2012 National Survey of Science and Mathematics Education

Status of Middle School Mathematics

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Disclaimer

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INTRODUCTION

The 2012 National Survey of Science and Mathematics Education was designed to provide up-to-date information and to identify trends in the areas of teacher background and experience, curriculum and instruction, and the availability and use of instructional resources. A total of 7,752 science and mathematics teachers in schools across the United States participated in this survey, a response rate of 77 percent. The research questions addressed by the study are:

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

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

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

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

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

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

The 2012 National Survey is based on a national probability sample of schools and science and mathematics teachers in grades K–12 in the 50 states and the District of Columbia. The sample was designed to allow national estimates of science and mathematics course offerings and enrollment; teacher background preparation; textbook usage; instructional techniques; and availability and use of science and mathematics facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being drawn into the sample. This report describes the status of middle school (grades 6–8) mathematics instruction based on the responses of 1,084 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 2012 National Survey of Science and Mathematics Education*.[2] The standard errors for the estimates presented in this report are included in parentheses in the

[1] A middle school mathematics teacher is defined as someone whose randomly selected class was a grades 6–8 mathematics course. Two of these teachers indicated that they taught in self-contained classrooms; the remainder indicated being departmentalized.

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

tables. The narrative sections of the report generally point out only those differences that are substantial as well as statistically significant at the 0.05 level.

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

- Characteristics of the middle school mathematics teaching force;
- Professional development of middle school mathematics teachers;
- Middle school mathematics classes offered;
- Middle school mathematics instruction, in terms of time spent, objectives, and class activities;
- Resources available for middle school mathematics instruction; and
- Factors affecting middle school mathematics instruction.

CHARACTERISTICS OF THE MIDDLE SCHOOL MATHEMATICS TEACHING FORCE

General Demographics

Three-quarters of the middle school mathematics teachers are female and the vast majority are white (see Table 1). Judging by the age of middle school mathematics teachers, it appears that as many as one-quarter may be nearing retirement in the next 10 years.

Nearly a third of middle school mathematics teachers have five or fewer years of experience teaching mathematics. In addition, over two-thirds are responsible for teaching two or more different mathematics subjects (e.g., remedial mathematics 7, Algebra 1).

Table 1
Characteristics of the Middle School Mathematics Teaching Force

	Percent of Teachers	
Sex		
Male	25	(2.0)
Female	75	(2.0)
Race		
White	89	(1.3)
Black or African American	6	(0.9)
Hispanic or Latino	5	(0.7)
Asian	3	(1.0)
American Indian or Alaska Native	1	(0.2)
Native Hawaiian or Other Pacific Islander	0	(0.2)
Two or more races	1	(0.3)
Age		
≤ 30	18	(1.4)
31–40	27	(2.1)
41–50	29	(2.3)
51–60	21	(1.8)
61+	5	(1.0)
Experience Teaching Mathematics at the K–12 Level		
0–2 years	14	(1.4)
3–5 years	17	(1.5)
6–10 years	25	(1.9)
11–20 years	28	(1.9)
≥ 21 years	15	(1.6)
Number of Mathematics Subjects Taught		
1	30	(2.5)
2	40	(2.0)
3 or more	31	(2.5)

In terms of preparation to teach mathematics, about a quarter of middle school mathematics teachers have a college degree in mathematics and a similar number have a degree in mathematics education (see Table 2). The vast majority of middle school mathematics teachers have had formal preparation for teaching leading to a teacher credential (see Table 3). Over half received their teaching credential as part of their undergraduate program, and a quarter received their credential as part of a master's program.

Table 2
Middle School Mathematics Teacher Degrees

	Percent of Teachers	
Mathematics	23	(1.8)
Mathematics Education	26	(1.9)
Mathematics or Mathematics Education	36	(2.2)

Table 3
Middle School Mathematics Teachers' Paths to Certification

	Percent of Teachers
An undergraduate program leading to a bachelor's degree and a teaching credential	55 (3.1)
A post-baccalaureate credentialing program (no master's degree awarded)	17 (2.1)
A master's program that also awarded a teaching credential	25 (2.7)
No formal teacher preparation	3 (1.1)

Content Preparedness

Table 4 shows the percentage of middle school mathematics teachers with college coursework in each of a number of areas. The vast majority of middle school mathematics teachers have taken at least one course in mathematics education and/or student teaching in mathematics. In addition, 63 percent of middle school mathematics teachers have taken a calculus course. Interestingly, only slightly more than half have taken a course in mathematics content for middle school teachers.

Table 4
Middle School Mathematics Teachers Completing Various College Courses

	Percent of Teachers
Calculus	63 (2.5)
Advanced Calculus	36 (2.2)
Differential Equations	22 (1.5)
Real Analysis	17 (1.7)
Mathematics content for middle school teachers	56 (2.3)
Linear Algebra	40 (1.9)
Abstract Algebra	28 (1.6)
Integrated Mathematics	39 (1.9)
Analytic/Coordinate Geometry	26 (2.0)
Axiomatic Geometry (Euclidean or non-Euclidean)	21 (1.7)
Statistics	69 (2.2)
Probability	40 (2.1)
Number Theory	32 (2.1)
Discrete Mathematics	26 (1.8)
Other upper division mathematics	20 (1.5)
Computer Science	61 (2.3)
Engineering	9 (1.2)
Mathematics Education	88 (1.7)
Student teaching in mathematics	74 (2.0)

The National Council of Teachers of Mathematics (NCTM) has recommended that middle school mathematics teachers take college coursework in six different areas: number (for which "mathematics for middle school teachers" can serve as a proxy), algebra, geometry, probability, statistics, and calculus. As can be seen in Table 5, half of middle school mathematics teachers have had college courses in all or nearly all of these areas, having completed at least 4 of the 6 recommended courses.

