Chapter Three

Teachers as Professionals

A. Overview

The National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics* (NCTM, 2000) and the National Research Council's *National Science Education Standards* (NRC, 1996) describe a vision for teaching in which teachers are treated as professionals, respected for their expertise, allowed to exercise their professional judgement, and provided ample opportunities to work collaboratively with their peers and to continue to learn throughout their careers. The 2000 National Survey of Science and Mathematics Education collected data related to teacher professionalism, including teacher perceptions of their autonomy in making curriculum and instructional decisions, their opportunities for collaborative work, and their participation in in-service education and other professional activities. These data are discussed in the following sections.

B. The School as a Collegial Work Place

Teacher perceptions on issues related to collegiality are shown in Tables 3.1 and 3.2 for science and mathematics, respectively. On the positive side, most science and mathematics teachers in each grade range indicate that teachers in their school share ideas and materials on a regular basis (54–66 percent). However, other indicators of collegiality are less encouraging. While slightly more than half of high school teachers report that they and their colleagues contribute actively to decisions about the science/mathematics curriculum, only about a third of elementary teachers do so. In addition, only about 1 in 4 science and mathematics teachers have time during the regular school week to work with their peers on curriculum and instruction and fewer than 1 in 10 indicate that science/mathematics teachers in their school regularly observe each other teaching classes as part of sharing and improving instructional strategies. The picture that emerges is one where teachers do not have time structured into the school day where they can collaborate.

Table 3.1
Science Teachers Agreeing* with Each of a Number of Statements Related to Teacher Collegiality, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
My colleagues and I regularly share ideas and materials related to science teaching	54	(2.7)	59	(4.2)	66	(2.3)
Most science teachers in this school contribute actively to making decisions about the science curriculum	30	(2.5)	48	(3.6)	56	(2.5)
I have time during the regular school week to work with my colleagues on science curriculum and teaching	22	(2.2)	25	(2.7)	27	(2.4)
Science teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	4	(0.9)	5	(1.2)	10	(1.1)

* Includes teachers indicating "strongly agree" or "agree" to each statement.

Table 3.2
Mathematics Teachers Agreeing* with Each of a Number of Statements Related to Teacher Collegiality, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
My colleagues and I regularly share ideas and materials related to mathematics teaching	56	(2.5)	54	(3.5)	62	(2.4)
Most mathematics teachers in this school contribute actively to making decisions about the mathematics curriculum	37	(2.5)	40	(3.0)	58	(2.1)
I have time during the regular school week to work with my colleagues on mathematics curriculum and teaching	25	(2.0)	30	(4.0)	28	(1.6)
Mathematics teachers in this school regularly observe each other teaching classes as part of sharing and improving instructional strategies	5	(1.1)	7	(1.3)	8	(1.0)

* Includes teachers indicating "strongly agree" or "agree" to each statement.

C. Teacher Perceptions of Their Decisionmaking Autonomy

Underlying many school reform efforts is the notion that classroom teachers are in the best position to know their students' needs and interests, and therefore should be the ones to make decisions for tailoring instruction to a particular group of students. The 2000 National Survey of Science and Mathematics Education asked teachers the extent to which they had control over a number of curriculum and instructional decisions for their classes. Results for science and mathematics teachers are presented in Tables 3.3 and 3.4, respectively. Note that in both science and mathematics, teachers in all grade ranges are most likely to perceive themselves as having autonomy in selecting teaching techniques (56–80 percent); determining the amount of homework to be assigned (67–83 percent); choosing tests for classroom assessment (42–80 percent); choosing criteria for grading students (45–71 percent); and selecting both the sequence (36–64 percent) and the pace (45–63 percent) for covering topics. In addition, there is a clear and consistent pattern of perceived autonomy increasing with grade range.

Fewer science and mathematics teachers, especially in the elementary and middle grades, perceive themselves as having strong control in determining the goals and objectives of their courses; selecting the content, topics, and skills to be taught; or selecting textbooks. For example, while teachers in 68 percent of the grade 5–8 science classes report having strong control over the selection of teaching techniques, only 22 percent of these teachers report strong control in selecting the content, topics, and skills to be taught. Again, perceived control generally increases with grade range.

