematics teachers do not feel adequately qualified to teach functions and statistics. Although there may be reason for concern given the importance of both topics in the middle school curriculum, the inclusion of predominantly high school content as part of the parenthetical text for each question, i.e. trigonometric functions and regression, might have led fewer teachers to report feeling confident regarding their ability to teach the topic. Also, 32 percent of teachers reported feeling not well qualified to use technology to support their mathematics instruction.

Over 50 percent of middle school teachers do not feel well qualified to teach topics focused on mathematical structures (e.g., vector spaces, group, rings, and fields) and topics from discrete mathematics. Further, over three-fourths of middle school mathematics teachers do not feel well qualified to teach calculus. However, these areas are more peripheral to the content included in the middle school mathematics curriculum.

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

	Percent of Teachers					
	Not Well Qualified		Adequately Qualified		Very Well Qualified	
Numeration and number theory	1	(0.6)	21	(3.9)	78	(4.0)
Computation	0	(0.1)	8	(1.5)	92	(1.5)
Estimation	0	(0.2)	14	(2.4)	85	(2.4)
Measurement	1	(0.6)	15	(2.7)	84	(2.7)
Pre-algebra	1	(0.4)	19	(4.5)	80	(4.5)
Algebra	9	(2.1)	33	(4.4)	57	(4.4)
Patterns and relationships	1	(0.6)	25	(4.2)	74	(4.2)
Geometry and spatial sense	3	(0.8)	37	(4.1)	60	(4.2)
Functions (including trigonometric functions) and pre-calculus concepts	46	(4.3)	34	(3.5)	21	(2.5)
Data collection and analysis	3	(0.7)	37	(3.6)	60	(3.7)
Probability	5	(1.0)	45	(4.2)	51	(4.1)
Statistics (e.g., hypothesis tests, curve fitting and regression)	37	(3.5)	43	(4.3)	20	(2.9)
Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)	57	(3.7)	32	(4.0)	10	(2.1)
Mathematical structures (e.g., vector spaces, groups, rings, fields)	63	(3.8)	30	(3.9)	7	(1.9)
Calculus	77	(2.6)	18	(2.4)	5	(1.1)
Technology (calculators, computers) in support of mathematics	32	(3.8)	48	(3.7)	20	(2.8)

Pedagogical Preparedness

The National Council of Teachers of Mathematics originally published *Curriculum and Evaluation Standards for School Mathematics* in 1989, followed by *Professional Standards for Teaching Mathematics* in 1991. 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 these documents. As can be seen in Table 7, 60 percent of middle school mathematics teachers reported being at least fairly familiar with the NCTM *Standards*. In addition, roughly three-fourths of 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
Middle School Mathematics Teachers' Familiarity with, Agreement with, and Implementation of the NCTM *Standards*

	Percent of Teachers	
Familiarity with NCTM *Standards*		
Not at all familiar	17	(3.2)
Somewhat familiar	23	(3.5)
Fairly familiar	37	(3.3)
Very familiar	23	(2.6)
Extent of agreement with NCTM *Standards*†		
Strongly Disagree	1	(0.3)
Disagree	3	(0.8)
No Opinion	21	(4.4)
Agree	64	(4.6)
Strongly Agree	12	(3.2)
Extent to which recommendations have been implemented†		
Not at all	1	(0.2)
To a minimal extent	20	(4.0)
To a moderate extent	54	(4.2)
To a great extent	25	(3.3)

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

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

Ninety-five percent of middle school mathematics teachers consider themselves well prepared to encourage female participation and 89 percent to encourage minority participation in mathematics. Roughly 90 percent of the teachers reported feeling well prepared to listen and ask their students questions to gauge their understanding of mathematics, and to develop students' conceptual understanding of mathematics.

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 additional professional development for middle school mathematics teachers if that goal is to be achieved, especially in the area of Internet usage in the classroom. Although 80 percent of teachers reported feeling well prepared to use calculators and computers for drill and practice, only about one-third of them reported feeling well prepared to have students use the Internet for general reference or data acquisition. (See Table 8.) Similarly, even fewer teachers reported feeling well prepared to use the Internet for collaborative projects.