Table 5
Middle School Mathematics Teachers' Coursework Related to NCTM Course-Background Standards

	Percent of Teachers
All 6 courses	15 (1.6)
4–5 courses	35 (2.1)
2–3 courses	30 (2.0)
1 course	14 (1.6)
No courses	6 (1.3)

The survey also asked teachers to rate how well prepared they feel to teach each of a number of topics. As can be seen in Table 6, a large majority of middle school mathematics teachers feel very well prepared to teach about the number system and operations (88 percent) and algebraic thinking (76 percent). Nearly two-thirds feel very well prepared to teach measurement, geometry, and functions. About half feel very well prepared to teach modeling or statistics and probability, and less than one-fifth feel very well prepared to teach discrete mathematics.

Table 6
Middle School Mathematics Teacher Preparedness to Teach Each of a Number of Topics

	Percent of Teachers			
	Not Adequately Prepared	Somewhat Prepared	Fairly Well Prepared	Very Well Prepared
The number system and operations	0 (0.2)	1 (0.4)	11 (1.3)	88 (1.4)
Algebraic thinking	0 (0.1)	3 (0.7)	21 (1.8)	76 (1.9)
Measurement	0 (0.1)	6 (1.3)	28 (2.0)	66 (2.1)
Geometry	2 (0.5)	8 (1.4)	28 (1.7)	62 (2.0)
Functions	2 (0.5)	10 (1.2)	29 (1.9)	60 (1.9)
Modeling	1 (0.4)	12 (1.5)	38 (2.2)	49 (2.3)
Statistics and probability	2 (0.5)	11 (1.1)	39 (2.0)	48 (2.2)
Discrete mathematics	17 (1.5)	27 (1.7)	38 (2.1)	18 (1.5)

Pedagogical Beliefs

Teachers were asked about their beliefs regarding effective teaching and learning in mathematics. As can be seen in Table 7, middle school mathematics teachers hold a number of views that are in alignment with what is known about effective mathematics instruction. For example, a large majority of middle school mathematics teachers agree that: (1) most class periods should provide opportunities for students to share their thinking and reasoning, (2) most class periods should conclude with a summary of the key ideas addressed, (3) students should be provided with the purpose for a lesson as it begins, and (4) most class periods should include some review of previously covered ideas and skills.

In contrast, many middle school mathematics teachers also hold views that are inconsistent with effective mathematics instruction. For example, 83 percent believe that students should be

provided with definitions for new vocabulary at the beginning of instruction on a mathematical idea, and 68 percent believe that students learn best in classes with students of similar abilities. Furthermore, 40 percent believe that hands-on/manipulatives should be used primarily to reinforce a mathematics idea that the students have already learned, and 37 percent believe teachers should explain an idea to students before having them investigate the idea.

Table 7
Middle School Mathematics Teachers Agreeing[†]
with Various Statements about Teaching and Learning

	Percent of Teachers	
Most class periods should provide opportunities for students to share their thinking and reasoning	95	(0.8)
Most class periods should conclude with a summary of the key ideas addressed	94	(1.0)
Students should be provided with the purpose for a lesson as it begins	92	(1.2)
Most class periods should include some review of previously covered ideas and skills	90	(1.4)
At the beginning of instruction on a mathematical idea, students should be provided with definitions for new vocabulary that will be used	83	(1.7)
Inadequacies in students' mathematics background can be overcome by effective teaching	83	(1.5)
It is better for mathematics instruction to focus on ideas in depth, even if that means covering fewer topics	83	(1.8)
Students should be assigned homework most days	75	(2.3)
Students learn mathematics best in classes with students of similar abilities	68	(2.1)
Hands-on activities/manipulatives should be used primarily to reinforce a mathematical idea that the students have already learned	40	(2.2)
Teachers should explain an idea to students before having them investigate the idea	37	(1.8)

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

Pedagogical Preparedness

The survey asked teachers two series of items focused on their preparedness for a number of tasks associated with instruction. First, they were asked how well prepared they feel to address diverse learners in their instruction. Second, they were asked how well prepared they feel to monitor and address student understanding, focusing on a specific unit in the randomly selected class.

As can be seen in Table 8, the majority of middle school mathematics teachers feel very well prepared to manage classroom discipline, encourage the participation of females in mathematics, and encourage the participation of students from low socioeconomic backgrounds in mathematics. Thirty-seven percent or fewer middle school mathematics teachers feel very well prepared to differentiate instruction.

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

	Percent of Teachers	
Manage classroom discipline	63	(2.8)
Encourage participation of females in mathematics	58	(2.5)
Encourage participation of students from low socioeconomic backgrounds in mathematics	54	(2.7)
Encourage participation of racial or ethnic minorities in mathematics	50	(2.5)
Encourage students' interest in mathematics	46	(3.2)
Plan instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity	37	(3.0)
Provide enrichment opportunities for gifted students	33	(3.1)
Teach mathematics to students who have learning disabilities	27	(3.3)
Teach mathematics to students who have physical disabilities	22	(3.0)
Teach mathematics to English-language learners	17	(2.2)

Table 9 shows the percentage of classes taught by teachers who feel very well prepared for each of a number of tasks related to instruction. In the majority of middle school mathematics classes, teachers feel very well prepared to assess student understanding at the end of a unit, implement the designated mathematics textbook/program during a unit, and monitor student understanding during instruction. Although teachers in over half of middle school mathematics class feel very well prepared to anticipate student difficulties, teachers in less than half feel very well prepared to find out what their students think or already know about the targeted mathematical ideas.