Table 3.3
Science Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions, by Grade Range

	Percent of Classes					
	Grades K–4		Grades 5–8		Grades 9–12	
Determining the amount of homework to be assigned	67	(2.5)	75	(2.4)	83	(1.5)
Selecting teaching techniques	56	(3.3)	68	(2.6)	80	(1.6)
Choosing tests for classroom assessment	53	(2.9)	70	(2.6)	80	(1.6)
Choosing criteria for grading students	50	(2.6)	63	(3.0)	71	(1.7)
Setting the pace for covering topics	45	(3.1)	56	(2.6)	63	(2.2)
Selecting the sequence in which topics are covered	44	(3.0)	59	(2.9)	64	(2.1)
Selecting other instructional materials	28	(2.1)	40	(2.8)	52	(2.5)
Determining course goals and objectives	14	(2.0)	24	(2.6)	39	(2.5)
Selecting content, topics, and skills to be taught	14	(2.0)	22	(2.4)	42	(2.6)
Selecting textbooks/instructional programs	8	(1.6)	22	(2.4)	36	(2.4)

*Teachers were given a five-point scale for each decision, with 1 labeled as "No Control" and 5 labeled "Strong Control."

Table 3.4
Mathematics Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions, by Grade Range

	Percent of Classes					
	Grades K–4		Grades 5–8		Grades 9–12	
Determining the amount of homework to be assigned	68	(2.6)	72	(2.5)	82	(1.5)
Selecting teaching techniques	63	(2.5)	71	(2.7)	74	(1.6)
Setting the pace for covering topics	45	(2.8)	49	(2.5)	50	(1.9)
Choosing criteria for grading students	45	(2.8)	56	(2.3)	70	(1.7)
Choosing tests for classroom assessment	42	(2.5)	66	(2.7)	79	(1.6)
Selecting the sequence in which topics are covered	36	(2.6)	50	(3.2)	52	(2.0)
Selecting other instructional materials	30	(1.9)	41	(2.4)	44	(2.3)
Determining course goals and objectives	12	(1.6)	20	(2.6)	27	(2.0)
Selecting content, topics, and skills to be taught	9	(1.3)	20	(3.1)	27	(2.0)
Selecting textbooks/instructional programs	5	(1.0)	14	(1.7)	25	(2.1)

*Teachers were given a five-point scale for each decision, with 1 labeled as "No Control" and 5 labeled "Strong Control."

Based on the results of a factor analysis, the items in Tables 3.3 and 3.4 were combined into two composite variables—Curriculum Control and Pedagogy Control. (Definitions of all composite variables, descriptions of how they were created, and reliability information are included in Appendix E.) Each composite has a minimum possible score of 0 and a maximum possible score of 100.

The items comprising Curriculum Control are:

- Determining course goals and objectives;
- Selecting textbooks/instructional program;
- Selecting other instructional materials;
- Selecting content, topics, and skills to be taught; and
- Selecting the sequence in which topics are covered.

For Pedagogy Control, the items are:

- Selecting teaching techniques;
- Determining the amount of homework to be assigned;
- Choosing criteria for grading students; and
- Choosing tests for classroom assessment.

Table 3.5 displays the composite scores for science and mathematics classes by grade range. These scores indicate that teachers perceive much more control over decisions related to pedagogy than over those related to curriculum. They also show that, as noted above, perceived control over both dimensions generally increases with increasing grade range. Differences between science and mathematics classes at the same grade range are minimal or non-existent.

Table 3.5
Curriculum Control and Pedagogy Control Composite Scores for Science and Mathematics Classes, by Grade Range

	Mean Score			
	Curriculum		Pedagogy	
Science Classes				
Grades K–4	51	(1.4)	82	(1.1)
Grades 5–8	63	(1.5)	90	(0.9)
Grades 9–12	73	(1.1)	93	(0.5)
Mathematics Classes				
Grades K–4	50	(1.3)	79	(1.3)
Grades 5–8	58	(1.6)	88	(0.8)
Grades 9–12	66	(1.1)	92	(0.4)

As can be seen in Table 3.6, there are some large regional differences in perceived control over decisionmaking. Given that state-wide textbook adoption is primarily a Southern and Western practice, it is not surprising that science and mathematics teachers in these regions are less likely

to consider themselves as having strong control over textbook selection. Other differences are apparent between science teachers in the South and those in the Midwest. For example, only 45 percent of the science teachers in the South feel empowered to select the sequence or pace in which topics are covered, compared to 60 percent of the teachers in the Midwest. Interestingly, regional differences among mathematics teachers are much less pronounced. (See Table 3.7.)