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

	Percent of Teachers	
Encourage participation of females in mathematics	95	(1.1)
Listen/ask questions as students work in order to gauge their understanding	91	(2.8)
Encourage participation of minorities in mathematics	89	(1.8)
Develop students' conceptual understanding of mathematics	88	(2.6)
Encourage students' interest in mathematics	87	(3.5)
Have students work in cooperative learning groups	86	(2.0)
Take students' prior understanding into account when planning curriculum and instruction	82	(3.2)
Make connections between mathematics and other disciplines	81	(3.5)
Use calculators/computers for drill and practice	80	(3.0)
Provide deeper coverage of fewer mathematics concepts	78	(3.5)
Manage a class of students engaged in hands-on/project-based work	77	(3.5)
Teach groups that are heterogeneous in ability	77	(3.3)
Use the textbook as a resource rather than the primary instructional tool	71	(3.7)
Use calculators/computers for mathematics learning games	71	(2.9)
Lead a class of students using investigative strategies	69	(3.6)
Use calculators/computers to collect and/or analyze data	65	(3.3)
Recognize and respond to student cultural diversity	64	(3.6)
Use calculators/computers to demonstrate mathematics principles	63	(3.4)
Involve parents in the mathematics education of their children	54	(3.6)
Use calculators/computers for simulations and applications	50	(3.6)
Use the Internet in your mathematics teaching for general reference	37	(3.2)
Use the Internet in your mathematics teaching for data acquisition	33	(3.1)
Teach students who have limited English proficiency	22	(2.5)
Use the Internet in your mathematics teaching for collaborative projects with classes/individuals in other schools	22	(2.9)

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

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 middle school mathematics teachers are least likely to feel prepared in technology-related areas. (See Table 9.)

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

	Mean Score	
Teach Students from Diverse Backgrounds	76	(1.4)
Use Standards-Based Teaching Practices	72	(1.5)
Use Calculators/Computers	62	(2.0)
Use the Internet	35	(2.3)

Professional Development of Middle School Mathematics Teachers

When asked about areas of need for professional development related to teaching mathematics, 80 percent of middle school teachers indicated at least a moderate need for professional development in the use of technology in mathematics instruction. Nearly half of the teachers indicated a need for more professional development on understanding student thinking, while just over 30 percent felt the need for more professional development focused on deepening their mathematics content knowledge. (See Table 10.) The data suggest that middle school teachers are more confident in their command of the mathematics content necessary for teaching middle grades than their ability to apply the content through various aspects of instruction or understand the different ways students think about the content.

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

	Percent of Teachers	
Learning how to use technology in mathematics instruction	80	(2.5)
Learning how to use inquiry/investigation-oriented teaching strategies	65	(3.2)
Learning how to teach mathematics in a class that includes students with special needs	60	(3.4)
Understanding student thinking in mathematics	46	(3.7)
Learning how to assess student learning in mathematics	36	(3.6)
Deepening my own mathematics content knowledge	31	(3.5)

Middle school mathematics teachers report low levels of participation in professional development specific to mathematics teaching; only about one-third have spent more than 35 hours in mathematics-related professional development in the previous three years. (See Table 11.)

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

	Percent of Teachers	
None	11	(3.4)
Less than 6 hours	12	(2.5)
6–15 hours	20	(2.7)
16–35 hours	27	(3.7)
More than 35 hours	31	(3.4)

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 76 percent of middle school mathematics teachers have attended a workshop on mathematics teaching in the previous three years. Collaborating with teachers locally, including observing their classrooms and meeting regularly to discuss

issues related to mathematics teaching, were mentioned by slightly over 50 percent of the teachers as professional development activities in which they have participated in the previous three years. Fewer than one-third of the teachers reported attending a state or national mathematics teachers meeting, and only 24 percent reported taking a formal college/university mathematics course in the previous three years.

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

	Percent of Teachers	
Attended a workshop on mathematics teaching	76	(3.3)
Observed other teachers teaching mathematics as part of your own professional development (formal or informal)	57	(3.8)
Met with a local group of teachers to study/discuss mathematics teaching issues on a regular basis	53	(3.5)
Attended a national or state mathematics teacher association meeting	29	(3.6)
Taken a formal college/university course in the teaching of mathematics	24	(3.1)
Taken a formal college/university mathematics course	21	(2.5)
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	15	(2.7)
Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications	9	(1.6)

A closer look at the data on most recent college coursework (Table 13) indicates that almost half (46 percent) of middle school mathematics teachers have not taken a college/university mathematics course since 1990. Twelve percent of middle school mathematics teachers have had no college coursework in mathematics education and another 35 percent have not taken a course on how to teach mathematics since 1990. Given the tremendous amount of change the mathematics education field has experienced since 1990, these data seem to indicate a serious need for retooling a high percentage of the middle school mathematics teaching force.