Table 9
Middle School Mathematics Classes in which Teachers Feel Very Well Prepared for Each of a Number of Tasks in the Most Recent Unit

	Percent of Classes	
Assess student understanding at the conclusion of this unit	72	(2.2)
Implement the mathematics textbook/program to be used during this unit[†]	62	(2.3)
Monitor student understanding during this unit	62	(2.2)
Anticipate difficulties that students will have with particular mathematical ideas and procedures in this unit	54	(2.5)
Find out what students thought or already knew about the key mathematical ideas	49	(2.3)

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

PROFESSIONAL DEVELOPMENT OF MIDDLE SCHOOL MATHEMATICS TEACHERS

One important measure of teachers' continuing education is how long it has been since they participated in professional development. As can be seen in Table 10, 89 percent of middle school mathematics teachers have participated in mathematics-focused professional development (i.e., focused on mathematics content or the teaching of mathematics) in the last three years.

Table 10
Middle School Mathematics Teachers' Most Recent Participation in Mathematics-Focused† Professional Development

	Percent of Teachers	
In the last 3 years	89	(1.6)
4–6 years ago	4	(0.7)
7–10 years ago	1	(0.5)
More than 10 years ago	1	(0.6)
Never	3	(1.0)

† Includes professional development focused on mathematics or mathematics teaching.

However, middle school mathematics teachers have participated in little professional development specific to mathematics teaching. Less than a third of middle school mathematics teachers have spent more than 35 hours in mathematics-related professional development in the last three years (see Table 11).

Table 11
Time Spent on Professional Development in the Last Three Years

	Percent of Teachers	
Less than 6 hours	23	(2.2)
6–15 hours	23	(2.0)
16–35 hours	23	(1.8)
More than 35 hours	31	(1.9)

As to how this time is spent, the workshop is the most common form of professional development, with 93 percent of middle school mathematics teachers having attended one in the previous three years (see Table 12). Three-fourths have participated in a professional learning community or other type of teacher study group, and over half have received feedback on their mathematics teaching from a formally assigned mentor or coach.

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

	Percent of Teachers	
Attended a workshop on mathematics or mathematics teaching	93	(1.4)
Participated in a professional learning community/lesson study/teacher study group focused on mathematics or mathematics teaching	76	(2.1)
Received feedback about your mathematics teaching from a mentor/coach formally assigned by the school/district/diocese†	57	(3.0)
Attended a national, state, or regional mathematics teacher association meeting	32	(2.6)

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

The emerging consensus about effective professional development suggests that teachers need opportunities to work with colleagues who face similar challenges, including other teachers from their school and those who have similar teaching assignments. Other recommendations include

engaging teachers in rigorous mathematics tasks, both to learn disciplinary content and to experience investigation-oriented learning; to examine student work and other classroom artifacts for evidence of what students do and do not understand; and to apply what they have learned in their classrooms and subsequently discuss how it went.[3] Accordingly, teachers who had participated in professional development in the last three years were asked a series of additional questions about the nature of those experiences.

As can be seen in Table 13, 70 percent of middle school mathematics teachers who have participated in professional development in the last three years have had substantial opportunity to work closely with other mathematics teachers from their school, and 57 percent have had substantial opportunity to work with others who teach the same subject or grade. Roughly half have had substantial opportunities to engage in mathematics investigations, to try out what they learned in their classroom and then talk about it as part of the professional development, and to examine classroom artifacts as part of their professional development.

Table 13
Middle School Mathematics Teachers Whose Professional Development in the Last Three Years Had Each of a Number of Characteristics to a Substantial Extent†

	Percent of Teachers	
Worked closely with other mathematics teachers from your school	70	(3.0)
Worked closely with other mathematics teachers who taught the same grade and/or subject whether or not they were from your school	57	(3.2)
Had opportunities to engage in mathematics investigations	51	(3.1)
Had opportunities to try out what you learned in your classroom and then talk about it as part of the professional development	51	(2.7)
Had opportunities to examine classroom artifacts (e.g., student work samples)	44	(3.1)
The professional development was a waste of time	4	(1.1)

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

College courses have the potential to address content in more depth than may be possible in other professional development venues, such as workshops. As another indicator of the extent to which teachers are staying current in their field, the 2012 National Survey asked teachers when they had last taken a formal course for college credit in both mathematics and how to teach mathematics. As can be seen in Table 14, less than a quarter of middle school mathematics teachers have taken a course for college credit in either mathematics or the teaching of mathematics in the last three years.

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

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

Table 14
Middle School Mathematics Teachers' Most Recent College Coursework

	Percent of Teachers	
Mathematics		
In the last 3 years	19	(1.6)
4–6 years ago	20	(1.5)
7–10 years ago	18	(1.8)
More than 10 years ago	42	(1.9)
Never	1	(0.4)
The Teaching of Mathematics		
In the last 3 years	19	(1.6)
4–6 years ago	17	(1.4)
7–10 years ago	17	(1.7)
More than 10 years ago	35	(2.3)
Never	13	(1.7)
Mathematics or the Teaching of Mathematics		
In the last 3 years	24	(1.7)
4–6 years ago	21	(1.5)
7–10 years ago	18	(1.8)
More than 10 years ago	37	(2.0)
Never	1	(0.4)

Another series of items asked about the focus of the opportunities teachers had to learn about content and the teaching of that content in the last three years, whether through professional development or college coursework. For about two-thirds of middle school mathematics teachers, professional growth opportunities gave heavy emphasis to how to use hands-on activities/manipulatives for mathematics instruction and planning instruction for students at different levels of achievement (see Table 15). Over half of teachers' professional growth opportunities gave heavy emphasis assessing students at the end of instruction, monitoring student understanding, and on difficulties that students may have with particular mathematical ideas and procedures. Relatively few professional growth opportunities gave heavy emphasis on providing enrichment experiences for gifted students or teaching mathematics to English-language learners.