Table 3.6
Science Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions, by Region

	Percent of Classes							
	Midwest		Northeast		South		West	
Determining the amount of homework to be assigned	78	(2.2)	73	(4.2)	72	(2.4)	70	(3.9)
Selecting teaching techniques	72	(2.4)	65	(4.3)	60	(2.4)	68	(4.8)
Choosing tests for classroom assessment	69	(2.4)	63	(4.6)	63	(2.8)	62	(4.2)
Choosing criteria for grading students	65	(2.5)	56	(3.7)	54	(2.5)	60	(4.2)
Setting the pace for covering topics	62	(2.7)	53	(4.9)	44	(2.4)	56	(4.5)
Selecting the sequence in which topics are covered	60	(3.0)	56	(4.8)	45	(2.4)	57	(4.3)
Selecting other instructional materials	40	(3.4)	36	(4.2)	33	(2.1)	38	(3.9)
Determining course goals and objectives	28	(2.7)	27	(4.2)	17	(2.0)	22	(2.7)
Selecting content, topics, and skills to be taught	28	(2.7)	22	(4.5)	18	(1.8)	26	(3.7)
Selecting textbooks/instructional programs	26	(2.7)	26	(3.4)	10	(1.5)	17	(2.4)

*Teachers were given a five-point scale for each decision, with 1 labeled as "No Control" and 5 labeled "Strong Control."

Table 3.7
Mathematics Classes Where Teachers Report Having Strong Control*
Over Various Curriculum and Instructional Decisions, by Region

	Percent of Classes							
	Midwest		Northeast		South		West	
Determining the amount of homework to be assigned	75	(3.0)	74	(2.7)	72	(2.1)	69	(3.0)
Selecting teaching techniques	71	(2.6)	71	(2.8)	66	(2.3)	66	(3.1)
Choosing tests for classroom assessment	60	(3.1)	63	(3.5)	58	(2.3)	53	(2.8)
Choosing criteria for grading students	55	(3.1)	59	(4.1)	53	(2.1)	52	(2.9)
Setting the pace for covering topics	52	(3.2)	54	(3.2)	42	(2.8)	45	(3.1)
Selecting the sequence in which topics are covered	46	(3.4)	54	(3.6)	38	(2.7)	44	(2.9)
Selecting other instructional materials	35	(2.5)	37	(3.3)	38	(2.4)	35	(2.6)
Determining course goals and objectives	20	(2.7)	24	(2.6)	15	(1.7)	17	(2.2)
Selecting content, topics, and skills to be taught	20	(2.4)	19	(2.7)	16	(1.9)	14	(2.3)
Selecting textbooks/instructional programs	16	(1.6)	18	(2.6)	11	(1.4)	9	(1.7)

*Teachers were given a five-point scale for each decision, with 1 labeled as "No Control" and 5 labeled "Strong Control."

Some regional differences are also apparent when looking at the Curriculum Control composite variable. (See Table 3.8.) Again, teachers in classes in the South appear to have the least control over curriculum-related decisions. There are no regional differences in overall control over pedagogy.

Table 3.8
Curriculum Control and Pedagogy Control Composite Scores for Science and Mathematics Classes, by Region

	Mean Score			
	Curriculum		Pedagogy	
Science				
Midwest	66	(1.7)	89	(0.9)
Northeast	64	(2.2)	87	(1.4)
South	53	(1.3)	85	(1.0)
West	60	(2.3)	87	(1.8)
Mathematics				
Midwest	60	(1.6)	86	(1.5)
Northeast	62	(1.9)	87	(1.3)
South	51	(1.4)	84	(1.0)
West	57	(1.7)	84	(1.4)

D. Professional Development

Having discretion in making curriculum and instructional decisions is one of the hallmarks of teachers as professionals. Another is keeping up with advances in their field, a task which is particularly challenging for teachers at the elementary level since they typically teach multiple subjects. Teachers were asked to reflect back to their preparedness "3 years ago" as a backdrop for asking about how helpful their recent professional development experiences have been. Tables 3.9 and 3.10 show the percentage of science and mathematics teachers reporting that they perceived a moderate or substantial need for professional development in each of a number of areas. The relative order of perceived needs was virtually identical between subjects and among grade ranges within subjects—teachers were most likely to report that they needed professional development related to instructional uses of technology and generally least likely to perceive a need for deepening their own content knowledge. Elementary and middle school science teachers were an exception, with content needs rated second only to technology. About 6 in 10 teachers in each subject/grade range category reports needing at least moderate help in learning how to teach students with special needs.

