Mathematics Implementation Study

Final Report

June 2000

WestEd
Deborah J. Holtzman
Tania J. Madfes
Steven A. Schneider

RAND
Vi-Nhuan Le
Daniel McCaffrey
Marika Suttorp
Laura Hamilton
Stephen Klein

James R. Smith
Gerald C. Hayward
Naomi Calvo

California Department of Education

Delaine Eastin, State Superintendent of Public Instruction
William Padia, Director, Office of Policy and Evaluation
Larry Boese, Contract Monitor, Office of Policy and Evaluation
http://www.cde.ca.gov/ope/

Research Team

WestEd
Deborah J. Holtzman
Tania J. Madfes
Steven A. Schneider

935 El Camino Real
Menlo Park, CA 94025
(650) 752-1400
http://www.wested.org/

RAND
Vi-Nhuan Le
Daniel McCaffrey
Marika Suttorp
Laura Hamilton
Stephen Klein

1700 Main Street
Santa Monica, CA 90407
(310) 393-0411
http://www.rand.org/

Management Analysis and Planning, Inc. (MAP)
James R. Smith
Gerald C. Hayward
Naomi Calvo

508 2nd Street, Suite 205
Davis, CA 95616
(530) 753-3130
http://www.edconsultants.com/

Advisory Group

Joan Akers
Mathematics Researcher

Judy Anderson/Ruth Cossey
California Math Council

Nicholas Branca
San Diego State University

Maria Carroll
Oakland Unified School District

Kathlan Latimer
Fairfield-Suisun Unified School District

Robert Manwaring
Office of the Legislative Analyst

Donna O'Neil/Chris Westphal
San Juan Unified School District

Special thanks to Gloria Guth, Brenda Hamilton, Jeanne Elliott, Patty Armstrong, Ann Muench, David Ditman, Pam Tyson, Marianne Smith, Lori Riehl, Jackie Vargo, and all others who assisted with the project and the preparation of this report.

The research reported in this document was supported by a contract to WestEd from the California Department of Education, Office of Policy and Evaluation (Contract #7398, "Mathematics Implementation Study"). The views expressed in this report are those of its authors and are not necessarily shared by the California Department of Education.

Table of Contents

(This page intentionally left blank.)

List of Figures

(This page intentionally left blank.)

Executive Summary

Background

In the spring of 1998, the California Department of Education (CDE) awarded a contract to WestEd, in partnership with the RAND Corporation and Management Analysis and Planning, Inc. (MAP), to study mathematics instruction in California. The study was designed to examine the instructional practices used in teaching mathematics in grades 4 and 8, the relationship between instructional practices and student achievement, and the influence of state and local policies on instruction. In addition to instructional practices, primary focuses of the study included curriculum materials, standards, assessment, professional development, and structural and student influences on instruction.

The key data-collection activity of the study was the spring 1999 administration of an extensive survey about teachers' mathematics instructional practices, professional development, and professional background to 800 fourth-grade and eighth-grade teachers in 11 California school districts. Researchers then statistically correlated the survey responses with mathematics achievement data of the responding teachers' students to look for associations between practice and achievement, controlling for prior year achievement and demographic factors. The student mathematics achievement data were from the Stanford Achievement Test, Version 9 (SAT-9). Classroom observations and interviews conducted with teachers, school administrators, and district personnel supplemented the quantitative analysis by providing depth to and context for the findings.

Major Findings

Instructional Practices and Effectiveness. The analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found very few relationships between specific instructional practices and student achievement, and those that were found were very weak. Classroom observations, similarly, found a wide range of practices among teachers of both higher-achieving classes and lower-achieving classes. While these findings do not necessarily prove that no strong relationship between practice and achievement exists, they do suggest that at the very least, the relationship is complex and not easily identified. There does not appear to be a particular instructional method that, even if widely implemented, would improve student mathematics achievement throughout the state.

Teachers themselves identified several different types of practices—and the use of a variety of practices *per se*—as contributing the most to their instructional effectiveness in mathematics. Most teachers appear to value an approach that balances computational mastery and conceptual understanding, and they seek further ideological and practical support for the implementation of this type of balanced approach.

Curriculum Materials. Although curriculum materials often play the major role in shaping instruction, many teachers expressed grave concerns about the programs their districts have adopted and said that they often use other programs—such as those from earlier adoptions or materials intended to be supplementary—instead of or in addition to the adopted programs. Teachers' main concerns about the adopted programs (most of which were from the state's 1994 adoption list) were that they are difficult to use, lack balance between computational skills and conceptual thinking, or are not aligned with current standards and assessments. Teachers who had engaged in materials-related professional development were more likely to use the adopted materials.

Standards. While most teachers liked the *idea* of standards as a guide to instruction, many thought that the currently adopted state standards are too ambitious. Teachers' familiarity with particular standards documents was highly variable, and there was considerable confusion, and some frustration, about different sets of standards (e.g., district, state, national). In general, as of the 1998–1999 school year, content standards had not yet made a consistent, significant impact on instruction at the classroom level.

Assessment. In contrast to standards, the SAT-9 has made a significant impact on schools and teachers, frequently appearing as a major driver of instruction. The test has, however, been the cause of much anxiety at the school level, partly because of a perceived lack of alignment with content standards and with curriculum. Many teachers feel that they are being compelled to "teach to the test" and think that this may not be in students' best long-term interests.

Professional Development. Unsurprisingly, fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers. Moreover, very few fourth-grade teachers who were surveyed reported having strong background in mathematics, and some identified a lack of familiarity with mathematics as being an obstacle to their instructional effectiveness. Many teachers at both grade levels indicated that professional development activities had helped their mathematics teaching, and said they would like more professional development and collaborative opportunities. Providing effective professional development for all teachers of mathematics is, however, a major challenge.

Structural and Student-Related Influences on Instruction. Many teachers identified structural factors, such as those relating to time and class size, as obstacles to their instruction. Teachers' concerns about class size, however, appeared to be as much about variation in student ability as about large classes *per se.* Additional factors identified as obstacles included students' lack of preparation, particularly in basic mathematics skills, poor student behavior and motivation, and lack of parent involvement or support.

Recommendations

The main recommendations that emerge from the findings are as follows:

1. At present, the State Board should not attempt to support a particular methodological approach through its selection of professional development activities or curriculum materials, other than a general advocacy of a "balanced" instructional program. Further research, preferably taking a longitudinal approach and using multiple measures of achievement, is needed to investigate the relationships between instruction and achievement. The State Board and the Legislature should recognize the need for more in-depth, high-quality research and should commit the necessary funds.

2. The State Board should establish a procedure for periodically reviewing the mathematics standards and framework in light of implementation problems, with input from classroom teachers. Districts should provide all teachers with a single set of unambiguous standards, including both content standards and performance standards.

3. The State Board and the Curriculum Commission should ensure that the curriculum materials that are available to teachers are aligned with standards, accommodate the wide range of student needs, and enable the presentation of a balanced instructional approach. To maximize the actual use of the materials and the effectiveness of their implementation, teachers should be provided with opportunities and incentives to engage in professional development related to the use of materials.

4. The State should provide sufficient resources for every California teacher of mathematics to participate in high-quality, sustained professional development. Professional development should attend both to mathematics content and to pedagogy. In addition to the use of materials, professional development should relate to the instructional implementation of the standards and framework in the classroom.

5. The State should continue to improve and augment the STAR program so that its components are properly aligned with state standards.

6. The State should "stay the course." Planning should take a long-term view, focusing on developing and revising policies based on feedback and research; the first hint of less-than-desired student performance should not be considered cause for an abrupt change of direction. The State Board and the Legislature should also take care to ensure that all of the current state education policies are aligned with and support one another.

7. The State Board should set a positive tone for professional discussion and policy debate. Representatives of all stakeholder groups should be "at the table," and a wide range of perspectives should be considered.

(This page intentionally left blank.)

Chapter 1

Introduction

In the spring of 1998, the California Department of Education (CDE) awarded a contract to WestEd, in partnership with the RAND Corporation and Management Analysis and Planning, Inc. (MAP), to study mathematics instruction in California. The study was designed to examine the instructional practices used in teaching mathematics in grades 4 and 8 and the influence of policy on instruction. The findings of the study, which was conducted from June 1998 through June 2000, are reported in this document. Implications for policy are presented as well.

The study focused on the following major research questions:

- What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

- To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

- What influence do state and local policies have on instructional practices? (e.g., policies relating to materials adoption, standards, assessment, etc.)

The original Request for Proposal (RFP) issued by CDE called for a highly comprehensive study at grades 2, 4, 8, and 10 with methods similar to those used in the Third International Mathematics and Science Study (TIMSS). However, the limited resources available necessitated a study somewhat more limited in scope and in the methods used. A detailed discussion of the employed methodology is provided in the following chapter. Key elements were a survey of 800 teachers about their instructional practices, a statistical analysis linking the survey responses with the mathematics achievement data of the responding teachers' students, and observations and interviews with 55 of the surveyed teachers. The study focused on grades 4 and 8 in 11 California school districts.

The RFP also discussed the importance of collecting baseline data about teachers' practices and the influences upon them prior to the emergence of new policies affecting mathematics education. However, several of these new policies were adopted prior to the study's main data collection activities, complicating the effort to establish a baseline. In fact, the study found that many teachers reported greater familiarity with the new policies—such as the California Mathematics Content Standards adopted by the State Board of Education in 1997 and the 1998 California Mathematics Framework—than with earlier policies and documents, such as the 1992 Framework. (Teachers' familiarity with these documents, and the extent to which the documents have influenced instruction, is further discussed in Chapter 5, “Content Standards.”) The flux in policy—and the simultaneous existence of policies that sometimes appear contradictory—not only complicates research efforts, but also creates challenges for teachers, as this report reveals.

Subsequent chapters of this report are as follows:

Chapter 2, Methodology: Describes the study’s research methodology and data collection instruments.

Chapter 3, Instructional Practices and Effectiveness: Presents and discusses quantitative and qualitative study findings on correlations between instructional practices and student achievement.

Chapter 4, Curriculum Materials: Presents study findings on the extent to which district-adopted curriculum materials are used by teachers and discusses teachers’ concerns about instructional materials.

Chapter 5, Content Standards: Presents and discusses study findings on teachers’ reactions to and familiarity with various standards documents, the impact of standards on instruction, and the alignment of standards with curriculum.

Chapter 6, Assessment: Presents and discusses study findings on the impact of the Stanford Achievement Test, Ninth Edition, Form T (SAT-9) and on perceived problems with this and other assessments.

Chapter 7, Professional Development: Presents and discusses study findings on the amount of professional development teachers reported having received since January 1998, the ways in which teachers report that professional development enhances their instruction, and the challenges of providing effective professional development on a wide-scale basis.

Chapter 8, Structural and Student Influences on Instruction: Presents and discusses study findings on the influences on instruction that are structural, such as those relating to time and class size, and that are student-related, such as those concerning student preparation, skill level, behavior, and motivation.

Chapter 9, Recommendations and Conclusions: Summarizes the study’s primary findings in relation to the research questions, discusses policy implications, and presents recommendations based on the findings and implications.

To assist the reader, chapters 3 through 8 each begin with a box highlighting primary findings, followed by a section providing the recent historical background and policy context for the topics discussed in the chapter.

Chapter 2

Methodology

The classroom (grades 4 and 8) constituted the primary unit of analysis for this study. Researchers also focused some attention on the school, district, and state levels, primarily through interviews. A mix of quantitative and qualitative methods were employed. The key quantitative activity was the administration of an extensive survey about teachers' mathematics instructional practices, professional development, and professional background to 805 California teachers; researchers then statistically correlated the survey responses with the SAT-9 data of the responding teachers' students. On the qualitative side, researchers conducted classroom observations of and interviews with 55 teachers and interviewed the principals at the schools of these teachers. District- and state-level interviews were also conducted.

The study and its instruments were designed around a common core of topics based on the project's major research questions. Thus, the data yielded by the survey, interviews, and classroom observations could be triangulated to confirm and enrich the findings. Nevertheless, each of the data sources yielded some different information so as not to be completely redundant. All, however, addressed the important ideas embodied in the research questions.

Teacher Survey

A survey administered to fourth-grade teachers and eighth-grade mathematics teachers constituted one of the primary sources of data for this study. A total of 805 teachers in 11 California school districts were surveyed about their mathematics instructional practices, professional development, and professional background. The research staff sent out the questionnaires used in this survey on a rolling basis from February through May of 1999.

Selection of Districts. A purposive sample of 11 districts was selected. This sample contained six districts considered to have "large" total student enrollments, and five districts considered to have "moderate" total student enrollments. Districts were chosen to be geographically dispersed across California, and most had relatively large numbers of minority, low-income, and limited English proficient (LEP) students. Taken together, the 11 districts contained 1.2 million students—20.2% of all students in the state.

Selection of Schools. Within each of the 11 districts, a random sample of schools was selected. The number of schools selected was designed to provide a target sample of approximately 800 teachers, including (a) a higher proportion of teachers from the larger districts, since larger districts contain a higher proportion of students, and (b) more fourth-grade teachers than eighth-grade teachers, since eighth-grade teachers generally teach mathematics to multiple classes and thereby represent a greater number of students. In the largest district, the targets were 75 fourth-grade teachers and 38 eighth-grade teachers. The corresponding targets in the other five large districts were 50 and 25, and in the moderate-size districts they were 40 and 20.

A systematic sampling procedure was used to select, within each district, a diverse set of schools in terms of student socioeconomic status, ethnicity, and language proficiency. Schools with fewer than 10 fourth- or eighth-grade students were excluded, as were alternative and community schools. Elementary schools selected for the Evaluation of California's Class Size Reduction Program also were excluded, so as to avoid an excessive burden on teachers. The number of schools selected as candidates for participation totaled 168 elementary schools and 79 middle schools.

Once schools were selected, research staff contacted the principals of the selected schools to obtain their agreement to participate in the study. Several of the initially selected schools, however, declined to participate and, as possible, were replaced with other schools of similar demographic profile. The total number of schools ultimately included in the sample was 158 elementary schools and 68 middle schools.[1]

Selection of Teachers. Within each school in the sample, questionnaires were sent to all of the fourth-grade teachers and all of the eighth-grade mathematics teachers. (Teacher names were obtained from the school principal, and the questionnaires were mailed directly to each teacher.) In sum, questionnaires were sent to 570 fourth-grade teachers and 235 eighth-grade teachers.

Questionnaire Development. The questionnaire was based on other, pre-existing survey instruments of similar nature, namely: (1) the "Survey of Elementary Mathematics Education in California" questionnaire developed by the Center for Research on the Context of Teaching at Stanford University; (2) questionnaires developed by Horizon Research, Inc. for the National Science Foundation's Local Systemic Change Initiative, and (3) the "Reform Up Close" questionnaire developed by the Wisconsin Center for Education Research. Once drafted, the questionnaire underwent numerous rounds of revision based on feedback from project staff, Advisory Group members, and CDE staff.

Two different versions of the questionnaire were developed, one for the fourth-grade teachers and one for the eighth-grade teachers. Most items on the two versions were

[1] More detailed information on the school sampling procedure is included in the RAND report in Appendix A.

identical; however, there were some differences necessary given that while most fourth-grade teachers teach mathematics to only one group of students, eighth-grade teachers often teach multiple mathematics classes per day. Because any given teacher may use different practices in different classes taught, the eighth-grade version instructed respondents to fill out the practices questions for only one class: their "first mathematics class of the day in which at least half of the students are in 8th grade." Teachers were then asked to indicate the class period for which they were filling out the questionnaire, and to write in the title of this class (e.g., Math 8, Algebra, Integrated Math, etc.).

Questionnaire Composition. The questionnaire was mainly composed of discrete-answer questions with a few open-ended response items. The items on the questionnaire were divided into the following topic areas:

- Current teaching situation: grade levels taught, number of classes per day taught, and subjects other than mathematics taught
- Mathematics instruction "in your class" (fourth-grade)/"in a particular class" (eighth-grade): amount of time for mathematics instruction, class size and class composition, frequency of use of a wide range of instructional practices (on a 5-point Likert scale, from "never" to "almost daily"), objectives for mathematics instruction, mathematics content topics taught, and curriculum materials
- Recent developments in mathematics education: familiarity with various standards documents, opinions about these documents, and ratings of school/district alignment with the documents (on a 4-point Likert scale, from "disagree strongly to "agree strongly," with a fifth option for "don't know")
- Professional development and support: amount of mathematics professional development (total and by certain topics) since January 1998, opinions about support, and frequency of teacher collaboration
- Professional background: mathematics courses taken, degree received, teaching credential, and years of teaching experience
- Teacher demographic information: gender and racial/ethnic background
- Additional comments: open-ended items about factors facilitating or impeding effective mathematics instruction.

The complete questionnaire (both fourth-grade and eighth-grade versions) is included in Appendix B.

Response Rate. Questionnaires were received back from 310 (54.4%) fourth-grade teachers and 139 (59.1%) eighth-grade teachers. However, 49 of these questionnaires were eliminated due to the following reasons:

- the respondent's class did not contain at least one-third students at the appropriate grade-level (fourth or eighth)
- the respondent had not been teaching for most of the school year

- the students of the respondent were lacking test scores
- at the fourth-grade level, the respondent was part of a team where different teachers shared or rotated students for mathematics instruction (meaning that students' test scores could not be linked to a particular teacher's instruction)
- the students in the respondent's classes could not be identified by project staff.

After these eliminations were made, questionnaires remained from 281 (49.3%) fourth-grade teachers from 136 schools and 119 (50.6%) eighth-grade teachers from 57 schools.[2]

Generalizability. Because the participating districts were not a random sample of all districts in California and because of the moderate response rate on the survey, the results of this study may not be representative of all the state's students and teachers. This is especially true for districts with small enrollments. Consequently, the relationships (or lack thereof) presented in this report cannot be generalized to the state as a whole. Nevertheless, due to the large number of students and teachers included in the sample, the results are likely to be meaningful and merit further consideration.

Student Achievement Data

The research design called for the linking of teachers' questionnaire responses with mathematics achievement data of their students to see if any correlations between practices and achievement existed. The student mathematics achievement data selected for use in this analysis were from the Stanford Achievement Test, Version 9 (SAT-9), a multiple-choice assessment administered to nearly all California students in grades 2–11. Students took this test in the spring of 1999, after they had been in the class of the participating teacher for most of the year.

Participating districts provided the data. Some districts were able to provide the student data given only teachers' names. Other districts required student identification numbers; in these districts, researchers obtained the class rosters of the teachers who had responded to the survey. A small number of rosters could not be obtained, so the questionnaires for these teachers had to be eliminated from the study.

The 281 fourth-grade teachers had a total of 6,885 students with valid SAT-9 scores. However, 70 of these students were missing demographic data and were excluded from further analyses, so the final fourth-grade sample consisted of 6,815 students. The 118 eighth-grade teachers included in the survey-test score linking analysis had 3,063 students,

[2] One of the 119 eighth-grade teachers filled out the questionnaire about a geometry class. Because this was the only geometry class in the sample, it was excluded from the analysis linking practices with test scores. However, this teacher was kept in the sample for most other analyses.

but 30 were missing demographic data, resulting in a final eighth-grade sample of 3,033 students.

The student demographic data included in the analysis consisted of gender, racial/ethnic group, home language, and whether the student participated in a gifted program, a special education program, and/or a free or reduced price lunch program. Students' 1998 SAT-9 mathematics scores and their 1998 and 1999 SAT-9 reading scores were included in the analysis as well. (See the RAND report in Appendix A for a description of how these data were used.)

School Visits: Classroom Observations and Interviews

In May and June of 1999, trained mathematics observers visited the classrooms of and conducted interviews with 55 teachers in the study. All of the teachers had filled out the questionnaire and were located in eight of the eleven districts participating in the study.

Selection of schools/classrooms for visits. Eight of the eleven study districts were selected for school visits. Within each district, the goal was to select two elementary schools and two middle schools to visit, and to observe and interview two teachers in each selected school, thereby yielding a sample of 64 classrooms observed. The procedure for selecting the visited schools/teachers was as follows:

- Within each district, all schools from which at least two teachers had returned the questionnaire were identified.
- If there were more than two such schools in the district, researchers randomly selected two from the list.
- The questionnaires from the teachers at the selected schools were screened (a) to make sure their classes consisted of at least half fourth or eighth graders and (b) to make sure that the observation sample as a whole would include a wide range of class types (e.g., at the eighth-grade level, not too many algebra classes; at both grade levels, not too many high-percentage LEP classes).
- For any school that did not have at least two teachers' classes meet the selection criteria, researchers randomly selected a replacement school and screened it similarly.
- The selected schools/teachers were contacted to request the visit. Schools that declined were replaced with others, using the same random selection and screening criteria. Teachers were offered a $25 honorarium for participation.
- For schools from which more than two teachers returned the questionnaire, two of the teachers were selected based on convenience factors (or, if possible, more than two teachers were visited/observed). At the eighth-grade level, efforts were made to

visit the exact class periods about which the teachers filled out the questionnaire, or, if this was not possible, to visit a "similar" class.

Fifty-five teachers—28 fourth-grade teachers from 14 elementary schools and 27 eighth-grade teachers from 14 middle schools—were visited and interviewed. The principals at 26 of the 28 schools also were interviewed.

The visited schools displayed a wide range of demographic characteristics and overall student achievement. For example, several different Academic Performance Index (API) rankings—both statewide rank and similar schools rank—were represented among the visited schools. Figure 2.1 shows the API rankings of the visited fourth-grade schools, and Figure 2.2 shows the API rankings of the visited eighth-grade schools.