Table 15
Middle School Mathematics Teachers Reporting that their Professional Development/Coursework in the Last Three Years Gave Heavy Emphasis† to Various Areas

	Percent of Teachers	
Learning how to use hands-on activities/manipulatives for mathematics instruction	67	(3.9)
Planning instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity	64	(4.0)
Assessing student understanding at the conclusion of instruction on a topic	57	(4.4)
Monitoring student understanding during mathematics instruction	55	(4.2)
Learning about difficulties that students may have with particular mathematical ideas and procedures	52	(3.1)
Deepening your own mathematics content knowledge	44	(3.8)
Implementing the mathematics textbook/program to be used in your classroom	39	(3.9)
Providing alternative mathematics learning experiences for students with special needs	39	(3.8)
Finding out what students think or already know about the key mathematical ideas prior to instruction on those ideas	37	(3.8)
Providing enrichment experiences for gifted students	31	(3.5)
Teaching mathematics to English-language learners	19	(2.2)

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

In addition to asking teachers about their involvement as participants in professional development, the survey asked teachers whether they had served in various leadership roles in the profession in the last three years. As can be seen in Table 16, less than a quarter of middle school mathematics teachers have supervised a student teacher, served as a mentor/coach, or led a teacher study group or workshop.

Table 16
Middle School Mathematics Teachers Serving in Various Leadership Roles in the Last Three Years

	Percent of Teachers	
Supervised a student teacher	24	(2.6)
Served as a formally assigned mentor/coach for mathematics teaching	22	(2.5)
Led a teacher study group focused on mathematics teaching	21	(2.4)
Taught in-service workshops on mathematics or mathematics teaching	14	(2.1)

MIDDLE SCHOOL MATHEMATICS CLASSES OFFERED

The typical middle school mathematics class has approximately 22 students; two-thirds of classes have between 15 and 28 students. Demographic data for middle school science students are shown in Table 17.

Table 17
Demographics of Students in Middle School Mathematics Courses

	Percent of Students	
Sex		
Male	52	(0.6)
Female	48	(0.6)
Race/Ethnicity		
White	58	(1.9)
Black or African American	17	(1.4)
Hispanic or Latino	16	(1.2)
Asian	5	(0.8)
American Indian or Alaska Native	1	(0.3)
Native Hawaiian or Other Pacific Islander	0	(0.1)
Two or more races	3	(0.4)

Roughly a quarter of middle school mathematics classes are heterogeneously grouped, containing students with a mixture of prior achievement levels; the remaining classes are grouped by prior achievement level of the students (see Table 18). Although the question was asked slightly differently on the 2000 National Survey,[4] these data indicate a substantial increase in the use of tracking in middle school mathematics classes. This phenomenon may be a result of the push to increase Algebra 1 enrollment at the middle school level.

Table 18
Prior-Achievement Grouping in Middle School Mathematics Classes

	Percent of Classes	
Mostly low achievers	27	(1.8)
Mostly average achievers	24	(1.8)
Mostly high achievers	23	(1.7)
A mixture of levels	26	(1.8)

Data from the school program questionnaire support this hypothesis. As can be seen in Table 19, three-fourths of middle schools have had some students complete Algebra 1 (compared to just less than two-thirds in 2000), though fewer than one-third have had 51 percent or more of their students complete Algebra 1. In contrast, just over one-fourth of schools have had students complete Geometry, and in these schools only a small percentage of students typically complete the course prior to 9th grade.

[4] Weiss, I. R., Banilower, E. R., McMahon, K. C., & Smith, P. S. (2001). *Report of the 2000 national survey of science and mathematics education.* Chapel Hill, NC: Horizon Research, Inc.

Table 19
Middle Schools with Various Percentages of 8th Graders Completing Algebra 1 and Geometry Prior to 9th Grade

	Percent of Schools	
	Algebra 1	Geometry
0 percent	25 (3.5)	72 (2.5)
1–10 percent	4 (1.0)	13 (1.4)
11–20 percent	10 (1.7)	7 (1.4)
21–30 percent	14 (1.7)	2 (0.5)
31–40 percent	11 (2.4)	3 (1.9)
41–50 percent	9 (2.3)	2 (1.0)
51–60 percent	7 (2.1)	2 (0.9)
61–70 percent	4 (1.5)	0 ---†
71–80 percent	6 (1.9)	1 (0.5)
81–90 percent	2 (0.9)	0 ---†
Over 90 percent	9 (1.8)	0 (0.1)

† No middle schools in the sample were in this category. Thus, it is not possible to calculate the standard error of this estimate

MIDDLE SCHOOL MATHEMATICS INSTRUCTION

The next three sections draw on teachers' descriptions of what transpires in middle school mathematics classrooms, in terms of: (1) teachers' autonomy for making decisions regarding the content and pedagogy of their classes, (2) instructional objectives, and (3) class activities.

Teachers' Perceptions of their Decision Making Autonomy

Teachers were asked the extent to which they have control over a number of curriculum and instruction decisions for their classes. In middle school mathematics classes, teachers are likely to perceive themselves as having strong control over pedagogical decisions such as determining the amount of homework to be assigned, selecting teaching techniques, and choosing criteria for grading student performance (see Table 20). In far fewer classes, teachers perceive themselves as having strong control in determining course goals and objectives, selecting what content/skills to teach, and selecting textbooks/programs.