Some striking differences appear in the perceived preparedness of science and mathematics teachers, particularly in the areas of understanding student thinking, assessing student learning, and deepening teachers' own content knowledge. In each instance, elementary level mathematics teachers were less likely than their counterparts in science to perceive that they needed professional development in these areas. Elementary level science teachers are more likely than science teachers in grades 9–12 to report needs for professional development in all but one area

(teaching students with special needs). Differences in teacher preparedness by grade level in mathematics were generally much smaller.

Table 3.9
Science Teachers Reporting They Perceived a Moderate or Substantial Need for Professional Development Three Years Ago, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Learning how to use technology in science instruction	85	(1.9)	78	(3.6)	71	(2.0)
Learning how to teach science in a class that includes students with special needs	59	(2.5)	59	(3.3)	59	(2.2)
Learning how to use inquiry/investigation-oriented teaching strategies	66	(2.2)	61	(3.7)	52	(2.0)
Understanding student thinking in science	62	(2.4)	58	(3.8)	47	(1.9)
Learning how to assess student learning in science	59	(2.5)	54	(3.3)	42	(2.1)
Deepening my own science content knowledge	71	(2.3)	67	(3.2)	38	(1.9)

Table 3.10
Mathematics Teachers Reporting They Perceived a Moderate or Substantial Need for Professional Development Three Years Ago, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Learning how to use technology in mathematics instruction	80	(2.2)	83	(2.2)	67	(1.8)
Learning how to teach mathematics in a class that includes students with special needs	57	(2.6)	59	(3.5)	55	(2.3)
Learning how to use inquiry/investigation-oriented teaching strategies	62	(2.6)	62	(3.6)	53	(2.2)
Understanding student thinking in mathematics	46	(2.3)	51	(3.5)	40	(2.3)
Learning how to assess student learning in mathematics	47	(2.4)	40	(3.5)	32	(2.0)
Deepening my own mathematics content knowledge	45	(1.9)	40	(3.1)	32	(2.2)

Table 3.11 shows the percentages of science and mathematics teachers in grades K–4, 5–8, and 9–12 spending various amounts of time on in-service education in their field in the last three years. While most science and mathematics teachers have had at least some in-service education in their field during that time, relatively few have devoted a substantial amount of time to these activities; percentages of teachers spending 35 or more hours on in-service education in science/mathematics in the prior three years ranged from 10 percent of the grade K–4 science teachers to 45 percent of the high school science teachers. Half of all K–4 science teachers report fewer than six hours of science-related professional development in the last three years. Taking these data together with those in Tables 3.9 and 3.10, it appears elementary science teachers are the most in need of professional development and the least likely to participate in it.

Table 3.11
Time Spent on In-Service Education in Science and Mathematics in Last Three Years, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Science						
None	24	(2.2)	15	(2.4)	8	(1.0)
Less than 6 hours	26	(2.1)	15	(2.4)	8	(1.5)
6–15 hours	26	(2.1)	27	(3.5)	16	(1.3)
16–35 hours	14	(1.7)	25	(3.7)	23	(1.7)
More than 35 hours	10	(1.5)	18	(2.5)	45	(2.0)
Mathematics						
None	14	(1.7)	14	(3.3)	7	(1.3)
Less than 6 hours	22	(2.2)	15	(2.7)	8	(1.4)
6–15 hours	32	(2.2)	29	(3.0)	17	(1.7)
16–35 hours	18	(1.7)	19	(2.3)	25	(1.8)
More than 35 hours	14	(1.7)	23	(2.5)	43	(2.2)

A similar pattern emerges among mathematics teachers. Earlier it was noted that high school mathematics teachers who do not teach advanced classes have weaker content backgrounds than do teachers of advanced mathematics classes. Unfortunately, while these teachers appear to be more in need of in-service education, they are less likely to participate in it. As can be seen in Table 3.12, only 36 percent of the high school mathematics teachers who teach lower level classes had 16 or more hours of in-service education in mathematics in the last three years, compared to 71 percent of those who teach at least one advanced mathematics class.