Figure 2.1
Fourth-Grade Visited Schools' 1999 Academic Performance Index Rankings

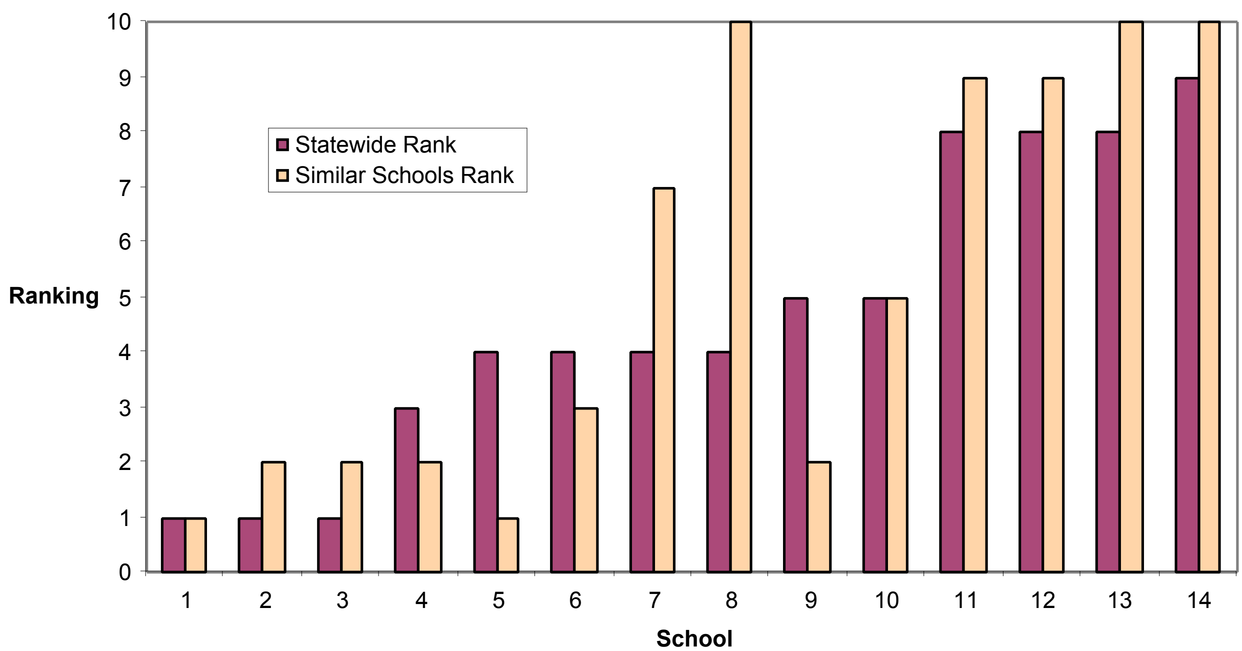
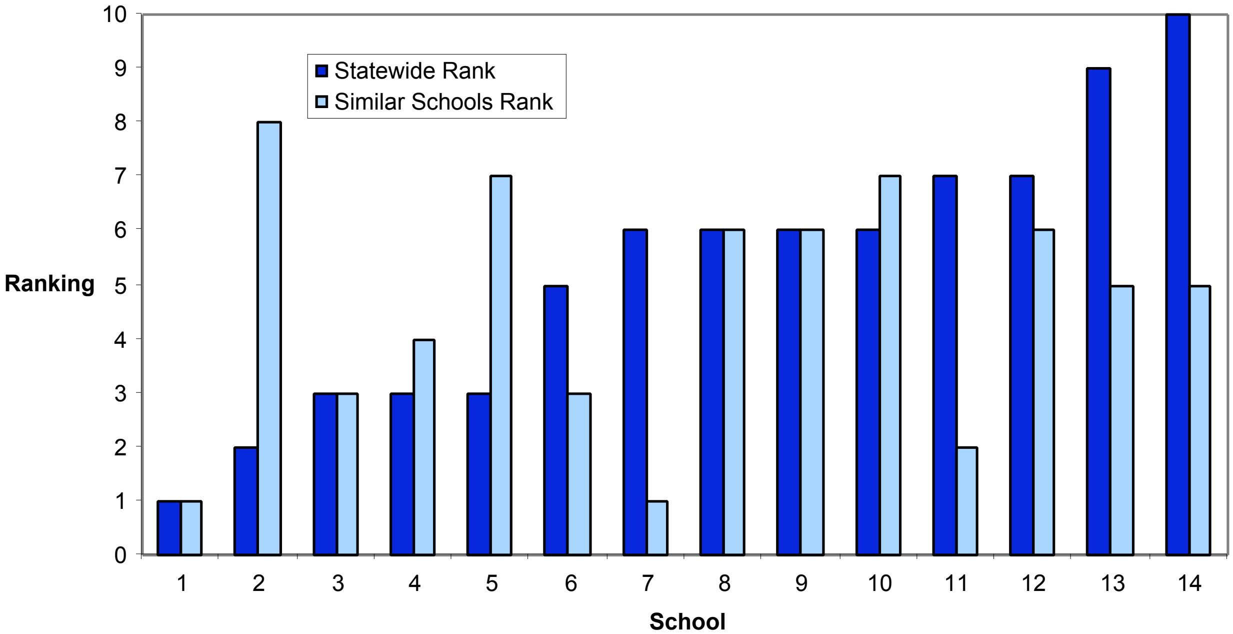


Figure 2.2
Eighth-Grade Visited Schools' 1999 Academic Performance Index Rankings



Classroom observations. Each teacher was visited only once, and only one mathematics lesson/class was observed.[3] In most cases the visit was made by a single observer, but in some cases two observers made the visit. Observers were asked to write up a summary of the observation, including attention to the content of the lesson; the organization of students; the purpose of the lesson; representations, tools, and resources used; assessment during the lesson; focus of classroom discourse; language differences; students with special needs; and behavior and discipline. The complete protocol for this write-up is included in Appendix B.

Observers were also asked to compare each teacher's practice *as observed* to practice as reported by the teacher on the questionnaire. The purpose of this comparison was to validate the questionnaire. However, because most of the questionnaire items about teaching practices asked about frequency of their use, complete validation was not possible given the "one-shot" observation. Observers could, nevertheless, attempt to verify the presence of practices teachers reported engaging in "almost daily," and, conversely, verify the absence of practices teachers reported "never" using. The overall results of this analysis, across all the classroom observations, did not find the questionnaire to be invalid. (Two

[3] That each class was observed only once is a limitation of the study, as instruction in that one class may not have been representative of the teacher's instruction. That the visits were made toward the end of the year compounds this problem, as instruction close to the end of the year may differ from instruction earlier in the year.

questionnaire items were, however, found to be ambiguous and were thus not included in the analysis.)

Teacher interviews. The teachers' whose classes were observed were also interviewed. A brief interview was conducted prior to the observation and consisted mainly of questions about the lesson planned. A lengthier interview was conducted following the observation and included questions about the lesson observed, the teacher's "philosophy and practice" regarding mathematics instruction, perceived influences on mathematics instruction, and effectiveness in teaching mathematics. Again, the complete protocol is included in Appendix B.

Principal interviews. As mentioned, the principals at most of the observed schools also were interviewed. The principal interview protocol, also included in Appendix B, contained questions about the school's mathematics program, support from the district, school and teacher discretion, influences on mathematics instruction and achievement, professional development, and areas for improvement.

District-Level Interviews

In four of the eight districts where school visits occurred, a district curriculum administrator (e.g., district mathematics coordinator) was interviewed. The district-level interview included questions about the district's mathematics program; influences on mathematics instruction in the district; the use of content standards; professional development; student mathematics achievement; strengths and weaknesses of district mathematics instruction; and accountability. The district-level interview protocol is included in Appendix B.

Other Interviews

Interviews were conducted with a variety of other stakeholders as well, in order to gain a wide range of additional perspectives on mathematics instruction and implications for policy. Individuals who were interviewed included members of the Legislature/legislative staff, members of the State Board of Education and their staff, administrators from the California Mathematics Project and the California School Board Association, a mathematics professor, and a focus group of teachers formed by the California Federation of Teachers.

Questions in these interviews solicited opinions on the current level of mathematics achievement in California, on the appropriate role of state policy makers for the improvement of mathematics instruction, and on the appropriateness of the current state strategy for improving mathematics achievement. Interviewers next presented some of the study's major findings and asked for opinions on the appropriate policy responses to these findings. Because the interviews involved discussion of study findings, they took place toward the end of the study, in April and May of 2000.

Tenth-Grade Pilot Study

In addition to the more thorough investigation at grades 4 and 8, some exploratory research and development work was conducted at grade 10. This exploratory work utilized instruments and protocols employed at the fourth- and eighth-grade levels, but did not analyze any student achievement data. The intent of this work was to refine the instruments and procedures for use in a future high school study and to frame the major issues involved in undertaking such a study. The tenth-grade research consisted of the following elements:

- The eighth-grade teacher questionnaire was adapted for the tenth-grade level. (See Appendix B.) Four mathematics teachers from two high schools within a single district completed the instrument. These teachers then participated in a focus group to critique the questionnaire and its appropriateness for use with high school teachers.

- Researchers conducted observations in classrooms of the four teachers who had participated in the focus group. The classes that were observed—two Geometry classes, one Algebra 1 class, and one Advanced Algebra class—each had more than 50% tenth-grade student enrollment. The observation protocol was the same as that used for the fourth- and eighth-grade levels.

- Interviews were then conducted with the four teachers, the mathematics department chair and principal at each school, and the district mathematics resource specialist. The protocols for these interviews were similar to those used for the larger study.

The findings from this exploratory study are not included with those from the main study in the body of this report. Rather, the implications for a tenth-grade study are included in Appendix D.

(This page intentionally left blank.)

Chapter 3

Instructional Practices and Effectiveness

Highlights of Findings

- **There is no strong correlation between specific types of instructional practices and student achievement.**
  An analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found only weak relationships between instructional practices and student achievement. Classroom observations, similarly, found a wide range of practices among teachers both of higher-achieving classes and lower-achieving classes. While these findings do not necessarily prove that no strong relationship between practice and achievement exists, they do suggest that at the very least, the relationship is complex and not easily identified. There does not appear to be a particular instructional method that, even if widely implemented, would improve student mathematics achievement throughout the state.

- **Teachers themselves listed several different types of practices—and the use of a variety of practices *per se*—as contributing the most to their instructional effectiveness in mathematics.**
  In the opinion of teachers, several different types of practices—and perhaps even more importantly, a *combination* of different types of practices—contribute to instructional effectiveness. For example, many teachers attributed their effectiveness to a focus on both computational mastery and conceptual understanding, or to the use of a variety of different strategies, perhaps based on diagnostic assessment of students' needs.

- **Although teachers value a balanced approach, they do not always have the training or support necessary to effectively implement such an approach.**
  Many teachers, especially at the fourth-grade level, believe that an approach balancing computation and conceptual understanding is important. However, teachers do not always have a clear sense of how to implement such an approach, nor do they always feel supported by the school, district, or state in the implementation of a balanced approach.

Background

Nearly every academic area has faced some degree of national, state, and/or local controversy surrounding appropriate content and instructional practices. For example, for much of the early 1990s, the debate between "whole-language" and "phonics" approaches dominated discussions of the teaching of reading. At the heart of the mathematics discourse in recent years has been a debate between "reform" practices, emphasizing hands-on, higher-order conceptual thinking, and "traditional" practices, emphasizing memorization and practice of basic skills, such as arithmetic. At times, and in some places, the debates have escalated to the point where the media has dubbed them the "math wars" (e.g., Hartocollis, 2000; Mervis, 2000).

Contributing to the debates has been a dearth of research on effective practices—especially research clearly indicating what, if any, types of practices seem to be associated with higher achievement. The lack of conclusive research stems partly from the difficulties inherent in analyzing student achievement and attributing effects to instructional and/or other factors. Educating children is a complex enterprise, especially given the diversity of their needs and the rapidly changing nature of society. Determining what seems to help improve achievement—particularly when there may not be any one or two easily identified and measured factors—can seem nearly impossible.

Exacerbating the dilemma of investigating factors contributing to achievement is that the educational landscape is in a near-constant state of flux. In part, this is due to the political nature of educational governance. A given set of policy makers may do a great deal to implement their ideas for educational improvement, but frequently their efforts are short-lived; no sooner do they put their programs in place than a new administration, with different ideas and different programs, takes over. The result is that few attempts at real change ever even become implemented at the level of the classroom—much less become implemented *effectively* (O'Neil, 2000). Those few that *are* implemented seldom take hold long enough for their effects on student achievement to be evaluated with reliability and validity. Before the effects of certain policies or approaches can be determined, researchers must document that these policies and approaches were even implemented.

There has, of course, been some prior research into mathematics instruction. One of the most well-known studies was the 1995–96 Third International Mathematics and Science Study (TIMSS), which was designed to foster a better understanding of how mathematics and science learning in the United States compares with that in other nations. The study looked at student achievement, curriculum and expectations for student learning, classroom instruction, and the lives of teachers and students. However, although this was the largest international comparison study ever conducted, it did not attempt to analyze the relationships between student achievement and instructional practice in individual classrooms. In fact, the TIMSS reports caution that "no single factor in isolation from others should be regarded as the solution to improving the performance" of U.S. students, and that "no single factor or combination of factors emerges as overwhelmingly important" with regard to patterns of achievement (U.S. Department of Education, 1997, pp. 15, 18).

Nevertheless, some earlier research has reported small, positive associations between achievement and some types of instructional practices. For example, Stipek, Salmon, Givvin, Kazemi, Saxe, and MacGyvers (1998) found that emphases on problem-solving and process-oriented solutions were related to higher scores on a mathematics test of conceptual understanding. Other studies have found a positive relationship between the teaching of higher-order thinking and achievement (Martinez & Martinez, 1998; Ginsburg-Block & Fantuzzo, 1998). Research has also demonstrated the value of collaboration (Webb & Palincsar, 1996) and of embedding instruction in real-world contexts (Verschaffel & DeCorte, 1997). Cohen and Hill (1998), meanwhile, found that teachers' use of practices consistent with the 1992 California Mathematics Framework was positively related to student achievement.

This study, too, explores the relationships between student achievement and instructional practices. Results of this analysis are presented in this chapter. The matter of the effects of policies on instruction—and the levels of actual implementation—is taken up in subsequent chapters.

Quantitative Findings on Instructional Practices and Effectiveness

As explained in the Methodology chapter, one of the essential elements of this study was a statistical analysis linking teachers' survey responses with the mathematics achievement data of the responding teachers' students. The goal of this analysis, which was conducted by RAND, was to identify practices associated with higher achievement. Results are presented below, preceded by a discussion of what types of practices appear most prevalent, as reported by teachers on the questionnaire.

- **On the questionnaire, teachers reported relatively frequent use of teacher-centered, problem-solving, and computational practices; conversely, instructional use of computers appeared to be an infrequently used practice.**

The questionnaire items were grouped into 12 scales, 7 of which related to instructional practices and 5 of which related to the influence of standards, professional development, and teaching environment. The scales were as follows:

1. Teacher-Centered Practices
2. Problem Solving
3. Computational Practices
4. Applications
5. Group Work
6. Individual Work [1]
7. Computer Use
8. Familiarity and Influence of Mathematics Frameworks and Standards
9. Alignment with District Standards
10. Perceived Teacher Support
11. Perceived Teacher Collaboration
12. Professional Mathematics Development

The grouping was done using a combination of judgments about item content and empirical analysis. Specifically, questions that were intended to measure the same construct were grouped together. These judgments were then evaluated with an empirical analysis using intercorrelations. Items within each scale usually correlated more strongly with one another than they did with items on other scales. Appendix A1 (at the back of Appendix A) shows the questionnaire items in each scale. For instance, the "Teacher-Centered Practices" scale comprised the following questionnaire items:

- Go over homework with the class
- Demonstrate how to solve a particular type of problem
- Listen to teacher presentation of a new topic or procedure

Figure 3.1 shows the mean, standard deviation, and reliability (coefficient alpha) of each of the seven "practices" scales at each grade level. (Survey results about the influence of standards, professional development, and teaching environment will be discussed in subsequent chapters.) Each of these seven scales used a 5-point Likert scale, where a rating of "5" indicated "almost daily" use of the practices, and a rating of "1" indicated that the practices were "never" used. As the table shows, teachers reported very frequent use of teacher-centered practices, and fairly frequent use of problem-solving and computational practices. The use of computers, on the other hand, appears to have been a practice only infrequently used by most teachers.

[1] It is important to note that the individual work and group work scales were not opposites of one another, and that teachers could engage in both types of activities and thereby receive high scores on both scales; i.e., if their students frequently worked collaboratively as well as independently. Similarly, teachers could receive low scores on both scales if they frequently engaged in other activities that were not represented on either scale.

Figure 3.1
Mean, Standard Deviation, and Reliability Coefficient for
Each of the Seven "Practices" Questionnaire Scales at Grades 4 and 8

Scales	Fourth Grade			Eighth Grade		
	Mean	SD	Alpha	Mean	SD	Alpha
1) Teacher-Centered	4.45	.51	.49	4.69	.39	.35
2) Problem-Solving	3.88	.46	.80	3.68	.44	.71
3) Computational Practices	3.56	.54	.59	3.45	.49	.52
4) Applications	2.85	.47	.53	2.73	.43	.43
5) Group Work	2.81	.71	.69	2.37	.59	.65
6) Individual Work	2.42	.74	.58	1.93	.58	.62
7) Computer Use	1.82	.75	.86	1.48	.55	.86

- ♦ **The frequency of certain types of practices appeared to be related to some student and teacher characteristics.**

There was, of course, considerable variation in teachers' reported use of particular instructional practices. In some cases, differences in practices appeared linked to other factors, such as classroom and student characteristics. For example, at the fourth-grade level, teachers with a higher proportion of gifted students were less likely to use computers or have students work individually. Teachers who reported that their class was "fairly homogeneous and average in ability" were more likely to use group work. Teachers with a higher proportion of gifted, LEP, and special education students were less likely to focus on mathematics applications.

At the eighth-grade level, teachers who described their class as "fairly homogeneous and high in ability" were more likely to report the use of computers, while teachers with students "fairly homogeneous and low in ability" were less likely to engage in teacher-centered practices. Teachers of classes with a higher proportion of female students reported emphasizing computational practices less frequently, but those teaching a higher proportion of African American students focused on computational practices more often.

Some teacher characteristics also appeared to be related to use of certain types of instructional practices. At the fourth-grade level, female teachers (74.1% of respondents) tended to report a focus on computational skills. African American teachers (6.6% of respondents) reported using group work less frequently, and Hispanic teachers (11.8% of respondents) reported engaging in individual work less often. Hispanic teachers were also less likely to emphasize applications and to use computers in instruction. Moreover, fourth-grade teachers who reported that they collaborated with one another and that their practices were influenced by standards were more likely to emphasize group work, individual work, applications, and higher-order thinking skills. Greater collaboration was also positively related to computer use, as was more mathematics professional development. Additionally, teachers who had taken more mathematics courses tended to report more frequent use of group work.

Among the eighth-grade teachers, greater influence of standards and more mathematics professional development (both as reported by the teachers themselves) were positively related to the reported use of problem-solving practices. Teachers of integrated math courses were more likely than either Math 8 or algebra teachers to indicate the use of computers, and were less likely to report engaging in teacher-centered practices.

- **The statistical analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found only weak relationships between instructional practices and student achievement.**

The regression analyses of the relationships between the teacher questionnaire scales and student achievement controlled for district, student ethnicity, student gender, participation in a gifted program, participation in a special education program, free or reduced lunch status, LEP status, prior year scores in mathematics and reading, and 1999 reading scores. In addition, at the fourth grade level, coverage of probability was also included as an independent variable[2]; at the eighth-grade level, type of mathematics course was included.[3]

A variety of other variables, such as teacher characteristics (ethnicity and gender), teacher background (certification type, degree, and mathematics coursework), class size, and instructional time devoted to mathematics, were not found in preliminary analyses to be significantly related to student outcomes, hence these variables were dropped. One exception was total number of years teaching, which was positively related to test scores: a one-unit standard deviation increase in years teaching was associated with a .074 standard deviation unit gain in scores at the fourth-grade level and a .043 standard deviation unit gain in achievement at the eighth-grade level. However, this variable was also related to instructional practices, meaning that if the analysis adjusted for total years teaching, the effects of instructional practices on achievement would be reduced. Because of this, the final analysis used two models, one with the total number of years included, and one without.[4]

---

[2] Preliminary analyses indicated that among all of the mathematics content topics listed on the questionnaire (in an item asking about teachers' coverage of each topic), only probability appeared to be related to achievement. Thus, the other topics were eliminated, while probability was retained.

[3] The course categories used in this analysis were Math 8 (included courses identified as Math 8, Math 7/8, pre-algebra, and problem solving), Algebra, and Integrated Math.

[4] More detail about how the analysis was conducted, as well as the results of the analysis, is included in Appendix A (the RAND report). The analysis was sufficiently multi-pronged and thorough to detect the presence of any strong correlations within the data itself, given the nature of the instrumentation.

The majority of teacher scales did not show a statistically significant relationship with student outcomes.[5] At the fourth-grade level, only one scale was significantly related to achievement when controlling for total years teaching: practices emphasizing applications. The relationship, however, was very weak (a one-unit standard deviation increase on this scale was associated with a .035 standard deviation unit gain in scores). In the model *excluding* total years teaching, the relationship between the applications scale and achievement lost its significance, but another scale—the use of practices emphasizing computational skills—was slightly positively associated with achievement. But again, this effect, significant only in one of the two models, was quite small—a one-unit standard deviation increase on the computational practices scale was associated with a .036 standard deviation unit gain in scores. In both models, some coverage of probability was positively associated with higher scores (a .088 standard deviation unit increase in scores with years of teaching excluded, and a .076 increase with years of teaching included).

The finding that coverage of probability and practices emphasizing application and computational skills were positively related to student achievement is logical given the content of the SAT-9, which includes many contextualized statistics items that require procedural and declarative knowledge. Because the test focuses on problems that are solvable via heuristics, it may not be the most appropriate measure to assess higher-order thinking skills. Thus, the failure to find a significant association between problem-solving practices and achievement might stem from limitations of the SAT-9 as opposed to a lack of relationship *per se.*

At the eighth-grade level, greater reported use of computers in instruction was negatively related to outcomes, but again, the effect was quite small: a one-unit standard-deviation increase on the computer-use scale was associated with a .041 standard deviation unit decrease in test scores. The negative relationship may be attributable to several sources. Students who receive computer instruction may spend more time "playing with" the computer than actually using it to solve mathematics problems. In a related manner, teachers who use computers may need to devote more instructional time to logistics (e.g., explaining how to use the computer), which might translate to less time focusing on mathematics concepts. Moreover, the SAT-9 may not be sensitive to detecting the effects of computer instruction. Some mathematics problems that can be presented via a computer may not translate well to a paper-and-pencil format. It might be the case that students who receive computer instruction are encountering different kinds of mathematics problems in their classrooms than those presented on the SAT-9.

Another finding at the eighth-grade level was that the teacher-centered scale was positively related to test scores for algebra courses, but such practices were unrelated to outcomes for

[5] Figures illustrating the regression coefficients for both models at both fourth- and eighth-grade levels are included in Appendix A.

Math 8 courses. This may be attributable to differences in the content of the two types of courses: whereas Math 8 courses typically entail ideas that have been introduced in prior mathematics classes, algebra tends to involve skills and concepts that are unfamiliar and qualitatively different from those previously learned. Hence, teacher-centered practices, such as going over homework or demonstrating how to solve a problem, may be more beneficial with algebra than with Math 8. This interaction illustrates the importance of considering course content when evaluating the relationship between achievement and instruction, as particular practices may be more effective with one course than another.

- **That the analysis found only weak relationships does not necessarily mean that stronger relationships do not exist.**

A few caveats must be kept in mind when interpreting the results presented above. First, as mentioned above, the nature of the SAT-9 may render it an inappropriate measure for assessing relationships between certain classroom practices and achievement. Moreover, there were concerns that the validity of the SAT-9 may have been compromised by efforts to "teach to the test." (The matter of "teaching to the test" will be discussed further in the chapter on Assessment.) If teachers are indeed narrowing their curriculum to the topics found on the SAT-9, serious questions arise regarding the inferences that can be drawn from the scores.

In addition, because the study did not employ an experimental design, we cannot be certain that the observed relationships are attributable solely to classroom practices. There may be other systematic student, teacher, and school variables that were not measured but that nevertheless affect what teachers do and what students learn.

Furthermore, the lack of significant relationships between many of the scales and the test scores should be interpreted cautiously because some of these scales were low in reliability. This makes it difficult to detect effects. The results for two of the scales—the teacher-centered practices scale and the problem-solving scale—should be viewed with particular caution as responses on these scales were highly skewed toward frequent reported use.

Even more importantly, all of the scales depended on the accuracy of teacher perception about their practices, which may not always have been 100%. Surveys are an imperfect measure of identifying instructional practices; like any such measure, the items are subject to inaccurate responses, particularly those that reflect social desirability.

Another possible explanation for the lack of effects stems from the study's focus on students' exposure to practices during a single academic year, which does not allow us to follow changes in teachers' practices or examine the effects of student exposure to these practices across several years. Some practices may have been implemented only a short time ago, in accordance with recently released standards. Teachers may need more time before they can effectively implement the practices, or students may need to be exposed to the practices for more than a single year before the effects of these practices on achievement become clearly evident.