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

	Percent of Teachers	
Mathematics		
1996–2000	30	(3.8)
1990–1995	24	(2.5)
Prior to 1990	46	(3.7)
The Teaching of Mathematics		
1996–2000	35	(4.1)
1990–1995	18	(2.3)
Prior to 1990	35	(3.4)
Never	12	(2.4)
Mathematics or the Teaching of Mathematics		
1996–2000	44	(4.1)
1990–1995	21	(2.3)
Prior to 1990	36	(3.5)

Middle 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 40 percent of them indicated that their professional development experiences emphasized learning how to use technology in mathematics instruction. Deepening mathematics content knowledge was mentioned by only 20 percent of responding teachers as receiving a high emphasis.

Table 14
Middle School Mathematics Teachers Reporting That Their Professional Development Gave Heavy Emphasis to Various Areas

	Percent of Teachers	
Learning how to use technology in mathematics instruction	38	(4.2)
Understanding student thinking in mathematics	35	(4.0)
Learning how to use inquiry/investigation-oriented teaching strategies	35	(4.2)
Learning how to assess student learning in mathematics	29	(3.3)
Deepening my own mathematics content knowledge	20	(2.6)
Learning how to teach mathematics in a class that includes students with special needs	12	(1.8)

Middle School Mathematics Classes Offered

The typical middle school mathematics class has approximately 22 students, with roughly equal percentages of male and female students. Non-Asian minorities make up 28 percent of the typical middle school mathematics classroom.

As can be seen in Table 15, 38 percent of middle school mathematics classes are heterogeneous in ability and 31 percent are considered "average" in ability.

Table 15
Ability Grouping in Middle School Mathematics Classes

	Percent of Classes	
Fairly homogenous and low in ability	11	(1.5)
Fairly homogenous and average in ability	31	(2.8)
Fairly homogenous and high in ability	20	(2.4)
Heterogeneous, with a mixture of two or more ability levels	38	(3.2)

Middle School Mathematics Instruction

This section draws on teachers' descriptions of what transpires in middle school mathematics 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 16, the vast majority of middle school mathematics teachers (88 percent) report placing a heavy emphasis on student learning of mathematical concepts, followed by learning how to solve problems (81 percent) and learning to reason mathematically (71 percent). In slightly over 50 percent of the classes, teachers reported placing heavy emphasis on algorithms and procedures, while roughly one-third reported focusing heavily on preparing students for standardized tests. Teaching students about the history and nature of mathematics was least likely to be reported as receiving a heavy emphasis.

Table 16
Middle School Mathematics Classes with Heavy Emphasis on Various Instructional Objectives

	Percent of Classes	
Learn mathematical concepts	88	(2.2)
Learn how to solve problems	81	(2.2)
Learn to reason mathematically	71	(2.9)
Learn how mathematics ideas connect with one another	58	(3.1)
Learn mathematical algorithms/procedures	57	(2.9)
Develop students' computational skills	57	(2.7)
Prepare for further study in mathematics	52	(3.0)
Learn to explain ideas in mathematics effectively	42	(2.9)
Increase students' interest in mathematics	42	(2.9)
Prepare for standardized tests	34	(2.5)
Understand the logical structure of mathematics	33	(3.1)
Learn to perform computations with speed and accuracy	30	(2.8)
Learn how to apply mathematics in business and industry	20	(2.4)
Learn about the history and nature of mathematics	3	(0.9)

Composite variables were created from the list of objectives in Table 16. The three composites are shown here with the objectives that comprise them:

Mathematics Reasoning
- Learn mathematical concepts
- Learn how to solve problems
- Learn 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

Teachers reported that mathematics reasoning objectives were much more likely to receive heavy emphasis than objectives centered around the learning of basic mathematics skills. However, nature of mathematics objectives were least likely to be reported as ones receiving heavy

emphasis in instruction. In some ways, these data reflect the spirit of the *Standards* and serve as evidence that teachers may be philosophically aligned with the instructional objectives the *Standards* encourage.