Table 20
Middle School Mathematics Classes in which Teachers Report Having Strong Control Over Various Curriculum and Instruction Decisions

	Percent of Classes
Determining the amount of homework to be assigned	77 (2.4)
Selecting teaching techniques	70 (2.6)
Choosing criteria for grading student performance	56 (2.7)
Determining course goals and objectives	24 (2.1)
Selecting content, topics, and skills to be taught	23 (2.2)
Selecting textbooks/programs	13 (2.3)

These items were combined into two composite variables: Curriculum Control and Pedagogical Control.[5] The mean score on the Pedagogical Control composite was much higher than on the Curriculum Control composite, an indication that middle school mathematics teachers feel substantially more in control of pedagogical decisions than curriculum-based decisions (see Table 21).

Table 21
Middle School Mathematics Class Mean Scores for Curriculum Control and Pedagogical Control Composites

	Mean Score
Pedagogical Control	87 (1.4)
Curriculum Control	45 (1.5)

Instructional Objectives

Teachers were given a list of potential objectives and asked to rate each in terms of the emphasis they receive in the randomly selected class. As can be seen in Table 22, middle school mathematics classes are more likely to have a heavy emphasis on deepening students' conceptual understanding and less likely to emphasize performing computations with speed and accuracy. Less than half of middle school mathematics classes have a heavy emphasis on understanding of real-life applications of mathematics or increasing students' interest in mathematics.

Table 22
Middle School Mathematics Classes with Heavy Emphasis on Various Instructional Objectives

	Percent of Classes
Understanding mathematical ideas	70 (2.0)
Preparing for further study in mathematics	57 (2.3)
Learning mathematical practices (for example: considering how to approach a problem, justifying solutions)	54 (2.2)
Learning mathematical procedures and/or algorithms	49 (2.2)
Learning about real-life applications of mathematics	42 (1.9)
Increasing students' interest in mathematics	37 (1.9)
Learning test taking skills/strategies	36 (2.5)
Learning to perform computations with speed and accuracy	23 (1.8)

Class Activities

The 2012 National Survey included several items that provide 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. As can be seen in Table 23, the majority of middle school mathematics classes

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

include the teacher explaining mathematical ideas, whole class discussions, and students explaining and justifying their method for solving problems on a weekly basis. Three-quarters of classes have students consider multiple representations in solving problems. It is somewhat striking that, in contrast to what is known from learning theory about the importance of reflection, only 21 percent of middle school mathematics classes have students write reflections on what they are learning.

Table 23
Middle School Mathematics Classes in which Teachers Report Using Various Activities at Least Once a Week

	Percent of Classes	
Explain mathematical ideas to the whole class	98	(0.5)
Engage the whole class in discussions	93	(1.1)
Have students explain and justify their method for solving a problem	85	(1.5)
Have students consider multiple representations in solving a problem (e.g., numbers, tables, graphs, pictures)	75	(1.5)
Have students work in small groups	70	(2.1)
Have students present their solution strategies to the rest of the class	60	(1.9)
Have students compare and contrast different methods for solving a problem	63	(2.1)
Give tests and/or quizzes that include constructed-response/open-ended items	51	(2.3)
Have students read from a mathematics textbook/program or other mathematics-related material in class, either aloud or to themselves	34	(2.3)
Have students practice for standardized tests	40	(2.4)
Give tests and/or quizzes that are predominantly short-answer (e.g., multiple choice, true/false, fill in the blank)	39	(2.1)
Have students write their reflections (e.g., in their journals) in class or for homework	21	(1.6)
Provide manipulatives for students to use in problem-solving/investigations	33	(1.9)
Focus on literacy skills (e.g., informational reading or writing strategies)	23	(1.9)
Have students develop mathematical proofs	18	(1.8)
Have students attend presentations by guest speakers focused on mathematics in the workplace	2	(0.6)

Four out of 10 middle school mathematics classes utilize four-function calculators and scientific calculators weekly (see Table 24). Roughly one-quarter of classes incorporate using the internet in mathematics instruction at least one a week.

Table 24
Middle School Mathematics Classes in which Teachers Report that Students Use Various Instructional Technologies at Least Once a Week

	Percent of Classes	
Four-function calculators	40	(2.5)
Scientific calculators	40	(2.8)
Internet	26	(2.6)
Personal computers, including laptops	22	(2.8)
Graphing calculators	13	(2.2)
Classroom response system or “Clickers”	11	(1.6)
Hand-held computers	5	(1.5)
Probes for collecting data	1	(0.7)

In addition to asking about class activities in the course as a whole, the 2012 National Survey asked teachers about activities that took place during their most recent mathematics lesson in the randomly selected class. A large majority of middle school mathematics lessons include the teacher explaining a mathematical idea to the whole class, a whole class discussion, and students completing textbook/worksheet (see Table 25). The teacher conducting a demonstration occurs in about 7 out of 10 mathematics lessons.

Table 25
Middle School Mathematics Classes
Participating in Various Activities in the Most Recent Lesson

	Percent of Classes
Teacher explaining a mathematical idea to the whole class	92 (1.0)
Whole class discussion	85 (1.4)
Students completing textbook/worksheet problems	78 (1.7)
Teacher conducting a demonstration while students watched	71 (2.1)
Students doing hands-on/manipulative activities	37 (1.7)
Students using instructional technology	30 (1.8)
Students reading about mathematics	23 (1.6)
Practicing for standardized tests	23 (1.9)
Test or quiz	19 (1.6)

The survey also asked teachers to estimate the time spent on each of a number of types of activities in the most recent mathematics lesson. As can be seen in Table 26, approximately 40 percent of class time is spent on whole class activities, 25 percent on small group work, and 25 percent on students working individually. Non-instructional activities, including attendance taking and interruptions, account for 10 percent of mathematics class time.