Finally, the survey questions addressed only the frequency with which teachers used particular practices and did not address the way in which they were used or the overall quality of instruction. Although classroom observations and teacher interviews, which will be discussed in the following section, helped alleviate this problem, the small-scale basis of this qualitative data collection limits the extent to which its findings can be generalized.

Qualitative Findings on Instructional Practices and Effectiveness

- ♦ **As with the quantitative survey/test score analysis, classroom observations did not find that any particular type of instruction or set of instructional practices was necessarily correlated with higher student mathematics achievement. Observed teachers with higher-achieving classes displayed a wide range of practices.**

The classes of the 55 teachers who were visited by trained mathematics observers ranged across the spectrum of achievement. Some of the teachers had classes who, on average, performed at the high end of the spectrum (as compared to the other classes in the sample and controlling for students' prior year achievement and demographic characteristics), while others were toward the middle or at the low end. When all of the teachers in the entire survey sample (281 fourth-grade teachers and 118 eighth-grade teachers) are divided into quartiles based on their classes' SAT-9 achievement, each quartile includes at least some of the observed classes, as illustrated by Figure 3.2.

Figure 3.2
Achievement Quartiles of the Observed Classes

Quartile	Number of Fourth-Grade Observed Classes in the Quartile	Number of Eighth-Grade Observed Classes in the Quartile
1 (lowest)	5	2
2	6	7
3	7	7
4 (highest)	10	10
Total	**28**	**26**[6]

[6] One eighth-grade class that was observed lacked student test scores, and thus was not able to be included in the survey analysis. Hence the total number of classes in this table is 54, not 55.

As the figure shows, however, the observed classes are not evenly distributed over the four quartiles, but rather cluster toward the upper end, with the fewest number of classes in the first quartile and the highest number in the fourth quartile. The reasons for this are not entirely clear, but may be due to a self-selection factor. Although candidates for classroom visits were chosen randomly (provided certain criteria were met), teachers were not required to host visits, but rather were presented with the option of being visited or not. Some teachers did indeed decline to be visited, either when initially contacted with the request or in subsequent cancellations. It may be that teachers with lower-performing classes were less likely to agree to be visited, thereby tilting the sample of visited classes toward the upper end of the achievement spectrum.

As with the quantitative analysis discussed in the previous section, an analysis of observers' qualitative write-ups/descriptions of the observed classes did not reveal any strong, overt trends or correlations between types of instructional practice and student achievement. For example, when the observation data on all of the top-quartile visited classes were examined (10 fourth grade and 10 eighth grade), no clear commonalities could be traced, nor did they appear to be much different, as a group, than the observed classes in lower quartiles. Overall, it appeared, on the basis of classroom observations, that no particular type of instruction was linked with higher student achievement (as a class) on the SAT-9.[7] To the contrary, teachers whose classes performed well (relative to the rest of the survey sample) displayed a wide range of instructional practices. Selected classroom profiles included in Appendix C highlight the range of practices employed by the teachers of observed top-quartile classes.

As a case in point, at one school that was visited, the two observed fourth-grade teachers both had classes in the top quartile of student achievement but held differing philosophies of instruction and displayed markedly differing types of instructional practice. Contrasting snapshots of the different philosophies and practices of these two teachers—Marc and Vince (pseudonyms)—are presented here.

> *In response to interview questions about teaching philosophy, Marc said that he wants the inherent creativity of mathematics to be apparent to his students, and that he doesn't want his students to be intimidated by the subject (as he was as a student). He said that he uses many visual representations and as many manipulatives as possible.*
>
> *In the lesson of Marc's that was observed, the class was working on a supplementary unit involving polygons in which students were designing a futuristic city. During the whole-class review of polygons that started the lesson, the class discussed the derivation of words and the relationship of terms used in mathematics to other activities and contexts. Marc related the word*

---

[7] However, as only one observation per teacher was conducted, and most observations were made toward the very end of the school year, few generalizations can be made about the observed' teachers' instructional practices. Multiple visits spread throughout the school year might provide a more complete picture of any given teacher's type of instruction.

lateral *to a recent field trip to the aquarium and reminded students of how they looked at the parts of fish, especially the fins. When working with students to show why a triangle was a right triangle, Marc asked students to show how they are supposed to bend their elbows (at 90 degrees) when doing a particular folk dance. (This teacher choreographs dances for students, relating the mathematics he is using.)*

The main part of the lesson had the students working together in teams to solve a design problem. The teams actively discussed the process of mathematical thinking required, while the teacher monitored the groups' work and worked with those who did not understand the task. All students appeared to be engaged in the tasks at hand and worked well together. After about 30 minutes of group work, Marc asked the groups to report, either in writing or by drawing, the method by which they obtained their information. He then took a survey. Marc closed the lesson by making sure that the group leaders took notes on what to do next; they were to continue after lunch.

Vince, meanwhile, mentioned in the interview that he believes students need reinforcement of basic arithmetic skills and that speed is important. His general approach to mathematics teaching is focused on raising test scores and preparing students to take standardized tests. Although he knows that cooperative learning has become "popular," he thinks it is only useful if students already have all the required skills and can be in homogeneous classrooms.

During Vince's lesson, two students at a time were called to the board to do drill problems on basic operations while the rest of the class worked on the problems at their seats. Some story problems were given; these, too, focused on operations (mainly simple adding or subtracting). Although the accuracy of students at the board was noted, no feedback was provided to the other students about their work. (Each student went to the board at least once.) The teacher kept score for the pairs who went to the board, and a play-off round for speed was the culminating activity. Although an aide circulated among students, the teacher never left his seat during the entire lesson. At various times, low-level, closed questions were asked of the students at the board; no explanations were offered. There was no discussion, nor was there conversation among students. Most students did, however, look engaged.

- **In the opinion of teachers themselves, several different types of practices—and perhaps even more importantly, a *combination* of different types of practices—contribute to instructional effectiveness.**

There is one further data source on the factors contributing to teachers' instructional effectiveness: teachers' self-report. The fourth-grade questionnaire included an open-ended item that asked, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?" The eighth-grade questionnaire included a similar, but not quite identical, item: "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"[8] Admittedly, teachers' responses to these questions were not systematically analyzed in relationship to the achievement of the teachers' classes, and thus can only be taken for what they are—self-report, with no external validation. However, they do provide a snapshot of what teachers themselves tend to think of as important to instructional effectiveness.[9]

Most likely because of the slightly different way the question was phrased at each of the two grade levels, the eighth-grade responses were somewhat different from the fourth-grade responses. Eighth-grade teachers, who were asked about their effectiveness "as a mathematics teach*er,*" were more likely to give responses having to do with themselves or their personal characteristics. Such responses, given by more than 65% of responding eighth-grade teachers (60 of 88) but only by about 35% of fourth-grade teachers, included things like:

- affection for or rapport with students
- love for or understanding of mathematics
- organizational or classroom management skills
- ability to motivate or explain
- enthusiasm, patience, or flexibility
- experience or background (in teaching or in other professions).

In contrast, fourth-grade teachers, who were asked about the effectiveness of their "mathematics teach*ing*," were much more likely to talk about instructional approaches or strategies. Indeed, more than 50% of fourth-grade respondents (120 of 219) gave such answers, but fewer than 30% of eighth-grade respondents did.

Within the broad category of "instructional approaches or strategies," however, many different types of responses were given. The larger subcategories included the following:

Tailoring instruction to students' needs. About 15 fourth-grade teachers talked about the importance of basing instruction on student needs, for example as determined by diagnostic assessments or by student feedback. Responses along these lines included the following:

> *Using student feedback to determine and provide what is needed for understanding*
>
> *I try to build on their individual needs*
>
> *Continual assessment of my students. I use this information to guide the content of my lessons.*

---

[8] The questions were phrased differently from one another because of the different context for mathematics teaching at grades 4 and 8. Most eighth-grade mathematics teachers teach mathematics as their only or primary subject area, so these teachers are appropriately considered "mathematics teachers." Fourth-grade teachers, however, generally teach multiple subjects, so the question asked about their mathematics teach*ing.*
[9] See Figure E1 in Appendix E for a graph of responses to the survey item.

One of the classroom observers, who visited a total of 13 classes (including both fourth-grade and eighth-grade classes), hypothesized that ongoing attention to students' needs might be an important factor in instructional effectiveness. This observer reflected:

> *Although one particular teaching strategy did not significantly correlate to the teacher efficacy [in the 13 observed classes], teachers' paying attention and responding to the vicissitudes of kids' attention/engagement emerged as the strongest correlate to efficacy.*[10] *This recommends a specific strategy: teachers should consider changing approach on an as-needed basis to keep students engaged. Moreover, classroom observation data suggest that classroom problems are related to teachers not noticing what is going on with students as they teach and not making necessary changes to re-engage students so that they do not fall behind. In contrast, students benefited from teachers who reflected on the following queries: "Am I using students' time well?" "Are the activities productive?" "How much of a given class allows students to be idle?" The teachers who mentioned these concerns tended to establish and promote more productive use of student time.*

Making real-world connections. Roughly 20 fourth-grade teachers gave a response about connecting mathematics to the real world or to students' lives. "Getting students ready for 'real-life' mathematics," wrote one teacher. "Application to the real world and everyday usage of mathematics is stressed," wrote another. "Make situations relevant to students' experiences," commented a third. The other responses in this subcategory were similar.

The use of hands-on materials and/or an activity-based approach. This subcategory was the largest, including responses from more than 30 fourth-grade teachers. Many of the responses merely mentioned "manipulatives" or "hands-on learning" without much elaboration, but some discussed the use of manipulatives in introducing concepts or in developing students' conceptual understanding. For example, one teacher talked about how manipulatives and exploration help students "discover concepts and formulas." Another said that "using manipulatives to introduce new concepts" enables students to "advance further with confidence."

Focusing on basic skills, step-by-step sequential building, or practice and reinforcement. About 25 fourth-grade teachers attributed their effectiveness to an emphasis on basic skills, step-by-step building, or repeated practice. "I have a step-by-step approach that builds sequentially from one skill to the next," wrote one teacher; "I make sure the students understand and have learned the material before we move on to more complex concepts," he continued. "Getting children to understand the basic skills and why we need math," wrote another teacher. Other responses spoke of such things as constant review and practice, scaffolding techniques, and memorization of basic mathematics facts.

[10] Efficacy in the observed class based on the observer's judgment of whether instruction was likely to contribute to students' understanding of mathematics; not necessarily linked to higher test scores.

Responses to the Instructional Effectiveness Survey Question by the Teachers of the Higher-Achieving Classes

Teachers of the higher-achieving classes in the survey sample attributed their effectiveness to a wide range of factors. The table below displays the responses of the teachers of the top performing classes in the survey sample—ten at each grade level—to the instructional effectiveness survey question.

Figure 3.3

Responses to the Instructional Effectiveness Survey Question by the Teachers of the Top Ten Classes

Class Rank in Study (1=highest)	Fourth Grade Responses to "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?"	Eighth Grade Responses to "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"
1	*Emphasis on both basic skills and problem solving; on-going application of skills in content areas & real life situations. Consistent daily homework in math encompassing a variety of skills & mathematical strategies. Emphasis on critical thinking in all content areas.*	*organized & prepared lessons!* *clear student expectations!*
2	*right now consistency—I am desperately in need of more training which our school is scheduled to receive next year.*	*[no answer given]*
3	*Sharing ideas with other teachers.*	*[no answer given]*
4	*Availability of manipulatives/materials* *Teachers knowledge of subject matter/seminars*	*—Patience* *—Willingness to try new things* *—Intelligence*
5	*scaffolding techniques - review/review/review* *memorize basic facts/ mental math* *teach logical thinking skills.*	*My high school math teacher (3 years)*
6	*I picked my own teaching materials.* *I only used MathLand about 10% of my teaching.*	*math degree* *love of math for math's sake.*
7	*—Flexibility to roll with the reality; tailoring instruction to the class.* *—Hard work.* *—Not allowing stragglers to get away.*	*[no answer given]*
8	*—Following an old math text as a guide* *—Teaching to top students & review for others* *—Dedication to students!*	*Collaboration with other teachers at my school and in the district. Respect for my students and vice versa which leads to good rapport and classroom environment*
9	*Knowing the subject matter and how to teach it.*	*My love of mathematics and my understanding of math*
10	*Relating math to real life situations* *Combining concept understanding with computation mastery*	*Belief in mathematics to analyze and solve a wide variety of problems*

Using a variety of different approaches or having a "balanced" program. By no means are any of the aforementioned subcategories mutually exclusive.[11] It was not uncommon, for example, for a teacher to list a focus on *both* basic skills and hands-on activities. For instance, one teacher wrote, "I have a balance of computation and problem solving activities; students use manipulatives and we work on conceptual development as well as learning algorithms."

In fact, many teachers said that variation in approach, *per se,* was the factor that most contributed to the effectiveness of their mathematics instruction. Responses such as the following came from approximately 30 fourth-grade teachers:

> *I use a variety of teaching techniques.*
>
> *The way I incorporate a variety of teaching strategies and activities to really help the students understand the concepts and why and how they solve the problems.*
>
> *A variety of methods; from traditional, such as textbooks, to more progressive ones such as the use of manipulatives, etc.*

Although relatively few eighth-grade teachers discussed instructional approaches as the primary factor in their effectiveness, some of those who did also mentioned the use of different strategies and approaches.

Overall, the evidence clearly indicates that most teachers do not believe that any one instructional approach is necessarily the most effective—at least not for all teachers (or for all students) at all times. What works well for one teacher with one group of students may be less effective for another teacher or for a different group of students. And what appears to work best for many teachers (at least according to the teachers themselves) is a combination of approaches, or—as some put it—a "balanced program." In this way, the findings from the quantitative survey analysis, the classroom observations, and teachers' self-report all suggest that there are no "magic bullets" for improving student achievement.

- **Many teachers believe that an approach balancing computation and conceptual understanding is important. However, teachers do not always have a clear sense of how to implement such an approach, nor do they always feel philosophically supported in the implementation of a balanced approach.**

The perceived need for "balance"—such as between computation and conceptual understanding, or "traditional" vs. "reform" approaches—was reiterated in responses to

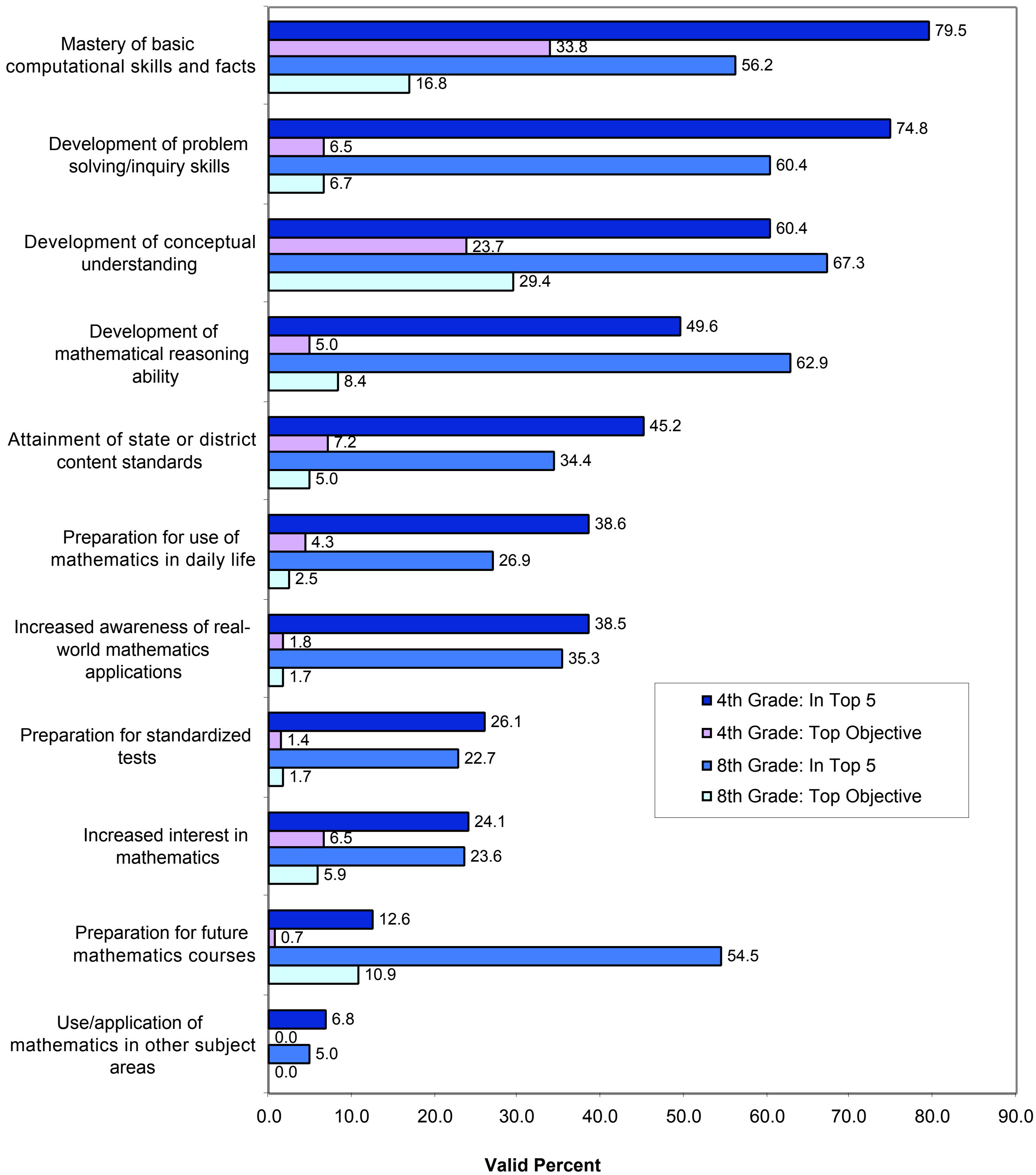
[11] There were also other large categories of responses to the effectiveness question, such as materials and professional development. (See Figure E1 in Appendix E.) These will be discussed in subsequent chapters. Instructional approach and teacher personal characteristics, were, however, the most commonly cited types of responses to the effectiveness question, as discussed here.

other survey questions and in interviews. For example, one survey item listed 11 possible objectives for mathematics instruction, and asked teachers to select the 5 objectives on which they placed the most emphasis for students in their class. Teachers were then asked to rank order the 5 objectives they had selected from 1 to 5 in terms of the emphasis they placed on each one. Figure 3.4 lists all 11 objectives, and shows what percentage of teachers included each objective among their top 5 and what percentage selected each objective as their top one. The chart includes separate figures for the fourth-grade teachers and the eighth-grade teachers.

As the figure shows, "mastery of computational skills and facts," "development of problem solving/inquiry skills," "development of conceptual understanding," and "development of mathematical reasoning ability," were the objectives most frequently selected—particularly as one of the top five—by teachers at both grade levels. Nearly 80% of fourth-grade teachers picked "mastery of basic computational skills and facts" as one of their top five objectives, but "development of problem solving/inquiry skills" followed close behind, selected by about 75% of fourth-grade teachers. Among eighth-grade teachers, "development of conceptual understanding" was the objective most commonly included in the top five, selected by 67.3% of teachers. Taken as a whole, the figure suggests that teachers highly value both basic skills mastery and problem solving/conceptual/reasoning ability.

[text continues on page 30]

Figure 3.4
Teachers' Top-Ranked Objectives for Mathematics Instruction
(fourth grade n=278; eighth grade n=119)



However, teachers' placing *value* on these various objectives does not necessarily mean that they are skilled at effectively teaching to each one. For example, some of the teachers who were interviewed talked about the importance of problem solving or of fostering conceptual understanding, but when these teachers' classes were observed, observers sometimes found little evidence of the stated objective in practice. One experienced observer, who visited four fourth-grade classrooms, commented:

> *Teacher understanding of "problem solving" is not consistent with currently used definitions espoused by NCTM and other reform groups. Two teachers told me they were concentrating on problem solving during my observations, yet in one class the students were doing routine, rote computations and in the other, students were being asked to recognize pairs of equivalent fractions. There is much concentration on procedural development, not conceptual development.*

Indeed, one elementary school principal who was interviewed commented on the need for teachers to receive additional professional development in how to create a balanced approach combining both computation and problem solving:

> *Last year was our PQR year, and we chose math as the area to examine and look at practices in. What came out of that process was that we, as a staff, realized that we needed more knowledge and more training in how to teach problem solving, while at the same time teaching computational skills. We know the current math push is for problem solving, and we agree with that, but I still think computation is important; if you can't add or multiply it's hard to solve problems. So, we dedicated staff development to this; we got additional training from district personnel—they came and did three sessions—to help teachers with strategies and ideas on how to specifically do that: obtain the level of computational skills but not to sacrifice problem solving. That's what our philosophy has been: to be able to do both effectively, and not one at the expense of the other.*

However, not all teachers even believed that there was *ideological* support for such a balanced philosophy. Several teachers objected to the tendency for curriculum policy to swing from one extreme to the other without stopping in the middle, or without remaining consistent for a suitably long period of time. "Too much of a swing from traditional math to inventive math and now back to traditional," wrote one fourth-grade teacher on the survey in response to the question, "What are the biggest obstacles to your mathematics teaching?" And, in response to the question "If there are specific state, district, or school policies that have hindered your mathematics teaching, please describe," an eighth-grade teacher wrote, "Constant change in direction: in today, out tomorrow." Another eighth-grade teacher said in an interview:

> *I feel very strongly that there needs to be a balance between skills and manipulatives. The theory behind figuring out how to do the problems, as well as memorizing algorithms, and I think that there needs to be a balance behind that…I'm aware that there's trends… We had gone on a trend towards interactive [mathematics], and we're now moving more towards the basics; I would like to see the pendulum kind of stop more in the middle, where we have a balance between the two.*

An eighth-grade teacher in a different district commented, “I’ve seen the modern math pendulum swing from one extreme to the other. Why can’t it stay in the middle? I believe in activity-based teaching to a point, but basic skills still need to be taught…. I believe in five years we’ll go back to basics.”

Apparently, then, while many teachers agree that the pendulum is swinging from one side to another, they do not always agree on exactly which way it is swinging; some see a trend back to basics, while others think the move is in the opposite direction, towards hands-on “reform” approaches. This likely is due to different emphases within different districts and also different emphases at national, state, and district levels. Indeed, some teachers commented that they felt different forces—such as the state vs. their district, or content standards vs. standardized tests—were pulling them in different directions, and that they did not always know how best to deal with this. As one fourth-grade teacher wrote, “Often I’m torn between ‘mixed messages.’ The district stresses conceptual understanding, hands-on, relationship-oriented math, while the state is requiring a more ‘traditional’ mastery of concepts. It’s often hard to know what and how to teach math.”

The current *Mathematics Framework for California Public Schools,* which was adopted by the State Board of Education in 1998 (see Chapter 5), states the following:

> *Mathematics education must provide students with a balanced instructional program. In such a program students become proficient in basic computational and procedural skills, develop conceptual understanding, and become adept at problem solving. All three components are important; none is to be neglected or underemphasized. (p. 7)*

Thus, to the extent that the body of this *Framework* supports the notion of balance, it may help alleviate some of the concerns teachers expressed. However, in order to have this effect, teachers will need to become familiar with the *Framework* and must have the means (e.g., aligned curriculum materials and professional development) to implement its ideas in the classroom. Such topics will be discussed in subsequent portions of this report.