Table 17
Mean Composite Scores Related to
Middle School Mathematics Class Objectives

	Mean Score	
Mathematics Reasoning	91	(0.7)
Basic Mathematics Skills	72	(1.2)
Nature of Mathematics	61	(1.1)

Class Activities

The 2000 National Survey of Science and Mathematics Education provides three sources of information about how mathematics is taught at the middle school level. One series of items listed various instructional strategies and asked teachers to indicate the frequency with which they used each in a randomly selected class. 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.

Data in Table 17 showed that teachers report placing heavy emphasis on mathematics reasoning and conceptual understanding. However, data in Tables 18–20 indicate that the predominant instructional strategies involve students answering textbook or worksheet questions and reviewing homework and worksheet assignments, with over 90 percent of middle school classes incorporating these activities at least once a week in their randomly selected mathematics class. Additionally, close to 80 percent of the teachers reported having students follow specific instructions in an activity, as well as having them practicing routine computations and algorithms at least once a week. Such high percentages for these instructional strategies may be an indication that teachers are heavily relying on rote computational practice and drill to strengthen students' conceptual understanding and reasoning abilities in mathematics, although such strategies may not be best suited for those purposes.

Table 18
Middle 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	(0.4)	5	(1.1)	22	(2.2)	71	(2.6)
Answer textbook or worksheet questions	0	(0.1)	3	(1.5)	6	(1.0)	30	(2.6)	61	(2.9)
Listen and take notes during presentation by teacher	4	(1.5)	7	(1.7)	15	(2.1)	38	(2.9)	37	(2.4)
Practice routine computations/algorithms	1	(0.4)	7	(1.4)	15	(2.2)	43	(2.6)	35	(2.9)
Follow specific instructions in an activity or investigation	0	(0.1)	3	(0.9)	18	(1.7)	44	(2.9)	34	(3.0)
Use mathematical concepts to interpret and solve applied problems	0	(0.1)	4	(1.1)	25	(2.1)	47	(3.0)	24	(2.8)
Use calculators or computers for learning or practicing skills	3	(0.9)	11	(1.8)	28	(2.7)	39	(2.8)	19	(2.1)
Work in groups	0	(0.2)	6	(1.2)	33	(2.9)	47	(3.1)	14	(1.9)
Use calculators or computers to develop conceptual understanding	6	(1.1)	19	(2.6)	29	(3.0)	33	(2.6)	13	(1.8)
Read from a mathematics textbook in class	8	(1.7)	21	(2.3)	27	(2.9)	32	(3.1)	13	(1.9)
Engage in mathematical activities using concrete materials	1	(0.4)	10	(1.8)	46	(3.1)	37	(3.1)	7	(1.5)
Use calculators or computers as a tool	19	(2.2)	29	(2.7)	25	(2.5)	20	(2.1)	7	(1.3)
Record, represent, and/or analyze data	0	(0.2)	13	(1.9)	42	(3.3)	38	(3.3)	6	(1.5)
Write reflections	35	(2.9)	29	(2.3)	21	(2.7)	11	(1.9)	4	(1.1)
Read other mathematics-related materials in class	15	(2.1)	41	(2.7)	30	(2.6)	13	(1.7)	2	(0.6)
Make formal presentations to the rest of the class	19	(2.3)	47	(2.8)	24	(2.9)	9	(1.9)	1	(0.3)
Design their *own* activity or investigation	13	(1.6)	41	(2.8)	37	(2.8)	8	(1.5)	1	(0.7)
Work on extended mathematics investigations or projects	22	(2.6)	46	(2.9)	25	(2.4)	6	(1.3)	1	(0.4)

Activities that focused more on students strengthening their ability to communicate mathematical ideas or carry out mathematical investigations are less frequent. In 35 percent of middle school mathematics classes, students never write reflections, while in nearly two-thirds, mathematics students make formal presentations no more than a few times a year. Similarly, having students design their own investigations or work on extended projects were rarely incorporated in middle school mathematics instruction, with 54 percent and 68 percent of classes, respectively, having students do these activities no more than a few times a year. This seems to leave working in groups as one of the only opportunities for students to talk and write about mathematics, with 61 percent of the classes having students work in groups at least once a week.

In addition to reporting on the frequency of using different instructional strategies, middle school mathematics teachers indicated which activities occurred in the most recent lesson in their randomly selected class. Having students complete textbook/worksheet problems and listen to lectures occurred in nearly 80 percent of the lessons. Ninety-one percent of middle school mathematics lessons included discussions as part of the lesson. While 43 percent of the lessons

used calculators, interestingly, only about 5 percent of the lessons included the use of computers or other technologies.