Table 3.12
Time Spent by High School Mathematics Teachers on In-Service Education in Mathematics in Last Twelve Months and Last Three Years, by Teaching Assignment

	Percent of Teachers			
	Teach No Advanced Mathematics Courses		Teach At Least One Advanced Mathematics Course	
Last Twelve Months				
None	28	(1.9)	12	(1.8)
Less than 16 hours	57	(1.9)	50	(2.7)
16 or more hours	15	(1.1)	38	(2.6)
Last Three Years				
None	14	(1.5	6	(1.1)
Less than 16 hours	50	(1.9)	24	(2.6)
16 or more hours	36	(1.9)	71	(2.8)

Tables 3.13 and 3.14 show the types of professional development activities that science and mathematics teachers reported participating in during the preceding three years. In each subject/grade range category, attending a workshop focused on teaching the subject was the most commonly reported form of professional development; well over half of the teachers reported this activity. Generally, the second most frequently reported activity—ranging from 33 to 57 percent of the teachers—was observing other teachers, either formally or informally. Meeting

with a local group of teachers to discuss teaching issues on a regular basis also appears to be one of the more common forms of professional development.

Table 3.13
Science Teachers Participating in Various Professional Development Activities in Past Three Years, by Grade Range

	Percent of Teachers		
	Grades K–4	**Grades 5–8**	**Grades 9–12**
Attended a workshop on science teaching	58 (2.7)	65 (3.7)	70 (2.2)
Observed other teachers teaching science as part of your own professional development (formal or informal)	33 (2.3)	38 (3.7)	57 (2.2)
Met with a local group of teachers to study/discuss science teaching issues on a regular basis	25 (2.6)	41 (3.7)	53 (2.3)
Taken a formal college/university course in the teaching of science	14 (2.0)	20 (2.7)	26 (1.8)
Taken a formal college/university science course	12 (1.7)	22 (2.7)	37 (1.9)
Served as a mentor and/or peer coach in science teaching, as part of a formal arrangement that is recognized or supported by the school or district	8 (1.9)	14 (2.4)	24 (2.0)
Attended a national or state science teacher association meeting.	5 (1.0)	22 (3.0)	43 (2.1)
Collaborated on science teaching issues with a group of teachers at a distance using telecommunications	4 (0.8)	10 (2.2)	17 (1.4)
Applied or applying for certification from the National Board for Professional Teaching Standards (NBPTS)	3 (0.9)	2 (0.9)	4 (0.6)
Received certification from the National Board for Professional Teaching Standards (NBPTS)	2 (0.8)	2 (1.1)	2 (0.5)

Table 3.14
Mathematics Teachers Participating in Various Professional Development Activities in Past Three Years, by Grade Range

	Percent of Teachers		
	Grades K–4	**Grades 5–8**	**Grades 9–12**
Attended a workshop on mathematics teaching	68 (2.6)	74 (2.8)	80 (2.0)
Observed other teachers teaching mathematics as part of your own professional development (formal or informal)	45 (2.3)	50 (3.6)	53 (2.1)
Met with a local group of teachers basis to study/discuss mathematics teaching issues on a regular basis	35 (1.9)	47 (2.9)	50 (2.0)
Taken a formal college/university course in the teaching of mathematics	18 (2.0)	21 (3.0)	18 (1.5)
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	13 (1.7)	12 (1.9)	20 (1.4)
Taken a formal college/university mathematics course	11 (1.3)	16 (1.9)	18 (1.8)
Attended a national or state mathematics teacher association meeting	7 (1.4)	21 (2.3)	40 (2.4)
Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications	5 (1.0)	7 (1.3)	9 (1.4)
Applied or applying for certification from the National Board for Professional Teaching Standards (NBPTS)	3 (0.8)	2 (0.7)	3 (1.0)
Received certification from the National Board for Professional Teaching Standards (NBPTS)	2 (0.6)	1 (0.5)	2 (1.0)

Within subjects, some differences exist among grade ranges, with a general pattern of teachers in the higher grade ranges being more likely than their elementary counterparts to report particular types of professional development. In mathematics, roughly half of the teachers in grades 5–12 reported meeting with a local group of teachers on a regular basis, compared to one-third of the K–4 teachers. Mathematics teachers in grades 9–12 were about twice as likely as those in grades 5-8 and six times as likely as K–4 teachers to report attending a national or state mathematics teacher association meeting; a similar pattern was observed for science teachers. The pattern of higher grades teachers being more likely to report professional development activities was even more pronounced in science than in mathematics.