Table 26
Average Percentage of Time Spent on Different
Activities in the Most Recent Middle School Mathematics Lesson

	Average Percent of Class Time
Whole class activities (e.g., lectures, explanations, discussions)	43 (0.9)
Small group work	24 (0.9)
Students working individually (e.g., reading textbooks, completing worksheets, taking a test or quiz)	24 (0.7)
Non-instructional activities (e.g., attendance taking, interruptions)	10 (0.2)

Homework and Assessment Practices

Teachers were asked about the amount of homework assigned per week in the randomly selected class. As can be seen in Table 27, most middle school mathematics classes assign between 31 and 90 minutes of homework per week.

Table 27
Amount of Homework Assigned in
Middle School Mathematics Classes per Week

	Percent of Classes	
Fewer than 15 minutes per week	5	(0.8)
15–30 minutes per week	13	(2.5)
31–60 minutes per week	29	(2.8)
61–90 minutes per week	29	(2.9)
91–120 minutes per week	14	(1.5)
More than 120 minutes per week	10	(1.6)

Teachers were also given a list of ways that they might assess student progress and asked to describe which practices they used in the most recently completed unit in the randomly selected class. The vast majority of middle school mathematics classes included informal assessment practices during the unit to see if students were "getting it" (see Table 28). For example, 98 percent of middle school mathematics classes involved the teacher questioning students during activities to monitor understanding. Using whole class informal assessments such as "thumbs up/thumbs down" was another common practice, used by 88 percent of classes.

In addition, the use of formal assessment techniques such as grading student work, quizzes, and tests, as well as reviewing the correct answers to assignments were prevalent features of mathematics units. Eighty-eight percent of middle school mathematics classes administered a test or quiz to assign grades and 85 percent assigned grades to student work. Probing student thinking at the beginning of a unit was included in only about half of middle school mathematics classes.

Table 28
Middle School Mathematics Classes in which Teachers Report
Assessing Students Using Various Methods in the Most Recent Unit

	Percent of Classes	
Questioned individual students during class activities to see if they were "getting it"	98	(0.6)
Reviewed student work (e.g., homework, notebooks, journals, portfolios, projects) to see if they were "getting it"	95	(0.9)
Went over the correct answers to assignments, quizzes, and/or tests with the class as a whole	93	(0.9)
Used information from informal assessments of the entire class (e.g., asking for a show of hands, thumbs up/thumbs down, clickers, exit tickets) to see if students were "getting it"	88	(1.3)
Administered one or more quizzes and/or tests to assign grades	88	(1.5)
Administered one or more quizzes and/or tests to see if students were "getting it"	86	(1.6)
Assigned grades to student work (e.g., homework, notebooks, journals, portfolios, projects)	85	(1.5)
Administered an assessment, task, or probe at the beginning of the unit to find out what students thought or already knew about the key mathematical ideas	52	(2.2)
Had students use rubrics to examine their own or their classmates' work	12	(1.3)

The survey asked how often students in the randomly selected class were required to take assessments the teachers did not develop, such as state or district benchmark assessments. Almost all middle school mathematics classes are required to take such an assessment at least

once a year, and nearly 70 percent of classes are required to take three or more such tests a year (see Table 29).

Table 29
Frequency of Required External Testing in Middle School Mathematics Classes

	Percent of Classes
Never	2 (0.4)
Once a year	19 (2.1)
Twice a year	10 (1.4)
Three or four times a year	38 (2.3)
Five or more times a year	31 (1.7)

RESOURCES AVAILABLE FOR MIDDLE SCHOOL MATHEMATICS INSTRUCTION

Instructional Materials

The 2012 National Survey collected data on the use of instructional materials in middle school mathematics classes. Roughly 8 in 10 middle school mathematics classes use commercially published textbooks/programs. The survey also asked if one textbook/program is used all or most of the time, or if multiple materials are used. Over half of middle school mathematics classes use a single textbook/program, while about 1 in 5 classes use non-commercially published instructional materials (see Table 30).

Table 30
Instructional Materials Used in Middle School Mathematics Classes

	Percent of Classes
One commercially published textbook or program most of the time	55 (2.4)
Multiple commercially published textbooks/programs most of the time	26 (2.1)
Non-commercially published instructional materials most of the time	19 (1.9)

Teachers whose randomly selected class uses a commercially published textbook/program were asked to record the title, author, year, and ISBN of the material used most often in the class. Using this information, the publisher of the material was identified. The publishers of the most commonly used middle school mathematics materials are Houghton Mifflin Harcourt, McGraw-Hill, and Pearson.

Table 31 shows the publication year of commercially published instructional materials used. In 2012, 40 percent of middle school mathematics classes were using materials published prior to 2007.

Table 31
Publication Year of
Instructional Materials in Middle School Mathematics Classes

	Percent of Classes†
2006 or earlier	40 (2.4)
2007–09	44 (2.7)
2010–12	16 (1.4)

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

It is interesting to note that while national experts in science and mathematics education are often critical of textbook quality,[6] most middle school mathematics teachers consider their instructional materials to be of relatively high quality, as those in over three-quarters of middle school mathematics classes feel their materials as good or better (see Table 32).