Table 19
Middle School Mathematics Classes Participating in Various Activities in Most Recent Lesson

	Percent of Classes	
Discussion	91	(1.6)
Students completing textbook/worksheet problems	79	(2.2)
Lecture	79	(2.4)
Students working in small groups	47	(3.2)
Students using calculators	43	(2.8)
Students doing hands-on/manipulative activities	32	(2.8)
Students reading about mathematics	24	(2.4)
Test or quiz	19	(2.9)
Students using computers	5	(1.2)
Students using other technologies	4	(1.0)
None of the above	0	(0.2)

When teachers were asked to report the amount of time dedicated to various activities (Table 20), the combination of lecture/discussion and individual student activities (such as reading textbooks, completing worksheets, etc.) accounted for roughly 60 percent of the time in a typical middle school mathematics lesson. Thirteen percent of class time was spent on non-instructional activities.

Table 20
Average Percentage of Middle School Mathematics Class Time Spent on Different Types of Activities

	Average Percent	
Whole class lecture/discussion	36	(0.9)
Individual students reading textbooks, completing worksheets, etc.	24	(1.1)
Daily routines, interruptions, and other non-instructional activities	13	(0.4)
Working with hands-on or manipulative materials	10	(0.9)
Non-manipulative small group work	11	(1.0)
Other activities	6	(0.7)

Data in Table 21 indicate that calculators and computers are used predominantly for drill and practice, demonstrating mathematics principles, and taking tests or quizzes, with over one-third of teachers reporting the inclusion of each of these activities at least once a week. Utilization of calculators and computers as tools to do simulations or to collect, retrieve, or exchange data were much less likely to be cited as regular activities. For example, 62 percent of teachers reported that their classes never use computers to collect data using sensors or probes, while over 60 percent report using computers at most a few times a year to work with simulations or retrieve and exchange data.

Table 21
Middle School Mathematics Classes Where Teachers Report that Students Use Calculators/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 mathematics principles	12	(2.2)	21	(2.8)	29	(2.3)	29	(2.6)	9	(1.4)
Do drill and practice	16	(2.2)	22	(2.6)	24	(2.7)	25	(3.2)	13	(1.7)
Take a test or quiz	18	(2.4)	19	(2.8)	29	(2.7)	26	(3.3)	8	(1.2)
Play mathematics learning games	20	(2.4)	27	(2.5)	38	(2.8)	12	(1.5)	3	(0.7)
Do simulations	33	(2.9)	30	(2.7)	28	(2.4)	6	(1.0)	2	(0.5)
Solve problems using simulations	34	(2.8)	28	(2.7)	24	(2.8)	11	(1.5)	3	(0.7)
Retrieve or exchange data	40	(2.7)	33	(2.8)	20	(2.1)	6	(1.2)	1	(0.6)
Collect data using sensors or probes	62	(2.8)	21	(2.4)	13	(1.8)	3	(0.8)	1	(0.4)

One potential explanation for the low use of calculators and computers 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 middle school mathematics teachers identify instructional technology as an area where they are in particular need of professional development. (See Table 10.) At the same time, other survey data show that teachers participate in very little professional development that focuses on mathematics instruction, so even though many of those experiences may have emphasized technology use, the total amount of professional development time devoted to this area was low. (See Tables 11 and 14.)

Resources Available for Middle School Mathematics Instruction

Mathematics teaching may well 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 below.

Textbook Usage

Teachers in the vast majority of middle school mathematics classes (91 percent) report using one or more commercially published textbooks to help guide instruction. Of these teachers, nearly 41 percent thought their textbook was very good or excellent, and roughly two-thirds reported that they cover at least 75 percent of the textbook in the randomly selected class. (See Tables 22 and 23.)

Table 22
Middle School Mathematics Teachers' Perceptions of Quality of Textbooks/Programs Used in Mathematics' Classes

	Percent of Classes	
Very poor	2	(0.6)
Poor	6	(1.4)
Fair	19	(2.3)
Good	32	(2.9)
Very good	32	(3.2)
Excellent	9	(2.2)

Table 23
Percentage of Middle School Mathematics Textbooks/Programs Covered During the Course

	Percent of Classes	
Less than 25 percent	1	(0.6)
25–49 percent	5	(1.1)
50–74 percent	30	(3.3)
75–90 percent	47	(3.6)
More than 90 percent	17	(2.4)

Facilities and Equipment

Middle 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 26 shows the percentage of middle 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" and "not needed."