Some between-subjects differences appear as well. For example, 37 percent of the science teachers in grades 9–12 reported taking a formal college/university science course in the last three years, compared to 18 percent of the mathematics teachers in those grades.

Tables 3.15 and 3.16 show that science and mathematics teachers in the higher grades are more likely than those in the lower grades to have taken college coursework in their discipline in recent years. The pattern is much more pronounced in science than in mathematics. For example, in 2000 only 19 percent of the grade K–4 science teachers compared to 31 percent in grades 5–8 and 43 percent in grades 9–12 had taken a science course for college credit since 1996. Analogous figures for mathematics teachers are 24 percent in grades K–4, 23 percent in grades 5–8, and 30 percent in grades 9–12.

Similarly, when college courses in either science or the teaching of science are considered, only 27 percent of the science teachers in grade K–4 compared to 51 percent at the high school level had taken a college course since 1996, while the analogous figures for mathematics were 35 and 38 percent.

Table 3.15
Science Teachers' Most Recent College Coursework in Field, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Science						
1996–2000	19	(2.0)	31	(3.0)	43	(1.7)
1990–1995	23	(2.0)	23	(2.8)	28	(2.2)
Prior to 1990	58	(2.7)	46	(4.0)	29	(1.9)
Teaching of Science						
1996–2000	22	(1.9)	28	(3.1)	34	(2.0)
1990–1995	22	(2.5)	19	(2.4)	21	(1.9)
Prior to 1990	39	(2.8)	33	(3.1)	26	(1.8)
Never	17	(1.8)	19	(2.4)	19	(1.9)
Science or the Teaching of Science*						
1996–2000	27	(2.1)	40	(3.7)	51	(2.1)
1990–1995	25	(2.5)	20	(2.5)	25	(2.2)
Prior to 1990	48	(2.8)	40	(3.8)	24	(1.8)

* These analyses include only the 89 percent of teachers who indicated when they last completed a course in science and in the teaching of science.

Table 3.16
Mathematics Teachers' Most Recent College Coursework in Field, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Mathematics						
1996–2000	24	(1.8)	23	(3.0)	30	(2.2)
1990–1995	24	(2.0)	29	(3.3)	26	(1.8)
Prior to 1990	52	(2.2)	48	(3.8)	44	(1.8)
The Teaching of Mathematics						
1996–2000	29	(2.2)	28	(3.0)	28	(1.9)
1990–1995	24	(2.1)	21	(2.7)	21	(1.5)
Prior to 1990	40	(2.1)	39	(3.8)	37	(2.0)
Never	7	(1.2)	11	(2.0)	14	(1.6)
Mathematics or the Teaching of Mathematics*						
1996–2000	35	(2.3)	37	(3.8)	38	(2.2)
1990–1995	25	(2.1)	25	(3.1)	24	(1.7)
Prior to 1990	41	(2.3)	38	(3.8)	38	(1.9)

* These analyses include only the 92 percent of teachers who indicated when they last completed a course in mathematics and in the teaching of mathematics.

Teachers were also asked about different ways they may have served as a resource for their school/district in the 12-month period preceding the survey; these data are presented in Tables 3.17 and 3.18. In both science and mathematics, grade 9–12 teachers were generally more likely than grade 5–8 teachers, who in turn were more likely than grade K–4 teachers, to have participated in each type of activity. For example, 38 percent of high school mathematics teachers indicated serving on a school or district mathematics curriculum committee in the past 12 months, compared to 29 percent of grade 5–8 mathematics teachers and 14 percent of those in grades K–4.