Table 32
Perceived Quality of Instructional
Materials Used in Middle School Mathematics Classes

	Percent of Classes†
Very Poor	2 (1.2)
Poor	4 (0.9)
Fair	19 (2.4)
Good	34 (2.6)
Very Good	33 (2.9)
Excellent	9 (1.6)

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

Ninety-one percent of middle school mathematics classes cover at least half of their materials; 69 percent address three-fourths or more (see Table 33). In addition, nearly half of middle school mathematics classes spend three-fourths or more of their instructional time using the materials (see Table 34).

Table 33
Percentage of Instructional Materials
Covered during Middle School Mathematics Courses

	Percent of Classes†
Less than 25 percent	2 (0.7)
25–49 percent	7 (2.1)
50–74 percent	22 (3.1)
75 percent or more	69 (3.5)

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

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

Table 34
Percentage of Instructional Time Spent
Using Instructional Materials during the Course

	Percent of Classes[†]
Less than 25 percent	14 (2.0)
25–49 percent	14 (1.9)
50–74 percent	23 (3.2)
75 percent or more	49 (3.5)

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

The survey also asked teachers to describe how they used their textbook/program in their most recent unit. As can be seen in Table 35, teachers in 68 percent of middle school mathematics classes supplement their textbook/program; in 52 percent of classes, teachers picked what was important from their materials and skipped the rest. Still, in a large majority of middle school mathematics classes, teachers use the textbook/program to guide the overall structure and content emphasis of their units.

Table 35
Ways Middle School Mathematics Teachers
Substantially[†] Used their Instructional Materials in the Most Recent Unit

	Percent of Classes[‡]
You used the textbook/program to guide the overall structure and content emphasis of the unit	71 (2.3)
You incorporated activities (e.g., problems, investigations, readings) from other sources to supplement what the textbook/program was lacking	68 (2.6)
You followed the textbook/program to guide the detailed structure and content emphasis of the unit	55 (2.7)
You picked what is important from the textbook/program and skipped the rest	52 (2.5)

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

Of the middle school mathematics classes in which teachers supplement their textbook/program, nearly all do so to help students at different levels of achievement learn targeted ideas and to provide students with additional practice (see Table 36). In about 7 of 10, teachers supplement to prepare students for standardized tests.

Table 36
Reasons Why Middle School Mathematics Instructional Materials Are Supplemented

	Percent of Classes[†]
Supplemental activities were needed so students at different levels of achievement could increase their understanding of the ideas targeted in each activity	97 (1.1)
Supplemental activities were needed to provide students with additional practice	96 (1.1)
Supplemental activities were needed to prepare students for standardized tests	71 (4.2)
Your pacing guide indicated that you should use supplemental activities	39 (4.1)

[†] Only classes using commercially published textbooks/programs in the most recent unit and whose teachers reported supplementing their textbooks/programs were included in these analyses.

Teachers who skip parts of their textbook/program were asked why. As can be seen in Table 37, teachers in 80 percent of these middle school mathematics classes skip activities because they have other ones that work better. In over three-quarters of these middle school mathematics classes, teachers skip activities because the ideas are not in their pacing guides/state standards. In 57 percent, teachers skip activities because students already know the content.

Table 37
Reasons Why Parts of Middle School Mathematics Instructional Materials Are Skipped

	Percent of Classes[†]	
You have different activities for those mathematical ideas that work better than the ones you skipped	80	(2.8)
The mathematical ideas addressed in the activities you skipped are not included in your pacing guide and/or current state standards	78	(3.2)
Your students already knew the mathematical ideas or were able to learn them without the activities you skipped	57	(3.9)
The activities you skipped were too difficult for your students	41	(3.4)
You did not have the materials needed to implement the activities you skipped	30	(4.4)

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

Facilities and Equipment

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

- Do not have one per group available;
- At least one per group available upon request or in another room; and
- At least one per group located in your classroom.

As can be seen in Table 38, middle school mathematics classes are likely to have access to the internet, four-function calculators, scientific calculators, and personal computers. Half of middle school mathematics classes have access to graphing calculators and about 1 in 5 classes have access to hand-held computers and probes for collecting data. However, nearly a quarter of middle school mathematic classes expect students to provide their own four-function calculators and scientific calculators (see Table 39).

Table 38
Availability† of Instructional Technologies in Middle School Mathematics Classes

	Percent of Classes	
Internet access	80	(2.0)
Four-function calculators	77	(2.0)
Scientific calculators	69	(2.7)
Personal computers, including laptops	68	(2.5)
Classroom response system or "Clickers" (handheld devices used to respond electronically to questions in class)	53	(3.0)
Graphing calculators	50	(2.9)
Hand-held computers (e.g., PDAs, tablets, smartphones, iPads)	21	(2.5)
Probes for collecting data (e.g., motion sensors, temperature probes)	18	(2.1)

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

Table 39
Expectations that Students will Provide their Own Instructional Technologies

	Percent of Classes	
Four-function calculators	23	(2.4)
Scientific calculators	22	(2.2)
Graphing calculators	8	(1.9)
Laptop computers	4	(0.9)
Hand-held computers	3	(0.9)

When asked about the adequacy of resources for instruction, teachers in the majority of middle school mathematics classes appear satisfied with their access to measurement tools, consumable supplies, instructional technology, and manipulatives (see Table 40). However, access to consumable supplies, instructional technology, and manipulatives are less likely to be considered adequate than access to measurement tools.