In the Next Chapter

As discussed above, many teachers believe in the importance of a balanced instructional approach, but feel thwarted in their implementation of such an approach by a lack of ideological support for it at the school, district, or state level. In addition, many teachers indicated that a lack of sufficiently balanced curriculum materials hindered their efforts to foster both computational mastery and conceptual understanding among students. This, along with other findings about teachers’ use of and thoughts on curriculum materials, is discussed in the following chapter.

(This page intentionally left blank.)

Chapter 4

Curriculum Materials

Highlights of Findings

- **Although curriculum materials often play the major role in shaping instruction, many teachers reported grave concerns about the programs their districts have adopted and said that they use other programs instead.**
  At the fourth-grade level, the most commonly cited obstacles to mathematics teaching had to do with curriculum materials. The use of curriculum materials did not appear to be as problematic at the eighth-grade level as at the fourth-grade level, but materials were still an issue. A substantial proportion of survey respondents said that they use programs other than those adopted by their district as their primary curriculum resource, suggesting that caution should be exercised in attributing low student achievement to adopted materials, since these materials may not even be in widespread use. Programs from previous adoptions and supplementary materials are what many teachers use instead of or in addition to the programs from the current adoption. A lack of professional development in the use of the adopted materials may be partly responsible for teachers' preference for other materials.

- **Teachers' main concerns about curriculum programs had to do with usability, balance, and alignment.**
  One of the most commonly cited concerns about districts' adopted programs was that they are difficult to use—that they are "unfriendly," hard to read, disorganized, or require too much photocopying. Another frequently mentioned concern about the adopted materials was that they lack a sufficient balance between computational skills and conceptual thinking. A third commonly cited concern about curriculum materials was that they are not aligned with standards and/or assessments.

- **Teachers do, however, appreciate the adopted curriculum programs for some purposes and would value *supplementary* use of these programs.**
  Many teachers believe that their district's adopted curriculum program works well as a supplement but not as a base text. Some teachers already use the adopted programs in this way, but other teachers feel they lack the freedom to do so or have difficulty finding appropriate alternate materials in sufficient quantities.

Background

Like several other states, California adopts instructional materials for the major subject areas, including mathematics, on a statewide basis. (However, whereas other states use such a process for all grades K–12, California's constitution mandates statewide adoption only for grades 1–8.) In predetermined years on a multi-year cycle for each subject area, the State Board of Education adopts the instructional materials that are deemed suitable for use, based on prespecified evaluation criteria tied to the most recently adopted curriculum framework. In general, the State Board adopts only programs that are designed for use by students and teachers as a principal learning resource for a full-year course of study. The most recent major ("primary") adoptions for mathematics programs were in 1994 and in 1999.

Until recently, there has been one major pool of state money from which districts could draw for the purchase of K–8 instructional materials: the Instructional Materials Fund (IMF). Districts are required to use at least 70% of their IMF funds (allocated to districts based on average daily attendance) for the purchase of instructional materials that have been adopted by the state. However, districts may spend up to 30% of their IMF funds on materials other than those adopted by the state, provided that these materials meet certain legal compliance criteria. Moreover, districts may petition the State Board of Education for approval to use up to 100% of their IMF allocations on non-adopted materials.

State-level changes over the past three years have significantly affected the nature and process of instructional materials adoption and purchase. In particular, the adoption of new state content standards and standards-aligned frameworks (see next chapter) instigated some changes to materials adoption. For future materials adoptions, adopted materials will be required to "help teachers present the content set forth" in the new standards. In an effort to facilitate the use of standards-aligned materials, the state legislature enacted AB 2519. This bill provided for a series of standards-based materials adoptions, including a special adoption for mathematics and language arts in 1999 and for mathematics in 2001. Unlike the usual adoptions, the 1999 AB 2519 adoption allowed for the adoption of partial or supplementary programs as well as basic full-year programs.

In addition, in 1998 the legislature appropriated $250 million per year (for four years, beginning in 1998–1999) for the purchase of the newly adopted standards-aligned materials in the four core curriculum areas (reading/language arts, mathematics, history/social science, and science). Districts were permitted to use these funds (also allocated based on average daily attendance), known as the Schiff-Bustamante Funds, for purchase only of the specially adopted standards-aligned materials.

The data collection for this research study took place in 1998–1999, before most of the new changes affecting instructional materials went into effect. Thus the data do not reflect these changes—in particular, the move toward materials that are aligned with the state standards. Most of the materials that teachers in this study reported using were among those adopted by the State Board in 1994, when the curriculum framework and adoption criteria were substantially different from those currently in place.

Curriculum Programs in Use

♦ **For many teachers, the textbook plays the major role in shaping curriculum and instruction.**

One of the questions asked of teachers who were interviewed was, "How do you decide what mathematics to teach?" Although the range of responses given was fairly wide, one of the more common responses was along the lines of "I follow the textbook." Two of these responses were as follows:

> *[from an eighth-grade teacher] How do I know what to teach? I basically just follow along through the book. That's how I'm knowing what I should be teaching.*

> *[from a fourth-grade teacher] I follow the book. The district said we have to use it. I occasionally use other texts too.*

Clearly, instructional materials have a strong impact on what teachers teach. Of course, even when teachers "use the book" to guide their curriculum planning, they may be selective about the content they choose to emphasize and the exercises they decide to assign. Hence, two teachers "following" the same text may be teaching significantly differently curricula. This difference can be magnified when one or both of the teachers use supplemental materials of their own choosing, as indicated by the speaker of the second remark quoted above.

Moreover, teachers do not always think that the materials they are given to work with are the most effective or the easiest to use, and some of them primarily use materials other than those adopted by their districts. For example, one of the fourth-grade teachers who was interviewed stated, "The old textbook runs curriculum." Here is a clear case of curriculum driven by a book, but perhaps not the book intended by the current district administration. These issues will be further discussed in the following sections of this chapter.

♦ **At the fourth-grade level, the most commonly cited obstacles to mathematics teaching had to do with curriculum materials. The use of curriculum materials did not seem to be as problematic at the eighth-grade level, but materials were still an issue.**

When asked on the survey, "What are the biggest obstacles to your mathematics teaching?" nearly half of the fourth-grade respondents (105 out of 234, or 44.9%) mentioned something having to do with curriculum materials. Indeed, no other type of obstacle was cited by nearly as many teachers; the next most commonly discussed obstacle had to do with class size/ability range, cited by about one-quarter (26.5%) of the fourth-grade respondents.[1] (Class size will be discussed in the chapter on structural and student influences on instruction.)

Similarly, in response to the question, "If there are specific state, district, or school policies that have hindered your mathematics teaching, please describe," the greatest number of fourth-grade responses (57 of 156, or 36.5%) had to do with curriculum materials.[2] Moreover, several teachers included comments about their curriculum materials in the survey's final question, "Do you have any additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?" Thus it would seem that, at the fourth-grade level, teachers perceive curriculum materials—and the adoption policies surrounding them—as a strong but often problematic influence on their instruction.

The matter of curriculum materials appeared to be slightly less of an issue at the eighth-grade level than at the fourth-grade level. Whereas over 40% of the fourth-grade teachers mentioned something having to do with curriculum materials as being one of the biggest obstacles to their mathematics teaching, only about 20% of eighth-grade teachers did so. However, curriculum materials still formed the second-largest category of eighth-grade responses to the obstacles question. Moreover, in the hindering policies survey question, curriculum materials constituted the largest category of eighth-grade responses, at 21.7%—not quite as large as the fourth-grade teachers' 36.5%, but certainly still substantial.

♦ Many teachers do not use the curriculum materials that have been adopted by their district as their primary curriculum resource.

In terms of the specific objections raised, the majority of respondents raised concerns about the nature of the particular mathematics curriculum program/textbook that had been adopted by their district (or, in a few cases, by their school). To place these comments in context, it is important to know what these texts were.

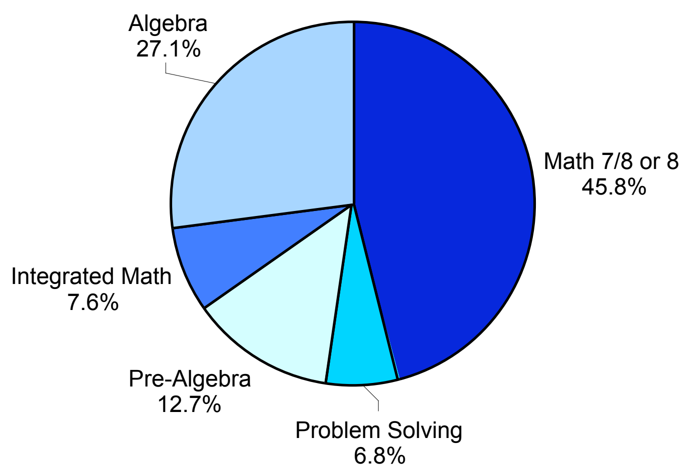
At the fourth-grade level, the most commonly adopted programs[3] were *MathLand* (Creative Publications), adopted by three of the eleven survey districts, and *Quest 2000* (Addison

[1] See Figure E2 in Appendix E for a graph of responses to this survey question.
[2] See Figure E4 in Appendix E for a graph of responses to this survey question.
[3] Here we are referring to the districts' *primary* adoptions. Several districts also adopted supplementary materials.

Wesley), also adopted by three districts. Dale Seymour *Investigations in Number, Data, and Space,* meanwhile, was the adopted text in two of the other districts. Of the remaining three districts, one district had adopted Houghton Mifflin *Mathematics* and another district had adopted *Mathematics Plus* (Harcourt Brace)[4]. In the final district, there was no one single program that was adopted for districtwide use.[5]

The matter of curriculum materials adoption at the eighth-grade level is somewhat more complex, as not all teachers are teaching the same type of mathematics course. Some may be teaching Math 8, while others are teaching algebra, still others are teaching integrated math, and so on. (Figure 4.1 shows the percentage of different types of eighth-grade mathematics courses represented in the survey sample.) Each different course type may have its own adopted text; thus, the range of curriculum materials used and adopted at the eighth-grade level is quite wide—much wider than at the fourth-grade level.

Figure 4.1
Eighth-Grade Courses in Survey Sample
(n=118)[6]



To simplify matters, the analysis of teachers' use of adopted curriculum materials at the eighth-grade level was limited to the eighth-grade teachers who filled out the questionnaire

[4] Interviews indicated that this district also allowed the use of *MathLand*.
[5] A curriculum administrator who was interviewed in this district indicated that the district had adopted three programs: *MathLand*, *Quest 2000*, and Dale Seymour *Investigations.* However, only a few schools in the survey sample from this district appeared to have adopted *MathLand*, and none seemed to have adopted either of the other two programs. According to the survey, the programs most commonly used by teachers in this district were Addison Wesley's *Mathematics*, Silver Burdett Ginn's *Mathematics: Exploring Your World,* and Holt, Rinehart and Winston's *Mathematics Unlimited.*
[6] The one teacher not included answered the questionnaire for a geometry class.

about Math 8 or Math 7/8 (henceforth referred to as “Math 8”).[7] As Figure 4.1 shows, such teachers constituted nearly one-half of the survey sample.

There were six survey districts in which five or more Math 8 teachers filled out the questionnaire. In all but one of these six districts, Glencoe’s *Interactive Mathematics* was the adopted curriculum program for Math 8. The Glencoe *Interactive* text was also the program most likely to be mentioned by name in the eighth-grade teachers’ written survey comments and in interview remarks. As a result, the analysis of eighth-grade teachers’ use of and concerns about their curriculum materials focused on this program.

Identifying districts’ adopted programs, however, is only part of the story in identifying what programs teachers use—a district’s adoption of a program does not guarantee its actual use by teachers in the classroom. As detailed in the text and Figure 4.2 below, many teachers indicated on the questionnaire that the text adopted by their district was not the primary text they themselves used.

Survey question #20b asked, “What mathematics textbook, published instructional program, or curriculum resource do you use the most in your class?” Although space was provided for only one program (teachers were asked to fill out the title, publisher, and copyright date if known), many teachers listed two, slightly complicating the analysis of the responses. If a teacher listed two programs, then use of each program was considered to be “in combination.” If a teacher listed only one program, then use of that program was considered “pure.” In reality, however, even teachers who listed only one program may have been using other programs as well, but they might have felt obligated by the phrasing of the question to list only one. This is a limitation of the data on what programs teachers were using.

As Figure 4.2 shows, in the one district where *Mathematics Plus* (Harcourt Brace) was the major adopted program, it appears to have been implemented to a relatively high degree, in terms of the number of teachers reporting its use as their primary program. Of 23 teachers in this district responding to #20b, 17 of them (73.9%) reported that this was their primary program. Three others indicated the use of *MathLand*, also allowed by this district. The fact that the district gave schools a choice about their program may help explain why such a high percentage of teachers in the district were indeed using the adopted programs.

The other districts—and programs—did not fare as well. In the district where Houghton Mifflin *Mathematics* was the adopted text, only 11 out of 19 teachers (57.9%) reported its use as the primary program, and only 9 of them reported using it “pure.”

[7] Unlike the previous chapter, this discussion does *not* consider courses identified as pre-algebra or problem-solving to be Math 8.

Figure 4.2
Use of the Adopted Program in Selected Survey Districts, as Reported in Survey Question 20b

Program	Number of Survey Districts That Adopted the Program	Number of Teachers in Those Districts Responding to #20b	Number (and Valid Percent) of Teachers Reporting "Pure" Use of the Program in #20b	Number (and Valid Percent) of Teachers Reporting Combination Use of the Program in #20b	Total Number (and Valid Percent) of Teachers Reporting Use of the Program in #20b
Fourth Grade					
MathLand	3	79 (of 85)	45 (57.0%)	6 (7.6%)	51 (64.6%)
Quest 2000	3	77 (of 83)	36 (46.8%)	10 (13.0%)	46 (59.7%)
Dale Seymour *Investigations*	2	33 (of 38)	7 (21.2%)	3 (9.1%)	10 (30.3%)
Mathematics Plus	1	23 (of 24)	17 (73.9%)	0 (0.0%)	17 (73.9%)
Houghton Mifflin *Mathematics*	1	19 (of 21)	9 (47.4%)	2 (10.5%)	11 (57.9%)
Eighth Grade (Math 8)					
Glencoe *Interactive Mathematics*	5 (for Math 8)	30 (of 35 Math 8)	10 (33.3%)	0 (0.0%)	10 (33.3%)

The numbers are similar for the districts that adopted *MathLand* and *Quest 2000*. In the three districts where *MathLand* was the sole adopted text, a total of 79 teachers answered #20b. 45 of these teachers (57.0%) reported the "pure" use of *MathLand*, and another 6 teachers (7.6%) reported using it in combination. Thus, only about two-thirds of respondents (64.6%) in these three districts reported using *MathLand* as at least one of their primary programs.

In the three *Quest 2000* districts, a total of 77 teachers answered #20b; 36 of them (46.8%) reported *Quest 2000* alone, and another 10 (13.0%) reported using it in combination with another program, for a total of 59.7% using *Quest 2000* as one of their primary programs.

Dale Seymour *Investigations* was used by an even smaller proportion of teachers. In the two districts where this was the adopted program, 33 teachers answered #20b. Of these 33 teachers, only 7 reported "pure" use of Dale Seymour, with 3 others reporting use of the program in combination. Thus, only 10 of 33 teachers (30.3%) in these two districts indicated that the district-adopted program was at least one of their primary programs. In one of the two districts, only 3 of 20 respondents listed the program in their answer to #20b.

A similar picture exists for the one eighth-grade program included in the analysis, Glencoe's *Interactive Mathematics.* Only 10 of the 30 Math 8 teachers (in the five *Interactive Mathematics* districts) who responded to the question about their most used program listed this text. In 2 of the 5 districts, *no* teachers listed it.

That many teachers are not primarily using their districts' adopted program comes as no surprise to most district curriculum and instruction administrators. For instance, in one of the *MathLand* districts, the district mathematics coordinator estimated in an interview that about 80 to 90% of district teachers were using *MathLand* to some extent, but that only about 15% had "fully implemented it," and that most had implemented it "about 50% or less." She suggested that since state frameworks and textbook adoptions are on seven-year cycles, teachers who don't like a particular approach or program have learned to "wait it out."

These data suggest that caution should be exercised in attributing low student achievement to currently adopted materials. In fact, these materials may not even be in widespread use.

♦ **Older programs, from previous adoptions, are what many teachers use instead of or in addition to the programs from the current adoption. Some teachers, meanwhile, make supplementary materials the core of their instruction.**

Since so many teachers did not report using the adopted text as at least one of their primary programs, the question arises as to what they were using instead (or, in the case of teachers who were using the adopted text as part of a combination, what else they were using). The answer, based on survey responses and interviews with teachers and principals, mainly appears to be textbooks from older adoptions. One relatively new teacher who was interviewed explained:

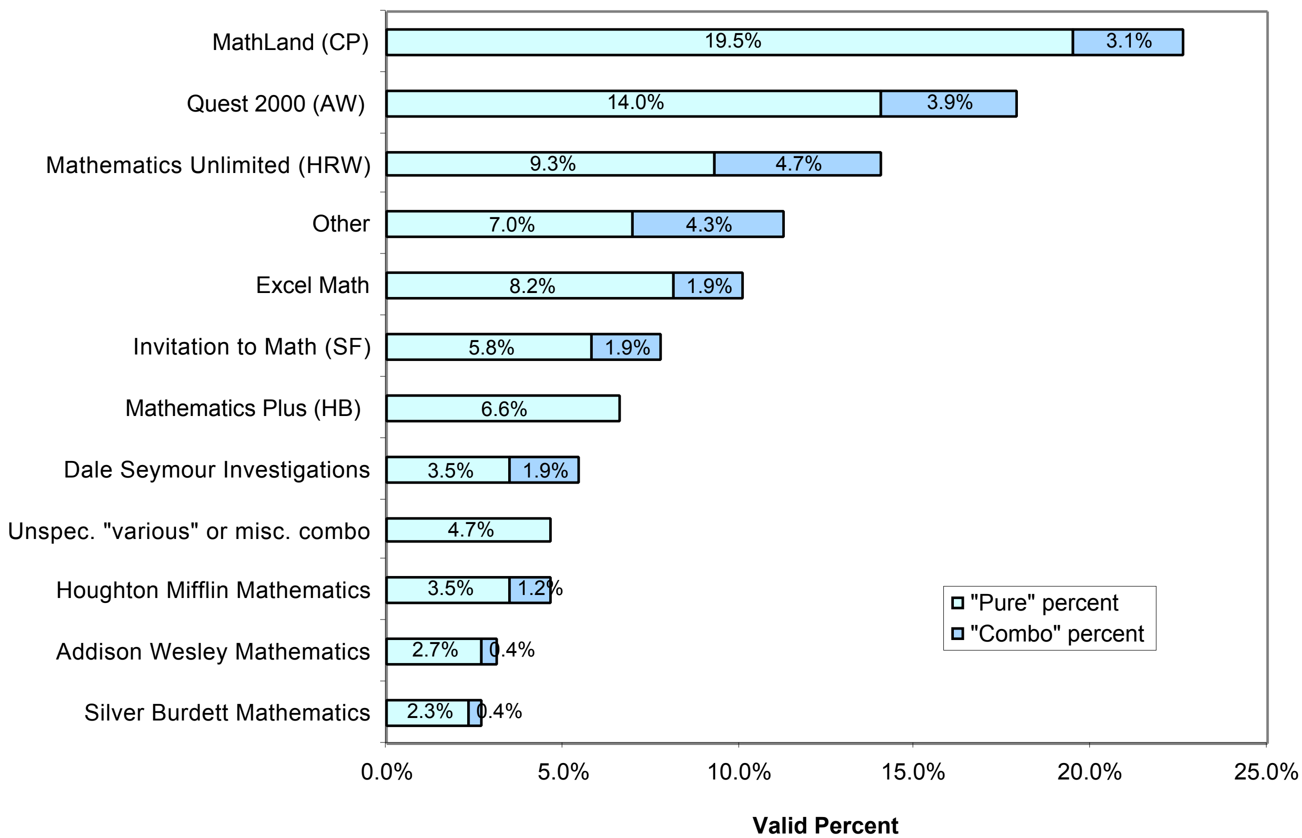
> *We're supposed to use* MathLand *as our text but my kids have a hard time using abstract examples and concepts. We end up using* Math Unlimited; *it's outdated but more concrete…. I found [it] in the closets."*

The text mentioned by this teacher—Holt, Rinehart and Winston's *Mathematics Unlimited* (1988)—was one of the most commonly mentioned older texts in use at the fourth-grade level, across all of the districts. In fact, as shown by Figure 4.3, this text was the third most commonly cited textbook used (behind *MathLand* and *Quest 2000*) *among all 257 fourth-grade teachers* who answered #20b, with 14% of teachers listing it as at least one of their primary texts (including 9.3% listing it as their only primary text).

The other older text that was cited by many fourth-grade teachers was Scott Foresman's *Invitation to Mathematics* (1988). It was the fifth most commonly cited text overall (not including the catchall "other" category), with 8.2% of teachers listing it as at least one of their primary texts, including 5.8% listing it as their only text.

Excel Math (Ansmar Publishers)—a curriculum that consists mainly of sets of "lesson sheets"—was the fourth most commonly cited text program in use among fourth-grade teachers, and represents an additional answer to the question of what teachers use instead of their district's main adopted program. In one of the *Quest 2000* districts, 9 out of the 24 teachers in the district listed *Excel* in their answer to #20b, and 7 of them listed it "pure." The use of *Excel* was even more pronounced in the district where only 3 out of 20 teachers indicated using the adopted program, Dale Seymour *Investigations.* In this district, 17 out of 20 teachers listed *Excel* as their primary resource, 14 of them "pure." While not the primary program in this district, *Excel* is made available by the district as a supplementary resource. It would appear, then, that many teachers are using materials intended as "supplementary" as the core of their program.

Figure 4.3
Percentage of Fourth-Grade Teachers Reporting Various Programs as Their Most Used Curriculum Resource (Survey Question 20b)[8]
n=257



Note: For the "other" category, the "pure" percentage represents the use of a single curriculum program other than any named here. The "combo" percentage part of "other" indicates the use of one curriculum program named here and another one not named here. The "unspecified various or miscellaneous combo" category includes two different types of responses to question 20b: 1) responses that did not name any particular program but merely stated "various" or "several"; and 2) responses that named two (or more) programs, neither of which were named here.

[8] At the eighth-grade level, too many different programs were named (largely as a result of the range of courses being taught) to construct a similar graph.

At the eighth-grade level, there was considerable variation to what teachers said they were using instead of *Interactive Mathematics,* but the general themes that emerge are similar to those found at the fourth-grade level. Among the 20 teachers in *Interactive Mathematics* districts who did not report using the adopted text, four of them listed Holt, Rinehart and Winston's *Mathematics Unlimited*, and two listed Scott Foresman's *Invitation to Mathematics*—both of which were programs from a previous adoption. Another five listed a different Glencoe program—*Applications and Connections,* and two more were using Glencoe *Pre-Algebra.*

- **Teachers may use programs other than the adopted ones for any number of reasons. For instance, they may have not received sufficient professional development on how to use the adopted programs.**

The fact that so many teachers do not predominantly use their districts' adopted programs could be attributable to a variety of reasons. One is that there may be a natural resistance to change that requires extra work, as changing from one program to another likely would, especially given that so many teachers rely on the text to guide their instruction. This natural resistance to change would be exacerbated if the purpose or the need for the change were not evident.