Similarly, 37 percent of high school science teachers, compared to 28 percent in grades 5–8 and 12 percent in grades K–4, had served on a school or district science textbook selection committee in the previous year. Roughly 1 in 7 high school science teachers, but only about 1 in 50 at the elementary level had been involved in teaching science in-service workshops for other teachers. Finally, high school science teachers were considerably more likely than science teachers in the lower grades or mathematics teachers in any grade range to have received a local, state, or national grant or award related to their teaching in these fields.

Table 3.17
Science Teachers Participating in Various Science-Related Professional Activities in Last Twelve Months, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Served on a school or district science curriculum committee	13	(1.5)	35	(3.1)	41	(2.1)
Served on a school or district science textbook selection committee	12	(1.5)	28	(2.9)	37	(2.1)
Mentored another teacher as part of a formal arrangement that is recognized or supported by the school or district, not including supervision of student teachers	15	(2.1)	19	(2.6)	24	(1.5)
Received any local, state, or national grants or awards for science teaching	2	(0.6)	6	(1.6)	16	(1.3)
Taught any in-service workshops in science or science teaching	2	(0.6)	10	(2.2)	15	(1.3)

Table 3.18
Mathematics Teachers Participating in Various Mathematics-Related Professional Activities in Last Twelve Months, by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Served on a school or district mathematics textbook selection committee	15	(1.8)	28	(3.0)	41	(2.2)
Served on a school or district mathematics curriculum committee	14	(1.5)	29	(2.5)	38	(2.1)
Mentored another teacher as part of a formal arrangement that is recognized or supported by the school or district, not including supervision of student teachers	16	(1.6)	17	(2.1)	19	(1.4)
Taught any in-service workshops in mathematics or mathematics teaching	4	(0.9)	13	(2.0)	14	(1.2)
Received any local, state, or national grants or awards for mathematics teaching	2	(0.7)	4	(0.9)	7	(0.8)

Tables 3.19 and 3.20 report teachers' ratings of the emphasis they perceived in their professional development experiences over the last three years. These data make it clear that learning to use inquiry- and investigation-oriented teaching strategies has been a priority in both science and mathematics professional development, ranking in the top two in every subject/grade range category. In mathematics, understanding student thinking has received special attention, especially in grades K–8 where it appears among the most emphasized topics. The emphasis given to technology in science and mathematics at the high school level is striking, especially compared to professional development emphases in grades K–8. Almost half of all high school science and mathematics teachers report that their professional development experiences emphasized learning to use technology for instruction to a great extent.

Finally, these data reveal an apparent mismatch between what teachers believe they need in professional development and what they actually receive. Taking all science and mathematics teachers together, learning to teach students with special needs was rated as one of the greatest needs. Yet across subjects and grade ranges, this area appears to have received the least attention among the listed topics. In a separate analysis, it was found that those who identified a moderate to substantial need for professional development in a specific area generally did not perceive their professional development experiences as emphasizing that area. For example, among

mathematics teachers in grades K–4, 45 percent indicated a moderate or substantial need for deepening their own mathematics content knowledge, yet only 21 percent of these teachers perceived a strong emphasis on content in their professional development experiences. Generally, one-third or fewer of the teachers perceived a strong emphasis in the area where they indicated a strong need. The one exception was technology, where roughly half of the science and mathematics teachers in grades 9–12 who indicated a strong need perceived a strong emphasis in their professional development on learning how to use technology in their instruction.

Table 3.19
Science Teachers Reporting That Their Professional Development Gave Heavy Emphasis to Various Areas,* by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Learning how to use inquiry/investigation-oriented teaching strategies	28	(2.4)	36	(3.9)	35	(2.3)
Understanding student thinking in science	22	(2.4)	28	(3.5)	21	(1.8)
Deepening my own science content knowledge	19	(2.1)	30	(3.6)	26	(2.0)
Learning how to use technology in science instruction	16	(1.7)	30	(3.3)	47	(2.4)
Learning how to assess learning in science	17	(2.2)	26	(3.3)	24	(1.9)
Learning how to teach science in a class that includes students with special needs	9	(1.6)	13	(2.9)	13	(2.2)