Note that high percentages of middle school mathematics classrooms use the overhead projector as well as the four-function calculator. Middle school mathematics teachers' apparent access to computers is similar to that for other instructional resources, with 77 percent reporting use of a computer and 60 percent of classes reporting the use of a computer with Internet access. With the growing popularity of graphing calculators, it is somewhat surprising that four-function calculators are so much more widely used in middle school classrooms. Perhaps more surprising is that 62 percent of middle school mathematics teachers reported not needing graphing calculators.

Teachers in 10 percent or fewer of middle school mathematics classes expressed a need for specific equipment. The only exception was in the category of "calculator/computer lab interfacing devices" where in 15 percent of classes, teachers responded that the equipment was "needed, but not available." These data are consistent with data regarding interfacing equipment throughout the report and may help explain the sparse usage of such equipment in the middle school mathematics classroom.

Table 24
Equipment Need, Availability, and Use in Middle School Mathematics Classes

	Percent of Classes					
	Not Needed		Needed, but Not Available		Used	
Overhead projector	9	(2.7)	0	(0.3)	90	(2.7)
Videotape player	49	(3.2)	1	(0.5)	51	(3.2)
Videodisc player	84	(2.7)	5	(1.4)	11	(2.4)
CD-ROM player	60	(3.1)	5	(1.0)	36	(3.3)
Four-function calculators	17	(1.8)	2	(0.7)	82	(1.9)
Fraction calculators	35	(3.4)	7	(1.3)	58	(3.2)
Graphing calculators	62	(3.2)	10	(1.9)	28	(2.6)
Scientific calculators	40	(3.4)	6	(1.5)	54	(3.5)
Computers	18	(2.8)	5	(1.1)	77	(3.0)
Calculator/computer lab interfacing devices	55	(2.9)	15	(1.9)	30	(2.8)
Computers with Internet connection	34	(3.5)	7	(1.3)	60	(3.5)

Summary

The middle school mathematics teacher workforce is predominantly female and predominantly white. Based on their age distribution and experience, nearly one-third of middle school mathematics teachers may be retiring within the next ten years.

Data on the content preparation of middle school mathematics teachers are mixed. For example, over 40 percent of middle school mathematics teachers have Master's degrees, and nearly two-thirds have taken coursework equivalent to a minor in mathematics or mathematics education. However, there are gaps in their preparation in a number of areas that NCTM recommends for mathematics teachers, i.e., probability and statistics, geometry, and the history of mathematics; 1 out of every 4 teachers have not taken any of the recommended courses.

On the pedagogical side, 60 percent of middle 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 at least to a moderate extent in their classrooms. High percentages of teachers reported feeling well prepared to encourage females and minorities in mathematics, listen and ask questions of their students, and develop their students' conceptual understanding of mathematics. However, middle school mathematics teachers were less likely to report being well prepared to incorporate calculators and computers in their instruction, beyond the use of both for drill and practice of basic mathematics skills.

Data on middle school mathematics teachers' professional development needs and participation indicate a need for many of them to retool. Workshop attendance continues to be the most common form of professional development, with slightly over three-fourths of the teachers reporting participation in one or more workshops within the previous three years. However, other data indicate that many middle school mathematics teachers have not taken a mathematics

or mathematics education course since 1990. Data also indicate a need to continue to help teachers be better prepared to incorporate technology in the mathematics classroom.

Composite data show that mathematics teachers in middle school place a heavy emphasis on mathematics reasoning and concepts. However, the typical middle school mathematics class spends a large proportion of time solving worksheet or textbook problems, reviewing homework and worksheet assignments, and practicing routine computation and algorithms, practices that do not seem to support the development of mathematics concepts and reasoning. While over 90 percent of the teachers reported incorporating discussion in their most recent mathematics class, additional data show that middle school teachers allow very few opportunities for students to communicate about mathematics.

Middle school mathematics teachers generally seem satisfied with their textbooks and report needing very little in the way of instructional equipment. Overhead projectors and four-function calculators are heavily used, while graphing calculators are generally not seen as necessary. Teachers expressed a need for calculator/computer lab interfacing devices, which may explain their low usage in the classroom.

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Appendix

Description of Composite Variables

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