A second reason why teachers may avoid using adopted materials, particularly if the adopted materials are very different from the materials used previously, is that teachers may feel unsure of how to use them. For instance, "not understanding how to use the text [*Quest 2000*]," was one teacher's response to the "obstacles" survey question; another teacher, in response to the "hindrances" survey question, wrote "I wasn't told exactly what the *MathLand* curriculum was or how to properly teach it." An administrator in this same district said in an interview that teachers who go to training sessions on *MathLand* (the district's adopted program) and see how it works try it and like it, but that others resist using it. An interviewed eighth-grade teacher in another district said that she likes *Mathematics Unlimited* because it is "more like what I used when I went through school."

Indeed, for teachers to use materials unlike those they have taught from before—and unlike those they learned from themselves as students—may require significant professional development. Yet 64% of fourth-grade survey respondents and 53% of eighth-grade respondents reported that since January 1998, they had had less than four hours of professional development on the "use of particular mathematics curricula or curriculum materials (e.g., a particular textbook.)" Admittedly, more professional development may have been available in years prior to 1998 when the materials were first adopted, but at the very least, it appears that materials-related professional development is not an ongoing activity for the majority of teachers. Moreover, new teachers would have missed out on earlier-provided opportunities.

A chi-square analysis did find a significant relationship ($p<.05$) between use of the adopted program and amount of materials-related professional development among fourth-grade teachers in the ten districts with clearly identified adopted programs. Teachers in these districts who had had more than 1 day of materials-related professional development since 1998 were more likely to report "pure" use of their district's adopted program than were teachers who had had less than 1 day of such professional development.

A third possible reason that so many teachers do not primarily use the adopted materials is that they find the adopted materials inadequate in one way or another. This was supported by comments teachers made about the programs in response to the survey's open-ended questions and in interviews.

While some of the comments about various programs were made by teachers who indicated that they did, in fact, use these programs, many of the comments came from teachers who said they used other programs (as their primary curriculum resource) instead. A brief numerical analysis of how many of the negative remarks came from users and how many came from non-users follows. Because *MathLand* and *Quest 2000* were the most commonly adopted and used fourth-grade programs, the numerical analysis focused on these two programs.

In the survey's section of open-ended questions, 28 of 85 teachers in the three *MathLand* districts (32.9%) wrote negative remarks about the program. 14 of these teachers reported in #20b that they used the program "pure," while 11 of the 28 teachers did not report *any* use of *MathLand* in #20b (presumably because of their objections to the program). Of the remaining 3 teachers, 2 reported using *MathLand* in combination, and 1 left #20b blank.

Meanwhile, in the three *Quest 2000* districts, 41 of 83 teachers—i.e., nearly 50%—remarked negatively on the program in open-ended comments. Of these 41 teachers, 18 were "pure" users, 5 were combination users, and 14 were non-users, according to #20b. (The remaining 4 left #20b blank.)

Despite the evidence that the adopted programs are problematic for teachers, it bears noting that many teachers do use their district-adopted programs without apparent complaint. Of the 45 reported "pure" users of *MathLand* in its three districts, 24 who also answered the open-ended questions did *not* comment negatively on the program.[9] For *Quest,* meanwhile, 14 of 36 "pure" users did not comment negatively.[10] Thus, not all users of these programs strongly objected to them, at least not in comparison with other items they felt were more important to comment on in their responses to the open-ended questions. A few teachers even wrote exclusively positive comments about the adopted programs.

[9] The other 7 "pure" *MathLand* users from these three districts did not choose to answer any of the open-ended questions, so their opinions on the program cannot be inferred.
[10] The other 4 "pure" *Quest 2000* users from these three districts did not answer any of the open-ended questions.

Nevertheless, because negative comments far outweighed positive comments and dominated the responses to the open-ended "obstacles" and "hindrances" survey questions, a closer look at these negative comments is warranted. The following section discusses the nature of teachers' concerns about their curriculum programs based on these comments.

The Nature of Teachers' Concerns with Adopted Curriculum Programs

♦ **One of the most commonly cited concerns about districts' adopted programs was that they are difficult to use—that they are "unfriendly," hard to read, or disorganized.**

Having established that many district-adopted programs are fairly unpopular, naturally the next question is, why? What is it that makes these programs unpopular? The scope of this study did not allow for a review of the programs themselves. Thus, we can only present teachers' perceptions, from their self-report on the survey and in interviews, of the problems with the various programs. *No independent confirmation or verification of teachers' remarks was attempted, and the authors of this report do not necessarily share the opinions presented herein.*

Many teachers' survey comments did not articulate specific objections to the adopted materials. For instance, "poor textbook selection by the district," "no good district math program," or "ineffective text" were among the obstacles and hindrances cited.

However, many other teachers did discuss the nature of their concerns about curriculum materials. One concern raised by many teachers is that the adopted programs are "unfriendly" or difficult to use. For instance, one teacher wrote, "The *Quest* series is extremely poorly organized. The T.E. [Teacher's Edition] does not show me what students will see. The student text is almost useless." Another teacher wrote, "Text [*Mathematics Plus*] is confusing and unclear at times."

Similarly, one of the main concerns expressed about the eighth-grade Glencoe *Interactive* text had to do with its readability. Several teachers, both in survey comments and in interviews, indicated that the reading level of the text is too difficult for many of the students. As one teacher wrote in response to the hindrances survey question, the "Glencoe text that has been mandated by district" is "very difficult to read by students!"

Several elementary school principals who were interviewed commented that teachers find it difficult to use *MathLand* and Dale Seymour because these programs lack sufficient "structure." In part, this may mean that they do not come with what many teachers consider to be a textbook— a traditional hard-bound pupil's edition—but rather consist of booklets, blackline masters, kits of manipulatives, and the like.[11] Some teachers in schools where these were the adopted programs bemoaned the lack of a textbook. "A textbook is tangible and is easier to give homework from," wrote one teacher, "It is also good as a reference."

- ♦ **Some teachers said that the adopted materials require too much photocopying, either because of the way the programs were designed or because of the way they were purchased.**

The lack of a textbook *per se* lies at the heart of another usability concern mentioned by some teachers—the amount of photocopying necessary. For instance, teachers may receive a full classroom set of student workbooks, but because these workbooks will need to be reused in subsequent years, students cannot actually write in the workbooks. The following were cited as obstacles/hindrances on the survey from fourth-grade teachers in two different districts:

> *Having to photocopy so many materials because student copies are not available or can't be written in by children.*

> *We can't use student workbook because we probably won't get more, so we have to copy them.*

Similarly, one principal who was interviewed commented that the adopted program, *MathLand*, requires much duplication of materials for student use. He reported that over one million copies were made to service 480 students.

The need to make copies was also an issue for some of the eighth-grade teachers. Even if students each have their own copy of the text itself, they usually do not have their own copies of the ancillary materials that accompany the text. Many teachers like to assign homework from these materials, necessitating photocopying. For example, one interviewed teacher said that although each student has his/her own copy of the base text (Glencoe *Interactive*), the program's skills workbooks exist only as a single classroom set, so students cannot take them home for homework. "I spend an exorbitant amount of my budget, and of my time, making copies. Because I don't have a book to go out of here [for homework]," she explained. Hence, some teachers' concerns about the adopted materials are not about the mathematical content of the materials, but about the way the materials must be used because of how they were purchased.

[11] As of 2000, *MathLand* does have a student book, but this had not yet been published at the time of data collection.

♦ **Another frequently mentioned concern about the adopted materials was that they lack a sufficient balance between computational skills and conceptual thinking.**

Another top concern about nearly all of the adopted materials, reported by both fourth- and eighth-grade teachers, was that they do not adequately address basic skills,[12] as demonstrated by the following representative survey comments, *each about a different curriculum program:*

> *The required curriculum materials: there is not an appropriate textbook which emphasizes basic computational skills.*
>
> *Adherence to district curricula that doesn't respond to the needs of the child—requires higher order skills, but doesn't teach them.*
>
> *I do not like the new math series [adopted by the district]—Too way out there! The book is assuming too much. Kids need more basic skills to use this book.*
>
> *[Adopted] text…does not stress basics enough!*

Teachers' desire for more coverage of basic skills does not, however, necessarily mean that they want their curriculum materials to be *exclusively* basic-skills oriented. Indeed, many teachers do appreciate the investigative, hands-on, activity-based approach taken by programs such as *MathLand*, *Quest 2000*, Dale-Seymour, and Glencoe *Interactive,* but have difficulty in implementing the approach for practical reasons (relating to the "usability" concerns discussed above):

> *I am not impressed with* MathLand *as a complete program. It's great to have the kids explore and discover but there is not enough time for them to discover everything.*
>
> *[About* Quest 2000*] The manipulatives are good, and there are many good activities, but it is poorly written and hard to "read."*
>
> *The current math program [Dale Seymour] is great if I'm willing to give every waking moment to prepare for it, and use my own money to buy the extra supplies that are needed, but then I also need to do that for science and language arts.*

Several teachers spoke of seeking a *balance* between basic skills and higher-order conceptual thinking and of wanting materials with such a balance:

[12] Again, this perception was not independently verified through an examination of the programs themselves.

> *[cited obstacle] Creating a balance in the curriculum and finding materials that support this kind of mathematics education.*

> *[cited obstacle] The lack of an adequate text which combines real life applications with adequate computation.*

> *The old Holt series was more sequential and provided lots of practice. Not open-ended, though.* Quest *too far out—did not cover a lot of material in a year. Excellent for constructing meaning, but took way too long. We seem to go from one extreme adoption to another.*

As such, many teachers do not want to completely *eliminate* the adopted materials, but merely wish to *supplement* them (or to use them as a supplement) to provide the desired balance. This was particularly the case with *MathLand*, as represented by the following two comments:

> MathLand *adopted program cannot be used as a core with students who have not mastered the basics. As a supplement, fine—it works.*

> *Our district has implemented* MathLand *as our only math resource. Teachers have found it ridiculous that one program can meet the wide range of classroom math needs. I wish we would adopt 2-3 programs to use and provide needed materials for an entire class (not just 20 ea. class).*

Teachers' desire for balance and their interest in using the adopted program as a supplement apply equally at the eighth-grade level, with Glencoe *Interactive.* As with the fourth-grade programs, one of the main reasons teachers dislike or avoid using the *Interactive* text is that they perceive it as too activity-oriented or theoretical, lacking a sufficient balance between computational practice and conceptual understanding. Teachers do see value in the program, but more as a supplement than as the base text. The district mathematics coordinator in one of the Glencoe *Interactive* districts spoke of how the district "ran into difficulties" when they adopted new materials in an attempt to implement the 1992 Framework and the NCTM standards:

> *The change was tremendously dramatic for most teachers. The grades that shocked me the most were the middle school grades, where we had been using replacement units for a number of years…. I would say almost all our middle school math teachers were using [the replacement units] to a certain extent. Well, the Glencoe* Interactive *was almost taking those replacement units and putting them in book form. So, to me, that should have been the easiest one [of all of the newly adopted texts at various levels within the district] to implement. Well, that's probably where we had some of the greatest resistance…. What teachers had had was predominantly computational kinds of materials, so they had been using these replacement units [as a rich supplement to make] mathematics almost come to life. Well, the whole thing just reversed. Now, those replacement units—the* Interactive *units—became the core. And teachers, they didn't see a cohesive mathematics program. They had used the replacements for enrichment, and relied on the*

> *computational as their core, and when it reversed, it didn't quite work…. The foundation needs to be there, and then you build on the foundation…. Teachers are looking for something they can really get their hands on, and what they see is, the computation stuff is the stuff they can really hang on to, and you can build on that. You try to go the other way, and it's much more difficult.*

In one of the other Glencoe *Interactive* districts, a teacher who was interviewed also spoke at length about the program and about her concerns that it lacked balance:

> *I do use the district-adopted curriculum [Glencoe* Interactive*], but I use it as supplementary material. I don't use it as the foundation of my program. And only because, all by itself, it's all theory. And there's really not a lot of practice involved. And I like the idea of interweaving the theory and the practice. So, if you have a book that's all skills and drills, it's not going to cut it. If you have a book that's all theory, it's not going to cut it. There needs to be a combination, a balance between the two…. The adopted text doesn't have the practice problems that I assign for homework…. My kids really like it because it's all fun and games, and they do get something out of it, but it's not as much as I would like. You really have to have the basic skills down in order to do this* Interactive *book, and I find a lot of these kids do not have their basic, basic skills, like long division—they do not have that down at the beginning of the year. So I can't even start this book until we've covered the basics…. There's a lot of parental concern with this* Interactive *book;* I *have a lot of concerns with it. I can't teach out of just the* Interactive *book.*

When asked, "What, if anything, would help you improve your math instruction?" this teacher simply replied, "A textbook. One that has a balance between skills and theory."

Another teacher who was interviewed said that the Glencoe text had influenced his teaching "in a positive way," and he indicated that he had received considerable professional development and support on its use that he had found effective and helpful. Even so, on the survey this teacher listed the Holt, Rinehart and Winston *Mathematics Unlimited* as being his primary text.

- **A third commonly cited concern about curriculum materials was that they are not aligned with standards and/or assessments.**

For many teachers, the concern about the curriculum materials was not necessarily about the materials *per se,* but rather about the materials' relationship to—and specifically, their lack of alignment with—state and/or district standards. This was particularly an issue at the fourth-grade level. On the survey, over one-third of fourth grade teachers (35.9%) said they disagreed with the statement, "Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching." The level of disagreement on this item was much higher than for any of the other 12 opinion items relating to standards. (The item with the next highest level of disagreement was, "The

NCTM standards have influenced my teaching for the better," with which 20.8% of responding fourth-grade teachers disagreed.)

Fourth-grade teachers' open-ended remarks also reflected the concern about lack of alignment between materials and standards. The concern was widespread, found in nearly every district included in the study. Each of the following survey comments was made by a teacher in a different district:

> *…Our district is stuck with a $1 million program that is ineffective and which doesn't address the state standards or our new district standards.*
>
> *Lack of adequate materials to implement all of the Math Content Standards (1998)*
>
> *Perhaps if we felt that the current program we are using corresponds with the state frameworks and state standardized tests…. Many teachers have felt that the two things [the program and frameworks/STAR test] don't support each other.*

As with this last comment, several teachers also expressed concern that the curriculum materials were insufficient for preparing students to take the required assessments. Representative survey comments about this included:

> *District not aligning curriculum to state assessment instruments*
>
> *Ineffective materials and adoptions with a very poor weighting of topics which doesn't relate to standardized tests in any way.*

One teacher who was interviewed indicated that the lack of alignment between the approach of the adopted program (Dale Seymour) and the SAT-9 was the major reason why teachers at his school were using an older text:

> *We have a new math adoption; supposedly we were to throw away the old one. The new math is 100% manipulatives, but as we're working with this, a lot of the teachers are finding that, when the students go to take the SAT-9, it doesn't help them at all. So, a lot of [my use of materials] is taking things that we used from the old adoption, and trying to fit them in with the new adoption. But in all honesty, I end up using the old adoption probably more.*

The issue of alignment will be discussed further in the subsequent chapters on standards and assessment.

- **Some teachers would like to have more freedom in their use of curriculum materials. Others indicated that they already have such freedom, supplementing liberally or choosing programs other than the adopted ones.**

As some of the remarks in the preceding discussion suggest, several teachers indicated a desire to have more freedom in selecting the programs they use, and many objected to being, as they put it, "forced" or "required" to use a particular program. In response to the "hindering policies" survey question, one fourth-grade teacher wrote:

> *School selected (school-wide adoption) instructional materials/publishers programs. Choices that aren't individual but [made by the school or the district]. I feel limited and constrained by materials selected by someone else…. To improve my instructional effectiveness I would like to select the choice of materials/text for my classroom program in mathematics as well as some other academic areas.*

Not every teacher, however, feels quite so constrained in the use of curriculum materials. While some districts or schools may strongly discourage use of materials other than the adopted programs, others appear to offer a bit more flexibility. Several teachers who were interviewed spoke of using many different programs or of supplementing heavily, and the following survey comments were made in response to the question, "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe":

> *Allow me to use the materials I choose, rather than requiring texts.*

> *A shift from "one size fits all" attitude to "use what resources we have" to implement and meet math standards.*

For some teachers, though, tracking down supplementary materials is a challenge—one that they would rather not have to face. The following remarks were among those made in response to the survey question about obstacles to mathematics teaching:

> *Cost of materials to enrich the program*

> *The textbook our district purchased. Having to supplement on my own materials that will clarify and enhance the different math concepts.*

> *Lousy curriculum—I mean lousy. As a new teacher who has had little instruction in math I am constantly forced to "pull" together curriculum and quite frankly feel like a failure most of the time (only in math).*

As this last comment suggests, the level of teachers' willingness to supplement may be a function of their experience level. Teachers who have been teaching for a while may have more of a "stock" of materials to use in supplementing (or, perhaps, in replacing) the adopted programs, while newer teachers may not. Indeed, one district coordinator who was interviewed even pointed out that new teachers seem to use whatever materials they are given, while more experienced teachers pick and choose from a wide array of resources. However, an analysis of data on fourth-grade teachers' experience level and use of adopted materials did not reveal that "pure" users of the adopted materials had significantly fewer years of teaching experience, on average, than teachers who did not use the adopted materials or who used them in combination.[13]

- **Some fourth-grade teachers cited a shortage of materials as being an obstacle to their mathematics teaching. In many cases, however, the shortage is linked to the program in use.**

Approximately 30 fourth-grade teachers indicated on the survey that an insufficient quantity of materials was one of the biggest obstacles to their mathematics teaching. About half of these teachers did not specify what *types* of materials were in short supply, mentioning only "lack of materials" or "inadequate supplies" in their answer to the open-ended question. Others specified books, manipulatives, or other supplementary materials. A few mentioned technology resources (such as computers or computer support).[14] Some of the teachers who were interviewed also spoke of insufficient quantities of materials.

In some cases, the shortage of materials appears to be a function of large class size. "Proper materials—not enough for a class over 25," wrote one teacher in response to the obstacles question on the survey. (Class size is further discussed in Chapter 8.) For some, the problem was manipulatives[15]; for others, it was books. Shortage of books becomes a particular problem when teachers want to assign homework out of the books, because there are not enough books for each student to take one home, or there are not enough "consumables," as discussed earlier in the chapter.

Large class size notwithstanding, the problem of materials shortage cannot be completely separated from concerns regarding the curriculum programs themselves. In particular, the reason that some teachers experience a shortage may be that they are using materials other than those adopted by the district, and these other materials may be in shorter supply than the adopted ones. One teacher wrote:

> *The biggest obstacle in my classroom is not enough math books for each student. Normally I have 2 to 3 students to math book.*

[13] Across all ten districts with clearly identifiable adopted programs, there was virtually no difference in the mean years of total teaching experience (as reported on questionnaire #32a) of "pure" users of the adopted text as compared to combination users/non-users (as reported on #20b). In the three *MathLand* districts, "pure" *MathLand* users did have fewer years of experience, on average, than other teachers; the same was true with the three *Quest 2000* districts. However, the difference between the means in each set of three districts was not statistically significant even at a .10 level.
[14] On a different set of survey items including questions about instructional use of computers, approximately 20% of fourth grade respondents and 33% of eighth-grade respondents indicated that they had "no access" to computers.
[15] On the other hand, several teachers cited an *abundance* of manipulatives as something that had *helped* their mathematics teaching.

This teacher, however, indicated that her primary text was the Holt, Rinehart and Winston *Mathematics Unlimited*, even though her district's currently adopted text was *MathLand*. Thus, it is likely that the book she had a shortage of was not the newly adopted program, but rather the older one, for which she would have been unable to get new or replacement copies. Other teachers who noted a lack or a shortage of materials may also have been referring to supplementary materials rather than to the primary adoption.

In the Next Chapter

As discussed in this chapter, one of the concerns held by many teachers was that adopted materials are not aligned with standards. Especially given how many teachers use their textbook to guide instruction, it is crucial that curriculum materials be aligned with standards. Standards, however, may have their own set of problems. These are discussed in the following chapter.

Chapter 5

Content Standards

Highlights of Findings

- **Teachers' reactions to content standards are mixed.**
  Some teachers appreciate the adoption of standards and the guidance they bring. Many teachers, however, believe that the new state standards are too ambitious—that some of them are developmentally inappropriate or that they focus on breadth at the expense of depth and cover more material than can be fit into a year. Eighth-grade teachers were particularly concerned about the requirement that all eighth-grade students take algebra.

- **Teachers' familiarity with content standards is highly variable.**
  Even within schools, some teachers were highly familiar with the standards, and others seemed barely to know about them at all. There was considerable confusion, and some frustration, about the existence of different sets of standards (e.g., district, state, national).

- **As of spring 1999, content standards had yet to make a consistent, significant impact at the classroom level.**
  Although teachers reported that local standards had influenced their teaching, interviews and observations suggested that the standards *per se* were not having a high level of meaningful impact on classroom mathematics instruction. The apparent lack of alignment between curriculum and standards may contribute to this problem. Alignment of content standards with curriculum and instruction is an ongoing process.

Background

Content standards—what students should know and be able to do—have been one of the hottest topics in education across the nation for the past several years. Of all of the subject areas, mathematics was one of the first in which standards were developed, and California was a leader in that effort, with the 1985 publication of the *Mathematics Framework for California Public Schools, Kindergarten Through Grade 12*. This document, which focused on the importance of discerning mathematical relationships, logical reasoning, and effective use of mathematics techniques, stressed the importance of mathematical power and understanding for *all* students. It identified seven strands of mathematical content: number, measurement, geometry, patterns and functions, statistics and probability, logic, and algebra. The document was groundbreaking, laying the foundation for much of the national mathematics reform efforts of the 1980s and 1990s.

Nationally, the mathematics standards movement hit full stride in 1989, with the publication of the *Curriculum and Evaluation Standards for School Mathematics* by the National Council of Teachers of Mathematics (NCTM). Developed by consensus among NCTM members, the document set out standards for each of three grade-level spans (K–4, 5–8, and 9–12), including emphases on problem solving, mathematical communication, mathematical reasoning, and mathematical connections. Content areas were similar to the California *Framework's* strands. For example, the standards for grades K–4 included number sense and numeration, measurement, geometry and spatial sense, patterns and relationships, and statistics and probability. The content areas for the other grade-level spans were similar.[1]

As the NCTM document took hold and began to spark national interest, California was working on an updated edition of its *Mathematics Framework*. The revised document, which came out in 1992, built on the concepts and recommendations contained in the 1985 version, in an effort to extend them into a more comprehensive vision for mathematics education and to reinforce the goal of mathematical power for all students. It kept the same basic strands of the 1985 edition (adding one more, discrete mathematics, and making changes to some of the others) and added "unifying ideas" for each grade span (K–5, 6–8, and 9–12). In general, the 1992 *Framework* was consistent with and aligned to the NCTM standards.

Neither the *Framework* nor the NCTM document, however, defined standards for individual grade levels. The 1994 reauthorization of the federal Elementary and Secondary Education Act (ESEA), Title I, called for states to articulate grade-level academic standards, and California began encouraging districts to develop local grade-level standards in mathematics (as well as in language arts) in 1996–97. Also in 1996, a "Mathematics Program Advisory" was distributed to superintendents and principals by the California Department of Education, the California Commission on Teacher Credentialing, and the California State Board of Education. This program advisory, a policy statement written in response to recommendations by a statewide Mathematics Task Force, emphasized the importance of a balanced mathematics program—one including basic skills in addition to conceptual understanding and problem solving.