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

Table 3.20
Mathematics Teachers Reporting That Their Professional Development Gave Heavy Emphasis to Various Areas,* by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Understanding student thinking in mathematics	32	(2.0)	34	(2.9)	23	(1.8)
Learning how to use inquiry/investigation-oriented teaching strategies	32	(2.2)	32	(2.9)	27	(1.6)
Learning how to assess learning in mathematics	29	(2.1)	28	(2.6)	22	(1.8)
Learning how to use technology in mathematics instruction	22	(1.9)	29	(2.6)	47	(2.2)
Deepening my own mathematics content knowledge	20	(2.0)	20	(2.2)	16	(1.4)
Learning how to teach mathematics in a class that includes students with special needs	14	(1.5)	13	(1.9)	10	(1.3)

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

Teachers who reported participating in professional development with a particular emphasis over the last three years were asked to describe these experiences in terms of whether they had "little or no impact," "confirmed what I was already doing," or "caused me to change my teaching practice." Tables 3.21 and 3.22 report the percentage of teachers indicating a change in their teaching practice. The data include only those teachers who report at least some science/mathematics-related professional development during that time. In general, the results

mirror the emphasis teachers perceived in their professional development; i.e., the more emphasis in an area they perceived, the more likely they were to report changes in their practice in that area.

Table 3.21
Science Teachers Indicating Their Professional Development Activities in Last Three Years Caused Them to Change Their Teaching Practices,* by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Deepening my own science content knowledge	19	(2.8)	24	(2.8)	16	(1.8)
Understanding student thinking in science	23	(3.0)	20	(3.2)	18	(1.6)
Learning how to use inquiry/investigation-oriented teaching strategies	31	(2.9)	30	(3.6)	28	(1.8)
Learning how to use technology in science instruction	22	(2.5)	33	(3.8)	42	(2.2)
Learning how to assess learning in science	17	(2.5)	20	(2.9)	16	(1.5)
Learning how to teach science in a class that includes students with special needs	10	(1.9)	16	(2.4)	13	(1.5)

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

Table 3.22
Mathematics Teachers Indicating Their Professional Development Activities in Last Three Years Caused Them to Change Their Teaching Practices,* by Grade Range

	Percent of Teachers					
	Grades K–4		Grades 5–8		Grades 9–12	
Deepening my own mathematics content knowledge	16	(2.2)	14	(2.7)	13	(1.7)
Understanding student thinking in mathematics	22	(2.0)	18	(2.7)	15	(1.7)
Learning how to use inquiry/investigation-oriented teaching strategies	31	(2.5)	26	(2.6)	23	(1.8)
Learning how to use technology in mathematics instruction	21	(2.5)	29	(2.8)	40	(2.0)
Learning how to assess learning in mathematics	19	(2.2)	19	(2.6)	15	(1.3)
Learning how to teach mathematics in a class that includes students with special needs	13	(1.8)	14	(2.1)	13	(1.4)

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

The apparent impact of science and mathematics professional development is disappointingly weak. With the exception of high school teachers' assessment of their technology-related professional development, fewer than a third of the teachers in each subject and grade range indicated that professional development experiences caused them to change their teaching practice. However, given that well over 50 percent of all science and mathematics teachers report fewer than four days of subject-related professional development in the last three years (see Table 3.11), this finding is not particularly surprising.

E. Summary

Much has been written about the less-than-optimal climate in which teachers work. In this chapter, the data presented on a key indicator of professional climate—collegiality—are not encouraging. In general, teachers do not have time during the school day to collaborate with their colleagues on issues of teaching science and mathematics.

Teachers are strikingly similar across subjects and grade ranges in the needs they perceive for their own professional development. Topping the list of reported needs is learning how to use technology for instruction. Among science teachers in grades K–8, deepening their content knowledge ranked a close second. By their own accounts, elementary science teachers are the most in need of professional development and the least likely to participate in it.

Participation in professional development activities related to science and mathematics teaching is generally low, especially among teachers in grades K–8 where less than 25 percent of the teachers have spent four or more days in professional development related to these subjects over the last three years. The workshop is the most commonly reported form of professional development.

In all their professional development experiences, science and mathematics teachers are most likely to report a strong emphasis on two topics: (1) learning to teach through inquiry and investigation, and (2) learning to use technology in instruction. There appears to be a mismatch between the needs teachers perceive and the emphases reported in their professional development experiences; in general, one-third or fewer of the respondents perceived a strong emphasis in an area where they indicated a strong need for professional development. Finally, less than a third of the teachers who participated in professional development indicated that they changed their teaching practice as a result.