Table 40
Middle School Mathematics Classes with Adequate† Resources for Instruction

	Percent of Classes	
Measurement tools (e.g., protractors, rulers)	70	(2.1)
Consumable supplies (e.g., graphing paper, batteries)	62	(2.3)
Instructional technology (e.g., calculators, computers, probes/sensors)	62	(2.2)
Manipulatives (e.g., pattern blocks, algebra tiles)	58	(2.1)

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

FACTORS AFFECTING MIDDLE SCHOOL MATHEMATICS INSTRUCTION

Teachers were asked about factors that affect instruction in their randomly selected class. As can be seen in Table 41, factors seen as promoting effective instruction in the majority of middle school mathematics classes include principal support, current state standards, district/diocese curriculum frameworks, and time for planning. Community views on mathematics instruction

are seen as promoting effective instruction in just over one-third of middle school mathematics classes.

Table 41
Factors Promoting† Effective
Instruction in Middle School Mathematics Classes

	Percent of Classes	
Principal support	80	(2.3)
Current state standards	72	(2.9)
District/Diocese curriculum frameworks‡	68	(2.8)
Time for you to plan, individually and with colleagues	67	(3.0)
Students' motivation, interest, and effort in mathematics	60	(3.1)
District/Diocese/School pacing guides	58	(3.1)
Time available for your professional development	56	(2.8)
Teacher evaluation policies	56	(2.6)
Students' reading abilities	53	(3.5)
Parent expectations and involvement	46	(3.0)
District/Diocese testing/accountability policies‡	45	(2.9)
Textbook/program selection policies	44	(3.1)
State testing/accountability policies‡	44	(3.0)
Community views on mathematics instruction	37	(3.2)

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

The teacher survey also included a series of items about technology-related issues. Teachers were asked to indicate how great a problem each posed for instruction in their randomly selected class. As can be seen in Table 42, these resources are generally not seen as problematic in middle school mathematics classes.

Table 42
Extent to Which Technology Quality Is a Serious
Problem for Instruction in Middle School Mathematics Classes

	Percent of Classes	
Old age of computers	13	(1.9)
Lack of availability of appropriate computer software	11	(1.6)
Lack of access to computers	9	(1.5)
Lack of availability of technology support	8	(1.4)
Slow speed of the Internet connection	7	(1.0)
Unreliability of the Internet connection	6	(0.9)
Lack of access to the Internet	4	(0.9)

Composites from these two series of questionnaire items were created to summarize the extent to which various factors support effective instruction. The means are shown in Table 43. Overall, these data indicate that the climate is generally supportive for middle school mathematics instruction.

Table 43
Class Mean Scores for the Factors Affecting Instruction Composites

	Mean Score
Extent to which School Support Promotes Effective Instruction	68 (1.7)
Extent to which the Policy Environment Promotes Effective Instruction	65 (1.4)
Extent to which Stakeholders Promote Effective Instruction	61 (1.6)
Extent to which IT Quality is Problematic for Instruction	21 (1.2)

SUMMARY

The overwhelming majority of middle school mathematics teachers are white, and three-quarters are female. Less than a quarter have a degree in mathematics, and slightly more than a quarter have a degree in mathematics education. Half have had college courses in all or nearly all of areas of mathematics that NCTM recommends for middle school mathematics teachers. Although middle school mathematics teachers hold a number of beliefs about teaching and learning that are in alignment with what is known about effective mathematics instruction (e.g., it is better for instruction to focus on ideas in depth, even if that means covering fewer topics), they also hold views that are inconsistent with this research. For example, roughly 8 in 10 believe that students should be provided with definitions for new vocabulary at the beginning of instruction on an idea.

Asked about their professional development experiences, the vast majority of middle school mathematics teachers have participated in mathematics-focused professional development in the last three years. However, less than one-third have had sustained professional development (more than 35 hours) in that time period. In addition, while most middle school mathematics teachers have had opportunities to work closely with other mathematics teachers as part of their professional development in the last three years, less than half have had substantial opportunities to examine classroom artifacts.

Data suggest that most middle school mathematics classes are tracked, with students assigned to them based on their prior achievement level. Middle school mathematics instruction relies heavily on lecture and discussion, with students often completing textbook/worksheet problems. However, the data also indicate that students explain and justify their method for solving problems and consider multiple representations in problem solving fairly regularly. In addition, over 80 percent of middle school mathematics classes use commercially published instructional materials, and roughly 4 in 10 classes are using textbooks published prior to 2007.

APPENDIX

Table A-1
Teacher Mean Scores for Composites

	Mean Score	
Perceptions of Preparedness to Teach Mathematics Content	81	(0.6)
Perceptions of Preparedness to Encourage Students' Interest in Mathematics	78	(1.6)
Perceptions of Preparedness to Teach Students from Diverse Backgrounds	58	(1.9)
Quality of Professional Development	66	(1.3)
Extent to which Professional Development/Coursework Focused on Student-Centered Instruction	55	(1.9)

Table A-2
Class Mean Scores for Composites

	Mean Score	
Perceptions of Preparedness to Implement Instruction in Particular Unit	84	(0.8)
Curriculum Control	45	(1.5)
Pedagogical Control	87	(1.4)
Reform-Oriented Instructional Objectives	81	(0.6)
Use of Reform-Oriented Teaching Practices	73	(0.7)
Use of Instructional Technology	28	(1.4)
Adequacy of Resources for Instruction	71	(1.0)
Extent to which Stakeholders Promote Effective Instruction	61	(1.6)
Extent to which the Policy Environment Promotes Effective Instruction	65	(1.4)
Extent to which School Support Promotes Effective Instruction	68	(1.7)
Extent to which IT Quality is Problematic for Instruction	21	(1.2)