The following year, in 1997, the California State Board of Education (SBE) adopted statewide grade-by-grade standards in mathematics, published as the *Mathematics Content Standards*

---

[1] In 2000, the NCTM published a revised standards document, entitled *Principles and Standards for School Mathematics.* Although this document had not yet been published at the time of the study's data collection activities, a discussion draft was circulated in 1998.

for California Public Schools: Kindergarten Through Grade Twelve. These new State-Board–adopted standards represented a departure from the *Framework* and NCTM documents. Although the standards within each grade level were organized around five strands similar to those from the earlier documents,[2] they emphasized fluency in basic computational skills to a much greater extent than the earlier documents had. Moreover, particular standards items were much more highly detailed, and placed significantly more emphasis on specific mathematical content, than those from the earlier documents.

The new state standards, *per se,* did not automatically replace the local standards that districts had been developing. Districts were, however, advised to align their local standards with the new state standards in order to ensure that the local standards were "at least as rigorous as" the state standards. The state's definition of rigor included breadth, depth, pace of learning, and levels of performance (CDE, 1998).

Finally, in 1998, the State Board adopted yet another updated *Mathematics Framework for California Public Schools, Kindergarten Through Grade Twelve*. This new *Framework* was strongly aligned with 1997 *Mathematics Content Standards,* and thus differed substantially from the 1985 and 1992 *Frameworks.* A strong grade-by-grade focus and attention to particular content replaced the more conceptual and thematic approach of the earlier *Frameworks.* The publication of the new *Framework* was somewhat controversial, as some members of California's professional mathematics education community felt that the document had not been developed in a sufficiently public and broad-based consensual process (Anderson, J., 1998; Becker & Jacob, 2000).

This chapter presents study findings about teachers' reactions to mathematics standards—the concept of standards in general and in some cases particular standards documents. The chapter also examines the impact that mathematics standards have had on classroom instruction.

Reactions to Standards

- ♦ **Teachers' reactions to standards are mixed. Some appreciate the adoption of standards and the guidance they bring, but many teachers also believe that the new standards are too ambitious.**

In response to the survey question, "If there are any specific state, district, or school policies that have *helped* your mathematics teaching, please describe," many teachers cited standards.[3] In fact, at the fourth grade level, standards formed the most frequently cited

[2] Number sense; algebra and functions; measurement and geometry; statistics, data analysis, and probability; and mathematical reasoning.
[3] See Figure E3 in Appendix E for a graph of responses to this survey question.

category of responses, mentioned by 28.2% of teachers. At the eighth-grade level, standards were mentioned by 28.8% of teachers, second only to professional development/teacher preparation, which was cited by 33.9% of the eighth-grade teachers.

Teachers said that the standards have helped guide their instruction and bring about much-needed uniformity. Sample remarks from the survey, each from a different district, include:

> *[from a fourth-grade teacher] Having knowledge of the district standards has helped me in terms of planning.*
>
> *[from a fourth-grade teacher] Standards have really made my teaching more focused—I now know exactly what my students need to know instead of relying on a textbook.*
>
> *[from an eighth-grade teacher] High district standards support high standards in classroom*
>
> *[from an eighth-grade teacher] Standards—easier for transferring students, promotes some sort of unity*

Some of the teachers who were interviewed also acknowledged the value and importance of standards, either in general or for them personally:

> *I've read the district and state standards. Our district ones are grade level expectancies. I want my kids to be where they need to be.*
>
> *I think standards are good because it's hard to help kids learn without basics.*
>
> *I am aware of the* California Framework, *the NCTM Standards, and the* California Content Standards. *I have seen the draft of the new NCTM Standards 2000. All of these have influenced my teaching for the better.*
>
> *The district level standards are aligned with the state standards, so the district ones are what I pay attention to. I am aware of national tests and national comparisons are made. It is really important to me to know that what goes on in my classroom should be going on in all classrooms.*
>
> *I believe standards are important. You have to know where you're going before you take off or you're going to just be everywhere. They've influenced me more since I've come to California. To me, "standard" is just a word that gets everybody to the same. If these are what are going to get all to the same page so we can be assessed in the same way, then good. It's important. They're not just a measure of what kids do, they're a measure of what we [teachers] do. I think standards have also helped us talk about what we do….The state standards have had the most impact on me. They give me direction. Also, the professional standards have helped me a lot. They keep me learning and relearning.*

These types of remarks notwithstanding, a large number of teachers made less favorable comments about standards. In response to the survey question, "If there are specific state, district, or school policies that have *hindered* your mathematics instruction, please describe," 12.2% of responding fourth-grade teachers and 18.8% of the eighth-grade teachers mentioned standards.

Teachers' concerns about the standards were mainly that the standards, especially the state standards, are too ambitious—that some of them are developmentally inappropriate or that they focus on breadth at the expense of depth and cover more material than can be fit into a year. Representative survey comments along these lines included the following:

> *Each year the state is requiring more and more of the students and their foundation in math is becoming thinly spread. Let's get the foundation stronger.*
>
> *I believe the new content standards expect too much from 9–10 year olds. It's difficult enough for them to understand current concepts within the parameter of our school year.*
>
> *District policy that all students be exposed to grade level material, even though they may not have mastered previous skills.*
>
> *There are too many topics that students are expected to learn. Need to eliminate some topics and allow for more conceptual development in a few key concepts.*

Interviews revealed that eighth-grade teachers were particularly concerned about the requirement that all eighth-grade students take algebra.[4] "I don't understand the push," said one teacher who was interviewed. "Cognitively, they [students] are not ready. They just don't understand it." A teacher in a different district stated, "The state standards say that algebra should be taught to all eighth graders, I'm against it. I think it's a maturity issue. Not all kids are ready. It's too abstract for some." Another interviewed teacher mentioned being "skeptical" about eighth-grade algebra, and a principal remarked that many middle school teachers have never taught algebra before and "are nervous."

Despite these concerns, however, the large number of comments made about eighth-grade algebra—both by principals and by teachers—made it clear that several districts were, in fact, preparing to implement it. As one principal put it, "I don't believe all eighth graders, and definitely not all seventh graders, are developmentally ready for algebra. However, the district has required the change. We will offer support for students during the year in the form of math lab and study club." As shown by Figure 4.1 in the chapter on curriculum

[4] The State-Board–adopted content standards are grade-specific from kindergarten through grade seven, and then are organized by discipline headings, beginning with Algebra I. Although the standards document says that "the standards for grades eight through twelve do not mandate that a particular discipline be initiated and completed in a single grade," the lack of other grade-eight-specific standards implies that at least some algebra must be taught in eighth grade. Many districts believe that the most appropriate way to address the standards is to require eighth-grade algebra.

materials, only 27.1% of the eighth-grade classes represented by the survey were algebra classes, so undoubtedly the transition to eighth-grade algebra for all students has been a major one.

Overall, these findings suggest that while most teachers like the *idea* of standards, they do not always think that the particular standards that have been adopted are the most appropriate ones. In other words, teachers support the theory behind standards, but may find themselves hindered by both the details and the realities of implementation.

Familiarity with Standards

- ♦ **Teachers' familiarity with content standards is highly variable. There is considerable confusion, and some frustration, about different sets of standards.**

While the teachers who mentioned standards on the survey and in interviews (as represented by comments in the preceding section) seemed to be fairly familiar with standards, not all teachers necessarily shared this familiarity. Observations and interviews in the eight visited districts revealed that teachers' familiarity with standards was highly variable. This variability was across districts, across schools within a given district, and even across teachers within a given school.

For example, a teacher in one district claimed that her district's standards "are on the wall in every classroom" and said that "our jobs as teachers are linked to these standards." However, the other teacher interviewed *in the same school* said, "As for the district standards, I'm a new teacher and not aware of what they are exactly." A third teacher in this district (but at a different school) mentioned that teachers were required to provide evidence that they met standards. Yet another teacher in the district said that they hadn't even *received* the standards.

In another district, there seemed to be some confusion about whether the district even had adopted standards. One principal reported that the district had created mathematics standards, but that "they remain unadopted." But a principal at a different school in the same district said, "Of course, we adhere to what the district standards are and what they want us to teach." At the school of this second principal, one teacher stated that "The district is just beginning to develop standards," while a second teacher stated that district standards are "the most important" document/policy having an impact on his mathematics teaching.

Not every district yielded quite this level of contradictory information, but by and large, there was not a great deal of consistency in interviewees' remarks regarding standards. An additional complication was that different people used the term "standards" to refer to different documents. For example, in discussing the "state standards," some people were talking about the 1997 State-Board–adopted standards, whereas others were talking about, say, the 1992 Framework. Similarly, some people used "standards" to refer to the NCTM standards; others meant the state standards, and still others meant their district standards.

Indeed, several principals and teachers reported confusion and frustration about having different sets of standards (e.g., national, state, district) or about having standards constantly changing:

> *[From a teacher] At all three levels [national, state, district] we have been bombarded. When we, as the math department, were given the standards, the NCTM, state, and local standards all conflicted with each other. We adopted the NCTM standards, which used to be closely aligned with the state standards. The state standards are what we are tested on. The new state standards are very different…It seems like a moving target. Every couple of years the state comes out with a different strategy and we all change and then things change again.*
>
> *[From a principal] I don't think teachers are very tuned to standards. There's confusion. Our people are lost. Our standards aren't exactly the same as the state's and there's confusion about why they would have different standards.*
>
> *[From a teacher] I am very involved with NCTM math reform. I also liked the 1992* Framework. *I am not up to date and am frustrated.*
>
> *[From a principal] Teachers are confused by the standards and they ask for more specifics. They [teachers] have not seen the new standards. Also, parents have been very upset about the changes in standards.*
>
> *[From a teacher] We have all these standards (state, district, school), but it doesn't meet student needs.*

There also tended to be some confusion about the extent to which district standards are aligned with state standards. In one district, the teachers who were interviewed appeared to have widely disparate impressions of the relationship between their district standards and the state standards, as demonstrated by the following comments from two different teachers:

> *[The state has] given us the standards and guidelines and tells us what to teach….Same kind of effect from the district; they are more stringent and require more.*
>
> *[from a fourth-grade teacher] The district standards are not as difficult as the state standards because the district standards do not have algebra, geometry, or integers.*

One teacher in this district stated that “I am accountable to my district standards…there’s not really any state standard influence.” In contrast, another teacher—who had recently finished working on performance assessments in the district office and said that he was “very involved” in standards and frameworks—remarked that the district standards were based on the state standards. A second teacher at the same school said that she was “aware that the district is trying to align its standards to state standards.”

Impact of Standards on Instruction

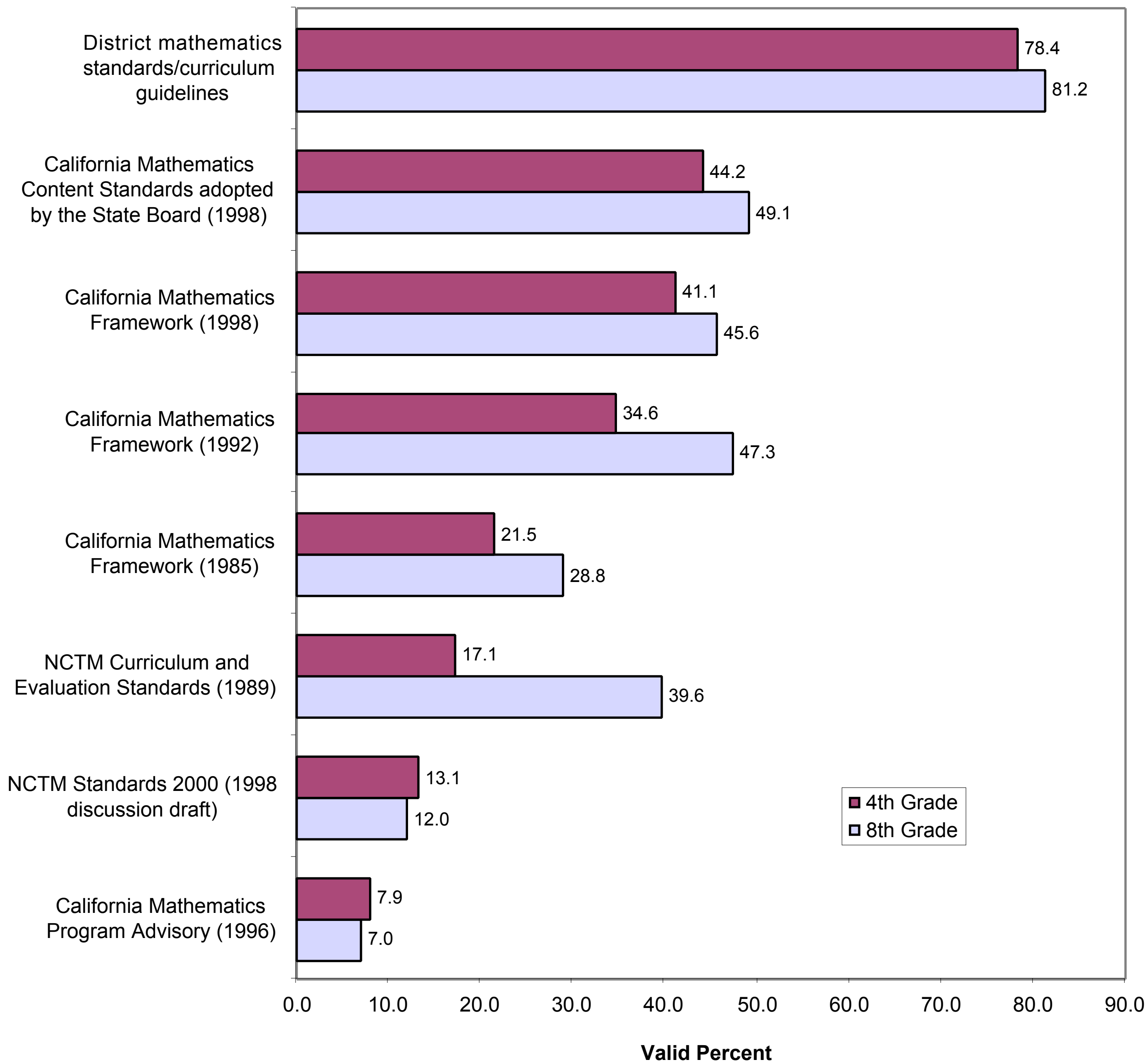
♦ **Although teachers report that standards—especially local standards—have influenced their teaching, other data suggested that the standards *per se* were not having a high level of meaningful impact on classroom mathematics instruction.**

Despite teachers’ concerns about the nature of the standards and the high level of confusion surrounding them, a large percentage of teachers reported on the survey that standards, particularly their district standards, have influenced their teaching. One of the items on the questionnaire listed the titles of several standards/frameworks documents and asked teachers to rate how familiar they were with each document, from “have not heard of this” to “has influenced my teaching.” Figure 5.1 shows the percentage of teachers who marked “has influenced my teaching” for each of the documents.

As the figure illustrates, roughly 80% of teachers at both fourth-grade and eighth-grade levels said that their local district mathematics content standards/curriculum guidelines had influenced their teaching. On the other hand, very few teachers reported that their teaching had been influenced by the national (NCTM) standards, although more eighth-grade teachers (39.6%) reported being influenced by these standards than fourth-grade teachers (17.1%). About 45% of fourth-grade teachers and 25% of eighth-grade teachers said that they did not know whether their district mathematics standards were aligned with the NCTM standards. The RAND analysis found that these teachers were less likely to report instructional focuses on individual work, group work, and problem solving.

[text continues on page 62]

Figure 5.1
Percentage of Teachers Who Reported That Particular Documents Have Influenced Their Teaching



Note: The total number of respondents (n) varied by item. For fourth grade, the range for n was 253 (for California Mathematics Program Advisory) to 278 (for district mathematics standards/curriculum guidelines). For eighth grade, the range for n was 108 (for NCTM Standards 2000) to 117 (for district mathematics standards/curriculum guidelines).

As for the state-level documents, only 21.5% of fourth-grade teachers and 28.8% of eighth-grade teachers reported that their teaching had been influenced by the 1985 California Mathematics Framework. However, this is not surprising, given that a majority of teachers at both grade levels reported having had 10 or fewer years of teaching experience. The 1992 and 1998 Frameworks appear to have exercised somewhat more influence on survey respondents, as shown by the figure. At the eighth-grade level, the percentage of teachers who said that 1992 Framework had influenced their teaching was slightly higher than the percentage reporting influence by the 1998 Framework. Since the 1998 Framework had only just been adopted when the survey was administered, this is perhaps to be expected, although more fourth-grade teachers reported influence of the 1998 document than of the 1992 document.

RAND's analysis found that teachers who said their teaching was influenced by the 1992 or 1998 California Mathematics Frameworks or the NCTM standards were more likely to report engaging in practices focusing on group work, applications, and problem solving. However, as discussed in Chapter 3, several other factors, such as student demographics, also were related to use of particular types of practices.

Very few teachers said that the 1996 California "Mathematics Program Advisory" had influenced their teaching. In fact, a majority of teachers (53.8% fourth grade; 66.7% eighth grade[5]) indicated that they had not even heard of this document. As this Program Advisory was addressed to superintendents and principals, rather than to teachers themselves, and was more a statement of policy and philosophy than a curriculum document, these figures are not surprising. Nearly all of the data collected by this study suggests that to maximize the influence of documents on instruction, the documents must be distributed to individual teachers. Moreover, this dissemination must be an ongoing process, as new teachers are constantly entering the profession.

Approximately 45% of fourth-grade teachers and 50% of eighth-grade teachers reported that their teaching had been influenced by the *California Mathematics Content Standards* recently adopted by the State Board. Of all of the documents listed on the survey, these standards were second only to district standards in terms of reported influence on teaching, at both grade levels. Given that these standards had been adopted only a little over a year prior to the survey administration, these figures, while still not even representing a majority of teachers, are higher than might be expected.

Other data, however, suggest a somewhat lower influence of the new state content standards on instruction. For example, one of the new state standards for fourth grade is, "Use concepts of negative numbers (e.g., on a number line, in counting, in temperature, in 'owing')." Yet of all of the fourth-grade teachers who reported that the new state standards

[5] These figures are slightly different than the ones given in the RAND report in Appendix A. The figures presented here are the percentages of teachers who actually responded to the survey question, whereas RAND imputed values for the missing responses and included those in the percentages.

had influenced their teaching, fully half of them (59 of 118) indicated on the survey that they did *not* teach negative numbers in their class. Similarly, nearly one-third of these teachers (38 of 118) reported that they did not teach use of variables, even though another fourth-grade standard calls for students to "demonstrate an understanding and the use of the concept of a variable."

Interviews and observations, too, suggested that the influence of standards (in general) might not be at the high level suggested by the responses to some of the standards-related survey items. Overall, direct impact of the standards on curriculum and instruction appeared to be relatively low, or at best, somewhat superficial in most of the districts visited. (See the "District Spotlight" for one exception.)

Although several of the teachers who were interviewed did say that they follow—or try to follow—standards in their teaching, many other teachers did not mention standards at all, or mentioned them only minimally.[6] A few interviewed teachers suggested that the standards (district or state) "did not apply" to them or to their students, for one reason or another. As one teacher stated,

> *We have district standards for eighth-grade math which are algebra. But we're not teaching algebra. Everyone is supposed to put the standard they are addressing on the board. So I just make them up with what I'm going to be teaching. But they're not real standards, they're goals. The district standards don't even apply to my class.*

Other teachers mentioned that they were aware that standards existed, but that they had not read them, or did not use them systematically:

> *I studied a little bit of the nationwide math standards in college last year. I wish I knew more. Being from out of state it's a learn-as-I-go with regard to the state standards.*

> *The state's standards seem to be covered in almost anything that we do anyway. I don't spend too much time matching individual standards with what I'm teaching.*

> *I know we have new state standards and also district standards that are aligned with the state….I have the state standards but I don't really refer to them.*

> *I perused the state standards prior to the SAT-9 and was disappointed that we had only covered half of them.*

---

[6] Several teachers who did not mention district "standards" *per se* did mention other district curriculum guidelines such as scope-and-sequence documents, timelines, benchmarks, or checklists. (Such comments were particularly frequent in two of the eight districts.) To some extent, the documents mentioned may resemble or serve some of the same purposes as content standards; one teacher said that the district scope and sequence gave "expectations for each grade level." Another teacher remarked that a district timeline essentially tells him "what to teach at what time to make it through the year, or what they expect to be covered by such-and-such a time throughout the year."

> *I use standards. But after I get to know my kids I pick the ones that I think I'll get the most out of and do those. The ones I miss, I just miss, because I'd rather the kids know something that they can build on rather than a hodgepodge of everything.*

The eighth-grade teacher who made this last remark later commented on the difficulty he has in helping students meet standards when the students lack sufficient preparation:

> *I use the standards. However, many of these kids come in here with limited reading skills and little or no computation skills. So I assess them. I spend one to nine weeks finding out what they know and compare it to what they should know when entering eighth grade. Then I must decide whether to give them what they should know or advance them. I base it on what the majority needs.*

When asked "How do you decide what mathematics to teach?" the majority of teachers who were interviewed did not mention standards prominently in their responses. Several teachers spoke instead of following the curriculum established by their school or district. To the extent that the curriculum is aligned with standards, then, instruction may also be aligned with the standards. Alignment of standards with curriculum is discussed further in the following section.

District Spotlight: Mathematics Content Standards That Matter

In one of the eight districts visited, the district's content standards have clearly exercised a powerful effect on schools and teachers. Every teacher interviewed in this district (6 total) talked about the content standards and the impact of the standards on curriculum and instruction. For example, when asked, "How do you decide what mathematics to teach?" standards figured prominently in the answers of five of the six teachers, and the sixth teacher implied the same in the answers to other interview questions. Following are some of the remarks of teachers in this district about the influence of the district's content standards:

> *We have 8 district standards. What I like about them is that they simplify our curriculum and tell us exactly what we can focus on….The standards guide my teaching.*

> *For planning purposes, I went through the district standards, month by month…. We are completely standards-based in our approach.*

> *My approach is to combine various strategies and to cover the standards….I teach the standards.*

The principals at the schools in this district also had a very high level of awareness of the standards. At one school, the principal said she thought that mathematics instruction was "clearly being driven by [district] standards" and mentioned that her school is piloting the new district report card, which focuses heavily on reading and mathematics standards. Another principal stated that curriculum is "absolutely dictated" by the district-developed standards, although teachers "have freedom" in how to teach them. She also mentioned that she thought the standards had helped with student achievement by allowing teachers to clearly communicate to parents where their children were and where they needed to go.

A principal at a third school in the district also commented that she thought the standards had had a major positive impact and made a direct difference in the classroom. She indicated that standards help her "talk to teachers," since she can better see what teachers are covering and what they should be covering, and she thinks that standards set up a positive atmosphere of peer pressure to produce good outcomes. She reported that all students have copies of the standards in their binders, and teachers link back to them during lessons. The classroom observer did not directly confirm this, although in a different school in the same district, the observer made the following note about a particular teacher's class:

> *It was interesting how explicit the emphasis was on standards and teaching to them. These are at the forefront of the teacher's plans; he referred to them when describing what he does and why he does what he does. Additionally, the teacher had all the standards printed and laminated. He has them hanging on the wall, covering at least an eighth of the wall space.*

Alignment of Standards with Curriculum

- **Alignment of content standards with curriculum and instruction is an ongoing process.**

Several principals and teachers who were interviewed discussed present efforts to align curriculum and/or instruction with standards. The following comments were made by interviewees in three different districts:

> *[From a principal] We've looked at district standards and SAT-9 to determine curriculum. Now we're going to break it down by quarter.*

> *[From a teacher] Curriculum decisions come from the state and are brought to our attention at a faculty meeting. Then it's up to the teachers to write a pacing plan. Each grade level sets goals for each semester.*

> *[From a teacher] I have modified some of my teaching style to fit what the standards are saying….There's definitely standards that are being put in place and things of that nature that have influenced by teaching….They come straight from the district. Like, the principal goes to a district meeting. And she comes back, and she says, "Okay, here's what's going on."…. Like for example, at the beginning of the school year, I'm a math teacher, and so I didn't do a whole lot of writing in my class. Well, now I do tons of writing in my class, because that's part of the standard now: "Students will be able to learn to read and write across the curriculum."*

The teacher of this last remark, however, was also one of the teachers who said that he decided what to teach by "following the book." As mentioned in the previous chapter, many teachers reported that curriculum materials—namely, the textbook—play the primary role in determining the content of instruction. Thus, *to the extent that curriculum materials are aligned with the standards* and instruction follows the curriculum materials, then instruction is aligned with the standards. And some interviewees did indicate such alignment:

> *[From a principal] The state framework determines the curriculum. As for the text, the principal and teachers look at the state approved books to try and meet the standards which state that by a particular age, a student must have mastery of specific skills….The school has full discretion over pacing, but we need to meet the standards.*

> *[From a teacher] The district standards are pretty much aligned with the book we use. They went through that whole process when they chose the book, back, like, two years ago. From what I understand—I wasn't here…. The curriculum is pretty well laid out. They tell you what concepts need to be done; you don't have to do it exactly the way it is in the book, but that's basically what you've gotta teach.*

The principal at this teacher's school, however, did not take it as a given that following the district-adopted text ensured coverage of the standards. She stated:

> *The district is attempting to align the math standards with curriculum….Our major job next year is to align curriculum, see if we're achieving the standards, and understand what the assessments show about changes that need to be made….Our priorities are to align curriculum to standards and to do a quarterly assessment here so that the goals are set for each grade level in math.*

Moreover, as demonstrated by some of the comments in the chapter on curriculum materials, it cannot always be assumed that curriculum materials are aligned with the standards. The ever-changing nature of standards, and the different sets of standards, only exacerbate this problem. An interviewed teacher in one district stated:

> *This year we made the transition to an algebra curriculum for eighth grade that is different than traditional algebra. This was supposed to be the transition year. Now, these books…have not been adopted by the district. They follow the old state standards and the NCTM standards, but they don't address the new state standards.*

Another teacher who was interviewed lamented similarly, "Math standards keep changing and how can we get a curriculum to match when it's always changing?" Yet another teacher commented, "I think we need to align our curriculum with the state standards because they are aligned with the SAT-9." This remark hints at the power of the SAT-9 in driving curriculum, to be discussed further in the following chapter. The extent to which the SAT-9 truly is aligned with the state standards also will be discussed.

District Spotlight: Aligning Mathematics Standards with Curriculum

School-level comments about alignment of mathematics curriculum with standards were particularly prominent in one of the eight districts visited (not, interestingly, the same district discussed above in which standards figured so prominently in interview responses). Principals and teachers at three out of the four schools visited in this district mentioned alignment efforts.

At the first school, the principal said that at the beginning of the year, the faculty had discussed the district mathematics standards and grade-level teams met to decide the goals and objectives for the year based upon the appropriate standards. They created a yearlong plan to address all of the standards, and teachers continue to work in grade level teams to plan how to meet the standards. A teacher at this school confirmed independently that the fourth-grade teachers had, indeed, met as a group to align their curriculum to the district standards.

At the second school in this district, the principal spoke of how “Standards are the basis now in the school and in the district” and stated that “the present school effort is to align curriculum to standards.” (She said that the school follows the direction of the district inasmuch as the district selects the text and adopts the standards, but the school itself develops the “course of study.”) A teacher at this school, meanwhile, discussed how the teachers had been “mapping” district standards to curriculum, resources, and practices. She implied that this had been a district-wide activity.

The principal at the third school discussed alignment between professional development efforts and the standards, explaining that the school has an outside consultant who comes in on a monthly basis to demonstrate how to use materials and “how the materials correspond to the district standards.” The relationship between the consultant and the content standards was not mentioned by the teachers at this school, but one of the teachers did discuss how, using the district and state standards as a guide, the mathematics teachers had met and “made a list of priorities” for teaching mathematics. She said that this had been a “useful discussion” and that they had “shared methods.”

In the Next Chapter

If content standards are not being taught, their impact on students is likely to be minimal. One way to promote classroom implementation of content standards is to align high-stakes assessments with the content standards. When such assessments exist, schools and teachers may have more motivation to help students master the standards. Assessment is the subject of the next chapter.

(This page intentionally left blank.)

Chapter 6

Assessment

Highlights of Findings

- **The SAT-9 has made a significant impact on schools and teachers.**
  Teachers are highly aware of the SAT-9 and its importance. At many schools, the influence of the SAT-9 goes beyond test preparation and extends into the realm of shaping the curriculum itself.

- **As much as it may drive instruction, the SAT-9 has been the cause of much anxiety at the school level.**
  Principals and teachers expressed grave concerns about overreliance on the SAT-9. A lack of alignment between the SAT-9 and the curriculum is one major area of concern; a lack of alignment between the SAT-9 and content standards is another.

- **Many teachers feel that they are being compelled to "teach to the test" and that this may harm students.**
  Some teachers believe that ultimately, teaching to the SAT-9 will negatively affect students' understanding of and appreciation for mathematics, as the test focuses on breadth rather than depth and does not sufficiently measure different types of mathematical achievement, such as conceptual thinking.

- **The augmented section of the STAR program caused particular anguish among teachers and students in spring 1999.**
  Although the augmented portion of the STAR program may have been more aligned with the state standards than the base SAT-9, many teachers felt that the augmented items were grade-level inappropriate and unfair to students, given the preparation they had had. Some teachers, however, indicated that they planned to adjust their curriculum coverage so as to better prepare students for the augmented items.

- **The quantity and timing of assessments can be problematic.**
  Several teachers and principals commented that too many assessments were taking time away from instruction. Also, the time at which any given assessment is administered plays an important role in how much of the content students have covered. Some teachers remarked that the SAT-9 included items that were not taught until mid- or late spring, after the test was administered.

Background

As with content standards, assessment in California over the past decade has had a rocky history. In the early 1990s, California implemented its first performance-based assessment system, the California Learning Assessment System (CLAS), specifically designed to measure students' mastery of curriculum laid out in the state *Frameworks*. However, in 1994, after just one year, funding for the test was vetoed by the governor for a combination of political, technical, and ideological reasons. In 1995, the state enacted the California Assessment of Academic Achievement Act (AB 265), which provided districts with funding to administer tests selected from a state-approved list.

Then in 1997, the Standardized Testing and Reporting (STAR) program was enacted. STAR, which was motivated by a perceived need for a statewide, comparable measure of academic performance for districts and schools that could report individual scores for all students, required all districts to administer the same nationally normed, "off-the-shelf," basic-skills, standardized test. The test selected as the centerpiece of the STAR program was the SAT-9 (Stanford Achievement Test, Ninth Edition, Form T), published by Harcourt Brace Educational Measurement. The STAR program, still in force today, required virtually all students in grades 2–11, including English language learners, to take the SAT-9 each spring.

Meanwhile, as part of the statewide Standards-Based Accountability System, most districts were required in 1997–1998 to implement multiple measures of assessment for at least one grade level in each of three specified grade spans. The SAT-9 had to be one of the measures (as specified by the STAR program), but districts were relatively free to choose the other measures, provided that certain criteria were met and that the different measures were combined (to determine student proficiency) in accordance with state guidelines. For mathematics, many districts elected to develop or purchase criterion-referenced or performance-based assessments to meet the multiple measures requirement (Guth et al., 1999).

In 1999, however, the Public Schools Accountability Act (PSAA)—the enactment of SBX1—replaced the Standards-Based Accountability System and its multiple measures requirement. Under the provisions of the PSAA, the SAT-9 is currently the sole indicator being used in a statewide index designed to rank schools' performance and determine their eligibility for a rewards and intervention program. Until other indicators of academic performance are deemed valid and reliable, the SAT-9 will remain the sole measure of student achievement.[1] As such, it has become a truly "high stakes" test.

---

[1] In spring 1999, the test was "augmented" with extra items designed to assess student mastery of the content standards adopted by the State Board of Education in 1997. Student achievement on these items is measured separately from the base test. A study conducted by William H. Schmidt of the Third International Mathematics and Science Study (TIMMS) Center found that the base (mathematics) SAT-9 is not aligned with the California mathematics standards (Boser, 1999).

The Impact of the Stanford-9

- **The SAT-9 has made a significant impact on schools and teachers and in some places appears to drive curriculum and instruction.**

Although, in theory, content standards (discussed in the previous chapter) should play the most important role in shaping curriculum and instruction, data suggest that assessment—and the SAT-9 in particular—actually carries more force. On the survey, 71% of fourth-grade teachers agreed strongly with the statement, "There is a school-wide effort to improve student mathematics achievement on the SAT-9." In contrast, only 51% of fourth-grade teachers agreed strongly with the statement, "There is a school-wide effort to implement our district mathematics standards." At the eighth-grade level, the figures for the two items were a bit closer together, but the SAT-9 still "won" over standards, with 80% agreeing strongly about the SAT-9 but only 70% agreeing strongly about the district standards.

Interviews with school-level personnel confirmed the importance of the SAT-9. Numerous principals and teachers spoke about "living and dying by the test scores," focusing professional development efforts on improving test scores, pacing instruction so that teachers can "strategically prepare" the students for standardized tests, and "anxiously awaiting" the SAT-9 results. (Interviews were conducted before the scores were released.) One principal explained that "the SAT-9 has been the catalyst" for changes occurring in her school; "Other state policies," she continued, "have had nowhere near the same level of influence."

Indeed, in answer to the question, "Did you do anything special to help your students prepare for this year's SAT-9?," the vast majority of teachers interviewed answered in the affirmative. A few of the teachers focused on basic skills or on particular content areas as part of this preparation. One eighth-grade teacher, for example, explained that her school had identified fractions and decimals as an area needing improvement on the test, "so we did a lot of review on that concept." Two fourth-grade teachers (both at the same school as one another) mentioned involving parents by speaking with them and telling them "we needed to help students prepare" or by sending letters home telling parents what skills were being tested.

More common responses, however, included work on "test-taking skills" (for example, in taking multiple-choice tests) and the administration of practice tests. As one teacher put it, "My main focus was teaching them how to take *a* test, as opposed to how to take this *particular* test." Another teacher, similarly, explained, "My focus was not on math as much as on how to read the questions." Several teachers mentioned the use of test-preparation booklets/materials, although in more than one instance, these materials had not arrived in time to be used for the current school year.

The amount of time spent specifically on SAT-9 preparation was variable. Roughly one-third of the teachers who were interviewed said they'd spent two to three weeks; about another third said one to two months or one day per week all year long. A few teachers reported that they had worked on SAT-9 preparation all year.

At many of the schools visited, the SAT-9 had an impact well beyond preparing students to take the test, extending into the realm of shaping the curriculum itself. Without prompting, many teachers mentioned the SAT-9 in their answers to questions about their "general approach" to teaching mathematics or about documents and policies that they felt had had an impact on their teaching. "The thing that jumps to mind is the STAR-9 testing," replied one teacher; "the greatest impact comes from the Stanford-9 and [another assessment used in the district]," stated another. Responses such as these, along with "preparing students to take standardized tests," were fairly typical.

Moreover, several principals stated unequivocally that the SAT-9 will "drive the way we teach" or had already done so. (Some interviewees acknowledged that assessment in general, rather than the SAT-9 alone, is the driving force.) The following comments were made by principals in three different districts:

> *We did a curriculum map last year related to the SAT-9. As a result our program has been skills based.*

> *SAT-9 played a large part [in influencing mathematics instruction at the school]—fortunately and unfortunately. You want to teach the students what they will be tested on.*

> *We use the make-up of the SAT-9 to determine what parts of the curriculum we should stress. For example, if there are more estimation problems on it we will cover that more next year.*

Some teachers, as well, made comments about the influence of the SAT-9 over their curriculum or their instructional practices. "The test influences what I teach," explained one teacher; "I try to cover all the areas that will be on the test," she continued. In a different district, a teacher remarked that after the students had taken this year's SAT-9, she asked them what they did not know on the test; they indicated geometry, so next year she intends to bring that in earlier. More generally, this same teacher stated, "If the SAT-9 is a test of skills, not theory, then we might as well continue to teach that way."

Perceived Problems with the SAT-9

- **As much as it may drive instruction, the SAT-9 has been a source of much anxiety at the school level. Principals and teachers expressed grave concerns about overreliance on the SAT-9.**

In response to the open-ended survey question about policies that have hindered mathematics teaching, 14.1% of fourth-grade teachers and 11.6% of eighth-grade teachers discussed assessment. Responses relating to assessment formed the second-largest category of responses to the question at the fourth-grade level, and the third-largest category at the eighth-grade level.

Many teachers commented simply that they felt there was too much emphasis on the SAT-9, on standardized testing, or on test results. Some teachers did indicate a belief that assessment as a measure of accountability is important— they just think that the SAT-9 may not be the most appropriate measure, particularly if it is the *only* measure. In response to the survey question about helpful policies, one eighth-grade teacher wrote, "Our district and school has focused on student learning and assessment has become a key issue. We look at assessment from many perspectives, not just testing." And an eighth-grade teacher who was interviewed commented:

> *I would hope we're being held accountable. The problem I see is that I don't think it's [the STAR test] the one way you test for that. I think it should be just one of a variety of things. But I definitely think we should be held accountable for student performance. If not, we're not doing our jobs….I just don't think it [accountability] should be measured with one set of tests, and that's it. The kids I have…are good kids; they came in with good scores, they'll go out with decent scores; they probably could have done that no matter whether I did a good job or not. On the other hand, you can get kids that are ill-prepared, and you know, how much you can help them improve — I don't know that anybody knows, is that 5 percentage points? Is that 25 percentage points? I guess we're all wondering, what's going to be the measure of achievement? So, that's all a little iffy when the test is the thing.*

The primary concerns that teachers expressed about the SAT-9 and its effects on instruction—and on students—are discussed in the following sections.

- **A lack of alignment between the SAT-9 and the curriculum is a major area of concern.**

One frequently cited concern about the SAT-9, as discussed in the chapter on curriculum materials, was that curriculum materials are not aligned with the test. "I'm seeing that my students struggle with standardized testing because the curriculum adopted program does not completely coincide. They have difficulty with transferring information learned while taking state test," wrote one fourth-grade teacher on the survey.

Many teachers who were interviewed expressed a similar sentiment. "The Stanford-9 test material is not in our curriculum!" bemoaned one eighth-grade teacher. Another spoke of how the SAT-9 was a "more traditional" approach that does not mesh with the curriculum. A fourth-grade teacher had even more to say about this:

> *The new adoption for the district — there's an obvious philosophy behind it that it should be hands-on…My biggest complaint with the hands-on is that [students are] not tested that way. It's like they [the district] want us to use hands-on materials, but then they test us in a much more traditional way, and the students, at least in this school, have a very hard time making that connection, you know, applying the hands-on stuff to the test. [And the test] is what the district's looking at…Regarding the district and the state, teachers are getting mixed messages about hands-on versus seatwork. I don't get a consistent message. No one fully explains to you how you're supposed to prepare kids for tests.*

One principal who was interviewed said that there had been much anxiety in her school over the STAR program; she said that the teachers were worried that the kids were being tested on topics not taught. A principal in a different district made a similar comment, about teachers seeing "a discrepancy" between things on the test and things that are taught. Several interviewed teachers confirmed this. "The test doesn't assess what's going on here," stated one teacher; "The SAT-9 is not a good judge," said another.

- **Many teachers feel that they are being compelled to "teach to the test," a particular problem if the test lacks balance and is not aligned with the standards.**

As suggested by the remarks from those who say that the test is driving curriculum, it appears that many schools and teachers are adapting instruction to fit the test. But many teachers strongly object to the idea of "teaching to the test," and believe that the overall effect on students will be negative. "Teaching for 'the test' drives the curriculum, in some areas to the detriment of what the students need," wrote one teacher on the survey.

Again, teachers who were interviewed echoed this sentiment. As one eighth-grade teacher stated emphatically, "The SAT-9 is going to have a negative impact. It really controls teaching and what is taught." Another interviewed teacher said that although he does not "believe in teaching to a standardized test," he feels "tugged in that direction, because everybody thinks it's important," and thus has to "honor it."

Some principals also expressed concerns about curriculum driven by assessment. One principal commented that looking at test scores might help improve the scores, but that this did not necessarily mean improving the curriculum. Another principal said that she worries that as teachers teach more and more narrowly to the tests, important things are getting left out of children's education. Previously, this principal remarked, she would have felt accountable to parents to give children a well-rounded education, but she now feels accountable to the district (who, in turn, is accountable to the state) to provide high scores. She thought that this sometimes gets in the way of giving students the best possible education.

Teachers helped provide an answer to the question of what, exactly, might be getting left out of children's education as a result of the emphasis on the SAT-9. As with instructional practices and curriculum materials, some teachers expressed the concern that the test lacks balance between computational mastery and conceptual understanding and between depth and breadth, and thus that "teaching to the test" inhibits a well-rounded mathematics instructional approach. Survey comments along these lines—each from a teacher in a different district—included:

> *[from a fourth-grade teacher, cited as obstacle] Trying to teach conceptually when we are responsible for the students doing well on a standardized test that is traditional.*
>
> *[from an eighth-grade teacher] The concern should be depth and understanding. Assessment tools need to address other intelligences. CLAS had the right idea. We need a TRUE multiple measure, not another multiple choice test.*
>
> *[from a fourth-grade teacher, cited as obstacle] Pressure to "teach to the test" and not have students explore and enjoy mathematics as much as I would like them to.*
>
> *[from a fourth-grade teacher] The time spent skimming over topics to prepare students for standardized tests could have been better spent by focusing on interesting concepts more thoroughly.*
>
> *[from an eighth-grade teacher, cited as hindering policy] The emphasis on the SAT-9! I am encouraged to spend time on too many topics so students don't get enough depth to remember topics so what they know this week they forget.*

Another major concern that many people voiced about the SAT-9 is that it is not aligned with content standards. For example, one principal said that "we have no measure" for determining if a student meets the district standards, implying that the SAT-9 does not serve this purpose. Another principal mentioned that there had been "some resistance to the SAT-9 because it is not aligned with the standards." She expounded further:

> *Do [the district math] standards align with the standardized tests that [students] have to take? No. They don't. And that's very frustrating for math teachers. What we're teaching and when we're teaching it, and when they take the standardized tests and they see that something is on*

there that they haven't taught yet — it's very frustrating. … Aligning our state testing with our standards is really important, so we don't have that frustration.

Indeed, some teachers particularly objected to the idea of "teaching to a test" that is not aligned with the standards. Two interviewed eighth-grade teachers commented:

I get the impression from the state government that we need to teach to the test. I mean, who cares about content anymore in the math class? We teach to the test. Because now they [the state government] are offering extra money tied to teachers whose test scores are high. And, so that speaks very loudly that…it doesn't matter about the content, let's teach to the test….I'm not going to, but that's what I'm hearing, and I'll bet you that, in time, the department will force me to do that….I think the standardized test that we have to take gets in the way. Because it forces me to teach to the test, instead of teaching to what the standards are.

There's a lot of pressure to make sure students perform well on [the SAT-9]. And personally, I think if the curriculum is strong and you teach the curriculum, then you don't have to worry about the individual test. But, I'm kind of shouting out in a field by myself on that. Or, at least, there are a lot of teachers shouting out there, and other people aren't listening. And I just fear that we're moving too much toward teaching to a test. It's not ever been stated that way, but I think it's moving in that direction. I avoid it [teaching to the test], thinking that the strength of the curriculum will do the job. And, I don't know what I'll have to do if the results aren't good, and I have to revise what I do. Because, I think, then the task is, change the curriculum…I think the problem we have right now is that the test and the curriculum are based on different standards, and they haven't brought them in line. And I'd like to see the test follow the curriculum — or, decide what the curriculum should be, establish the statewide standards, or national standards, or whatever the heck we're going to use, and then make sure the test follows that. And not the other way around. I don't want a curriculum chasing the test. I want the test to match the standards. And I don't think we're anywhere near there yet….

Of course, there is the further issue of which standards the test should be aligned to, given that (as discussed in the chapter on standards) different sets of standards—district, state, national—may not be aligned with each other. One fourth-grade survey respondent remarked, "There is a discrepancy between the need to cover all possible test topics to improve test scores, and the NCTM standards that emphasize thoroughness and deeper understanding of concepts and number sense."

- **Although the augmented portion of the STAR program may be more aligned with the state standards than the base SAT-9, the use of the augmented test in spring 1999 caused considerable anguish among teachers and students.**

At least in theory, the use of the new "augmented," standards-based sections of the STAR program may alleviate some of the concerns that people have about lack of alignment between the test and the standards. However, it appears that considerable progress remains to be made with the use of these new sections. According to sources within the California Department of Education, some of the augmented items (as administered in spring 1999) failed to meet technical standards of validity and reliability.

Moreover, several people objected to the augmented sections of the 1999 test on the grounds that they were unfairly difficult, especially given the level of preparation most students had had prior to the test. On the survey, one fourth-grade teacher wrote that augmented test was “despicable.” “After hours of dreary testing,” she continued, “students are made to feel ignorant of things they have never laid eyes on. I am disgusted.” Another fourth-grade teacher reported that teachers had not been informed about “the new augmented portion of the math test that was added” until shortly before the test was administered and that there had been “no helpful information to aid or guide us.”

Other survey comments suggested the test’s content was grade-level inappropriate. Many of these comments did not mention the augmented sections *per se*, but, given other remarks that were made, it seems likely that the augmented sections were the basis for the comments. The following remarks were made by fourth-grade teachers in three different districts:

> *[cited as hindering policy] Rewriting requirements to meet STAR (which are not reasonable to begin with), which essentially want me to push 4th graders into 6th grade math without experiencing 5th.*

> *[cited as hindering policy] State tests should test concepts taught at this grade level.*

> *The “Star” testing is inappropriate for the “average child”—Great info for the students that excel in given areas/topics. I question the validity of results.*

Similar findings came from interviews. One principal remarked, “the augmentation portion was a bust”; she said that the test “set the students and teachers up because the expectations were not matched by what students found on test.” And the following remarks were made by interviewed teachers in two different districts, the first one an elementary-school teacher and the second one a middle-school teacher:

> *I was really upset by the augmentation test. The students were asked to work with negative integers. I didn’t teach them that.*

> *The SAT-9 tests a lot of stuff that they haven’t even learned…The problem is that we’re supposed to be aligned with the state test. And so, that means basically we need to advance all our students before they’re ready….The seventh graders had to take this test, the STAR test…While they were taking it, I could just see the frustration on their faces, and I was like, what’s going on? … [I*

realized], oh my gosh, they're so frustrated because this is the stuff I'm teaching my eighth graders right now, but my seventh graders haven't even seen this material yet.

This teacher said that as a result of this experience, next year he plans to move content down from the eighth grade to the seventh grade to the "best of his ability." Similarly, an interviewed fourth-grade teacher said, "I don't believe in teaching to the test but it's not fair for a child not to have exposure to what's on the test." She indicated that next year, she will add new topics to her curriculum—those on the augmentation test—so that students have exposure to them.

In this way, then, the use of the augmented portions of the STAR program may indeed be having the effect desired by the state: they seem to be spurring at least some teachers to teach particular content at levels they otherwise would not have. To the extent that this content is indeed aligned with the standards, then the test is encouraging standards-based instruction. As one principal put it, "[The augmented test] has really been an issue with our math teachers, because they feel that it's out of reach of most students. But maybe that's the purpose of it: make it within reach." However, this same principal also stated that there had been "a lot of resistance" among teachers to changing their curriculum to match what was on the state augmented test.

Quantity and Timing of Assessments

♦ Testing takes time away from instruction.

Another area of concern with regard to assessment is the amount of class time needed to administer and prepare for tests. Many teachers felt that this time could be spent in more instructionally valuable ways. On this matter, the SAT-9 was viewed as only one of the culprits; other assessments, such as those required at the district-level, also were partly responsible. Survey comments along these lines included:

[from a fourth-grade teacher] There have been a large number of tests required this year that took away from teaching time and covered areas not presented in our current text. There should be a more relevant, valuable, and enjoyable way to assess and educate students.

[from an eighth-grade teacher] Too many standardized tests given in fourth quarter cause loss of teaching time and promote apathy in the students.

[from an eighth-grade teacher] If you look at the amount of time taken by state and district assessments you lose about 5–10 days of instruction.

A principal who was interviewed also expressed the concern that too much time was being devoted to testing, and that it was cutting into instruction time. And an interviewed teacher in a different district said he thought that the district assessment, given three times over the course of the year, "was a little much":

> *We lost three instructional days, plus whatever preparation we were doing for it. And then also, it took some time to grade the papers, all that kind of stuff, which took away from my preparation time as well….So I thought it was a little much…to do three of them; I felt it would be better if it was just one.*

Some interviewed teachers said that they had stopped what they were doing in order to prepare students for assessments (including the SAT-9), and a few of them resented having to do this. As one teacher put it, "It [test preparation] slowed me down with respect to my regular instruction."

- **The time at which an assessment is administered also plays an important role in how much of the content students have covered.**

Some teachers voiced concerns not only about the amount of time required to prepare for and to give assessments, but the particular scheduling of these assessments, as indicated by the following interview comments from two teachers at one school:

> *I mean, it's really hard, because, like, we'll get a test coming up, a [district] performance-based assessment test, coming up, and I'll look at it, and I'll go, "Oh, gee, we haven't even covered this yet." So I'll have to stop what I'm doing, cover this material, so that they can do well on the performance-based assessment test. And then go back to my regular material.*
>
> *The district has had…performance-based assessments that we had three times this year…And I have no trouble doing performance-based assessments, but when it comes from the district, it doesn't necessarily fit with what you're doing at the time. I'd rather have an assessment that goes along with what they [students] are doing….It was like, just take this chunk out of time, and do this thing that's not associated with what you're teaching.*

Another scheduling concern is that some assessments—the SAT-9 in particular—are administered before students have been exposed to all the content in the assessments. One interviewed eighth-grade teacher stated that although the SAT-9 was given in the early spring, it focused on the last third of the year's curriculum, and the class simply "hadn't gotten to a lot of those topics yet." Another eighth-grade teacher, interviewed toward the end of the school year, said that her class had covered several more standards since the test was given, as a result of the way the book was set up. She hypothesized that if her students could "take the test today, they could get at least ten more right." As it was, however, she stated, "The SAT-9 was extremely frustrating — it was a whole week of upset and tears" for her students, whom she said are among the best at her school. She teaches five gifted classes.

In the Next Chapter

As shown in this chapter, the SAT-9 has made a significant impact on instruction, as teachers are eager to help their students do well on this high-stakes test. However, teachers' good intentions alone may not be sufficient to raise student achievement. Even if student achievement on the SAT-9 does improve, achievement on measures of assessment that measure different types of mathematical skills and abilities might not. The implementation of meaningful instructional change that truly raises students' understanding of mathematics might require changes in teacher preparation and professional development. These will be discussed in the following chapter.

Chapter 7

Professional Development

Highlights of Findings

- **Fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers in the period between January 1998 and spring 1999.**
  While about two-thirds of eighth-grade teachers reported having had more than 20 hours of mathematics professional development from January 1998 through spring 1999, over 50% of fourth-grade teachers said that they had had 10 or fewer hours of mathematics professional development during this same time period. However, this is unsurprising, as fourth-grade teachers are teaching other subjects in addition to mathematics.

- **Some teachers, especially at the fourth-grade level, identified a lack of comfort with mathematics content as being an obstacle to their teaching.**
  Very few fourth-grade teachers who were surveyed reported having a strong background in mathematics. Most of the eighth-grade teachers who responded to the survey appeared to have a relatively strong background in mathematics, including a mathematics-related teaching credential, but it is unclear how representative these data are of the larger pool of middle-school mathematics teachers.

- **Many teachers identified professional development as something that had helped their mathematics teaching, and they would like more.**
  Areas in which teachers seek additional professional development include standards and instructional techniques. Teachers would also like more opportunities to collaborate with one another.

- **Providing effective professional development for all who need it is a major challenge.**
  Some teachers and principals discussed the importance of professional development being accessible and worthwhile. Site-based professional development and moving to a specialist model at the elementary school level were among the solutions proposed by district administrators.

Background

Previous chapters have discussed instructional strategies, curriculum materials, standards, and assessment. While any or all of these may exert a strong influence on instruction, they are unlikely to exert a strong positive influence on student achievement unless teachers know how to use them for that effect. For many teachers, the acquisition of such skills and knowledge comes primarily through professional development.

Learning to teach is a life-long process, of which pre-service preparation is just one phase. Ideally, teachers emerge from this phase as strong novices, equipped with the skills and dispositions to facilitate continuation of the learning process. Thus, pre-service programs are only the beginning of a teacher professional development continuum. Subsequent educational programs help teachers to become *competent* through emphasizing increased knowledge of subject matter, pedagogy, learning theory, and classroom management techniques. These professional development experiences can be formal or informal, as well as long-term or "one-shot."

To increase their subject matter competency, many teachers enroll in formal university courses in mathematics content or mathematics education. Over the past sixteen years, thousands of California teachers have also participated in the CDE-sponsored California Mathematics Projects, housed at colleges and universities, focused on improving teachers' understanding of subject matter as well as instructional practice. Hundreds of elementary teachers have acquired new curriculum materials as well as strategies for teaching through participation in the Math Matters project, also sponsored by CDE. California teachers have also received professional development in mathematics through their involvement in long-term, National Science Foundation funded, district-based programs such as the Statewide Systemic Initiative sponsored *Math Renaissance* for middle schools, Local Systemic Change Projects, or Urban Systemic Initiatives (USIs).

County Offices of Education and school districts offer teachers a variety of professional development opportunities (often called "in-services") that vary from one-shot sessions to those involving a long-term series. Almost every school district invests considerable resources in sessions devoted to helping teachers become familiar with newly adopted instructional materials and since 1984, funds from the Eisenhower Professional Development Program have enabled local districts to increase and enhance professional growth opportunities for teachers of mathematics.

The California Mathematics Council (CMC), a professional organization, sponsors three major multi-day conferences for teachers of mathematics grades K-14. Approximately 9,000 teachers attend CMC conferences held at conference sites at Asilomar, Palm Springs, or Fresno each year. Local affiliates of the CMC also sponsor smaller conferences where teachers learn about new resources and strategies.

Informal professional development occurs in a variety of ways. Many teachers increase their knowledge through reading professional journals published by CMC or the National Council of Teachers of Mathematics. Teachers also share their expertise with one another at their own school sites through grade-level or departmental meetings focused on mathematics topics or through informal conversations in the lunchroom.

Over the past 15 years significant federal, state, and foundation funds have been devoted to mathematics professional development. Most of the data on teacher professional development in this study reflect only a snapshot in time—January 1998 through Spring 1999—and not the multitude of professional development opportunities available to teachers nor the intensity of professional development involvement of individual teachers. Rich descriptions of mathematics professional development experiences and their impact on classrooms were, however, provided during teacher and administrator interviews. Many of these experiences were prior to January 1998, indicating the limitation of the survey data.

Amount of Professional Development

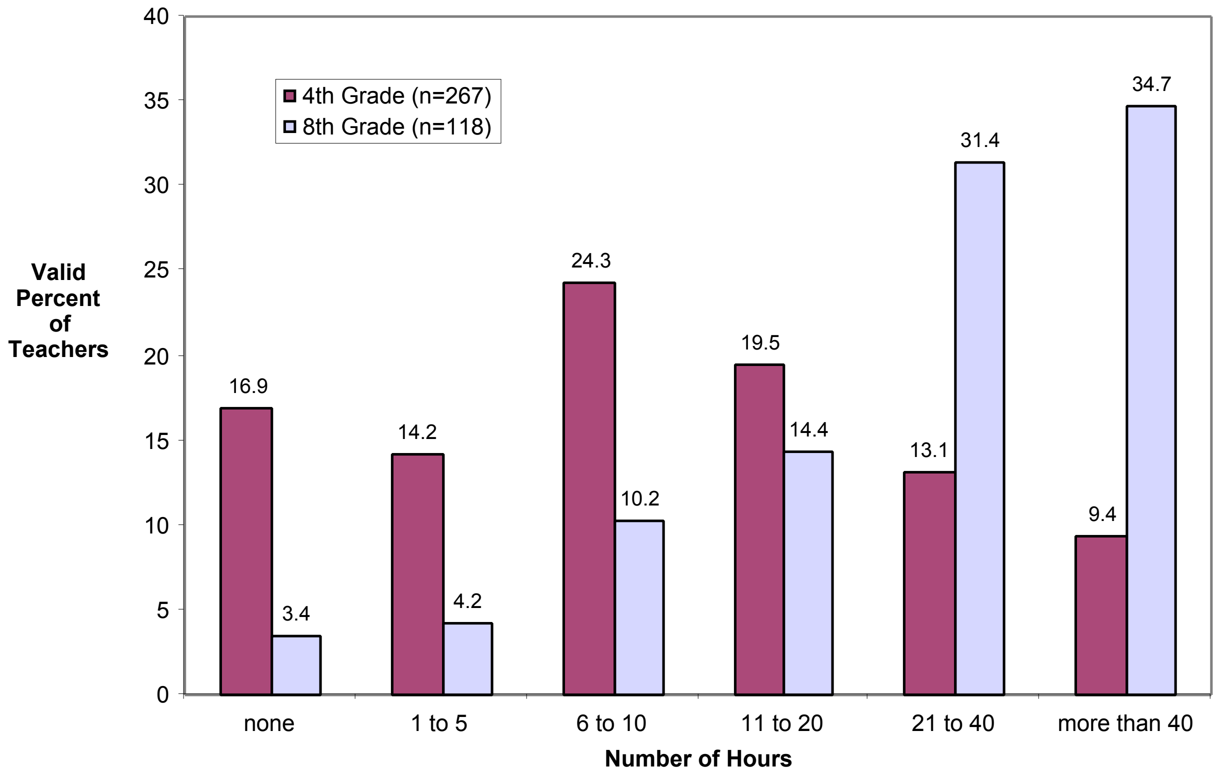
- ♦ **Unsurprisingly, fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers.**

One of the questions on the survey asked, "Since January 1998, approximately how many hours have you spent in mathematics professional development?" Respondents were prompted to include "attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences." As teachers completed the survey in the spring of 1999, the period of reference covered a little over a year.

As Figure 7.1 shows, fourth-grade teachers reported having had fewer hours of mathematics professional development than eighth-grade teachers in the year-plus time period covered by the question. About 30% of fourth-grade teachers said that they had had 5 or fewer hours, and another 24% said they had had 6 to 10 hours. For the eighth-grade teachers, on the other hand, approximately one-third of the teachers reported having had more than 40 hours, and about another third indicated 21 to 40 hours.

That fourth-grade teachers have had fewer hours of mathematics professional development than eighth-grade teachers is not surprising. Fourth-grade teachers, of course, are teaching multiple subjects, of which mathematics is just one, while most of the eighth-grade teachers who were surveyed were teaching primarily mathematics. Thus, the eighth-grade teachers are probably more likely than the fourth-grade teachers to have engaged in professional development that focused specifically on mathematics.

Figure 7.1
Reported Number of Hours Spent in *All Types* of Mathematics Professional Development, January 1998–Spring 1999



More in-depth findings on professional development and preparation in mathematics are presented in the following sections.

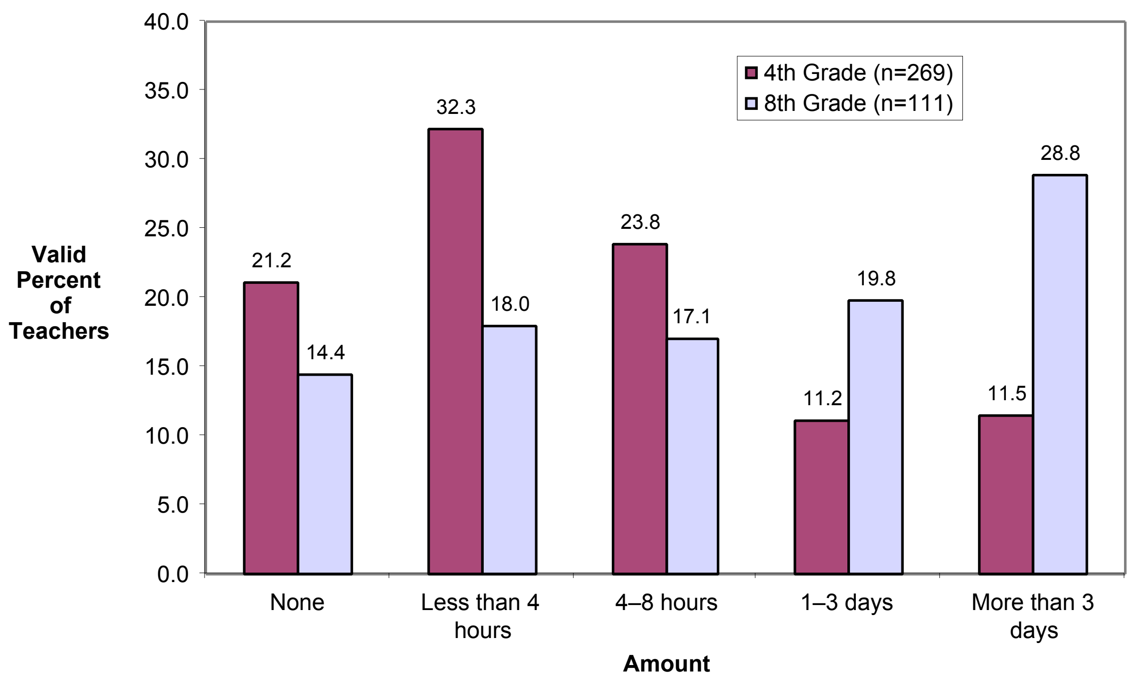
The Lack of Professional Development as an Obstacle

Several of the teachers who were interviewed mentioned increased professional development as something that would help them improve their mathematics teaching. On the survey, about 11% of fourth-grade teachers and 4% of eighth-grade teachers cited things such as "lack of training" and "insufficient professional development" as being among the biggest obstacles to their mathematics teaching. Many did not specify what, in particular, they felt was lacking in terms of professional development and training, but some did.

♦ **Some teachers, especially at the fourth-grade level, identified a lack of comfort with mathematics as being an obstacle to their teaching. Very few fourth-grade teachers who were surveyed reported having strong background in mathematics.**

A few teachers, especially at the fourth-grade level, indicated that the main problem was lack of comfort with or conceptual understanding of the subject matter. "My limited exposure to math concepts," wrote one fourth-grade teacher in response to the obstacles question on the survey; "I lack depth of understanding in concepts" wrote another. On a different survey question that asked how much time teachers had spent in specific types of mathematics professional development since January 1998, about 20% of fourth grade respondents said that they had had *no* professional development in mathematics content, and 32% said they had had less than four hours. In contrast, eighth-grade teachers reported having had considerably more content-related mathematics professional development. (See Figure 7.2.) Again, this is to be expected, as eighth-grade teachers have had more overall mathematics professional development.

Figure 7.2
Reported Amount of Professional Development in Mathematics *Content*
January 1998–Spring 1999



One factor that may influence comfort with mathematics, obviously, is mathematics background and preparation. The survey included several questions aimed at identifying mathematics background and preparation such as mathematics courses taken in high school and college, subject area of degree, and type of credential.

The mathematics background of most fourth-grade teachers appears relatively limited. In terms of high school mathematics courses, only about a third of fourth-grade respondents indicated that they had taken more than three such courses. At the college level, nearly one-third of fourth-grade respondents did not indicate that they had taken *any* college mathematics courses, and another third indicated that they had taken only one. Similarly, only four fourth-grade teachers reported having a bachelor's degree in mathematics. Almost no fourth-grade teachers had a mathematics-specific teaching credential, although 11 of 260 (4.2%) said they had a supplementary authorization in mathematics.

♦ **Most of the eighth-grade teachers who responded to the survey appeared to have a relatively strong background in mathematics, including a mathematics-related teaching credential.**

Unlike the fourth-grade teachers, responding eighth-grade teachers appeared to have substantial mathematics background. 75% of the responding eighth-grade teachers reported having taken four or more high school mathematics courses, and about 65% said they had taken at least three college mathematics courses. 37% reported having a bachelor's degree in mathematics. Moreover, only 13.4% of responding eighth grade teachers said that they did not have any mathematics-related teaching credential. Nearly half (47.9%) said they had a full mathematics credential ("single subject credential in mathematics" or "standard secondary credential in mathematics"). About another third (30.3%) had no full mathematics credential but did say they had a supplementary authorization in mathematics. (See Figure 7.3.)

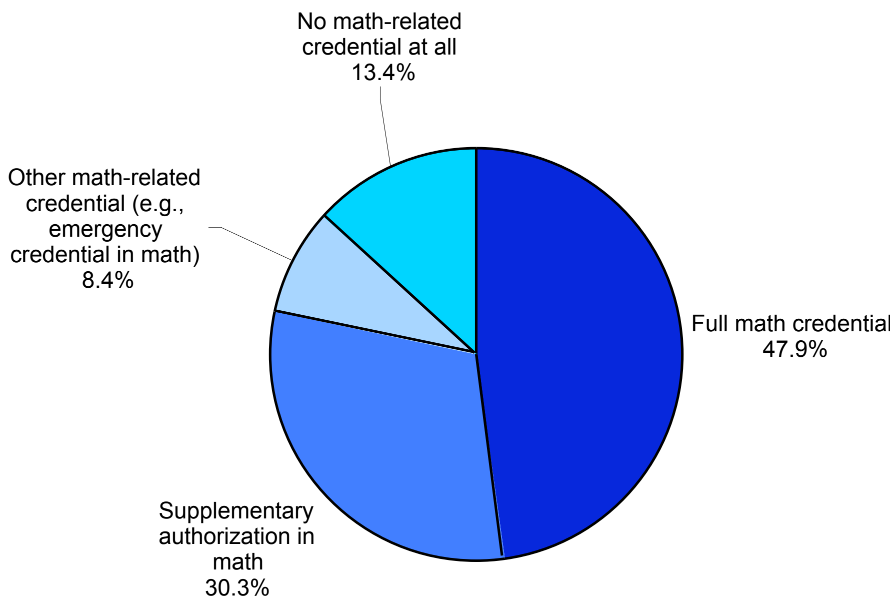
It is not entirely clear, however, how representative these figures are of the larger pool of eighth-grade mathematics teachers. Teachers with more mathematics background may have been more likely to respond to the survey than teachers with less mathematics background.

Middle school teachers' mathematics background may also vary to some extent by district. The district mathematics coordinator in one large district that was visited stated that until a few years ago, all middle school mathematics teachers in the district had a major, minor, or a supplementary credential in mathematics, and even now (at the time of the interview), only 22 middle school mathematics teachers did not.[1] In a different district, however, the

[1] This administrator did, however, acknowledge that fewer and fewer math majors, and more and more teachers with elementary credentials only, were becoming middle school mathematics teachers. He also pointed out that having a major, minor, or supplementary authorization does not necessarily guarantee having conceptual understanding of mathematics.

district mathematics coordinator who was interviewed indicated that only 17% of middle school mathematics teachers have a background in mathematics. In a third district, the district administrator who was interviewed expressed the opinion that middle school teachers "simply do not get adequate subject matter preparation in math" to be able to teach it effectively, particularly with the increased expectations called for in the new standards.

Figure 7.3
Eighth-Grade Mathematics Teachers' Credentials
n=119



One of the interviewed district administrators discussed the relationships among professional development, teacher preparation, familiarity with mathematics content, curriculum materials, and standards. The context for these remarks was the description of a district-sponsored program that aimed to provide 60 hours of mathematics professional development to every teacher teaching mathematics in grades K–8:

> *The first two or three days were really getting [teachers] used to the materials, getting [them] to know what the materials were…and then at the same time trying to talk about some of the mathematics….And what we kept finding was, you have to start spending a lot more time on good content, because the preparation for so many people was really weak. It became very clear when you started talking about some of the lessons and some of the units. So, we began to do more what I would call* content. *Not so much on pedagogy… Particularly I think in the upper grades, some*

of the people began to realize, these materials, they were moving into areas they hadn't ever spent any time on. Well, now, you move to today, where the standards come in—the standards ratcheted it up another couple levels. And you talk now to fifth grade teachers, and they'll tell you, "Wait a minute, half that stuff we still don't teach"…Integers, negative numbers, fractions. Many times they may have done awareness, or introductory kinds of things, but to have mastery? I mean, it's almost like they say, "Wait…this is too hard for my kids," but I think what they're really saying is, "I don't understand this myself." They haven't taught this material. But now, the expectation [is that they will]. As we've moved to the middle school concept, you have folks with elementary credentials moving up, and the math content is moving down…Well, [soon] you're gonna have a teacher with an elementary credential trying to teach algebra… I firmly believe they can. But they just aren't gonna have a strong background.

- **Other areas in which teachers seek more professional development include standards and instructional techniques. Teachers would also like more opportunities to collaborate with one another.**

Indeed, another area in which some teachers expressed a desire for more professional development was with standards. "We need district inservices and materials to support the new standards," remarked one fourth-grade survey respondent. As Figure 7.4 shows, two-thirds of responding fourth-grade teachers indicated that they had had less than four hours of standards-related mathematics professional development since January 1998, and more than half of the eighth-grade teachers reported that they had had eight hours or less of such professional development.

The picture is similar for professional development relating to mathematics instructional techniques, as illustrated by Figure 7.5. "Lack of training in excellent teaching methods," wrote one eighth-grade teacher in response to the "obstacles" survey question; "lack of specific teaching techniques," wrote a fourth-grade teacher. And a different fourth-grade teacher who was interviewed, when asked what would help him improve his mathematics instruction, gave the following response:

I'd like more strategies on how to motivate kids and teach them how math is relevant to their lives. More fun activities, math games, that kind of thing. I follow the book too closely. I need more background and training in using 100s charts—that's one thing that comes to mind. I'm just getting familiar with the curriculum itself… Also, I haven't been able to collaborate with other teachers. That would be beneficial to teachers in general, especially ones just starting out like I am.

The apparent low level of professional development in standards and strategies between January 1998 and spring 1999 may, however, be a function of the cyclical nature of professional development offerings (e.g., those based on the adoption of curriculum materials).

Figure 7.4
Reported Amount of Professional Development in Mathematics Standards (State and/or District) or Framework
January 1998–Spring 1999

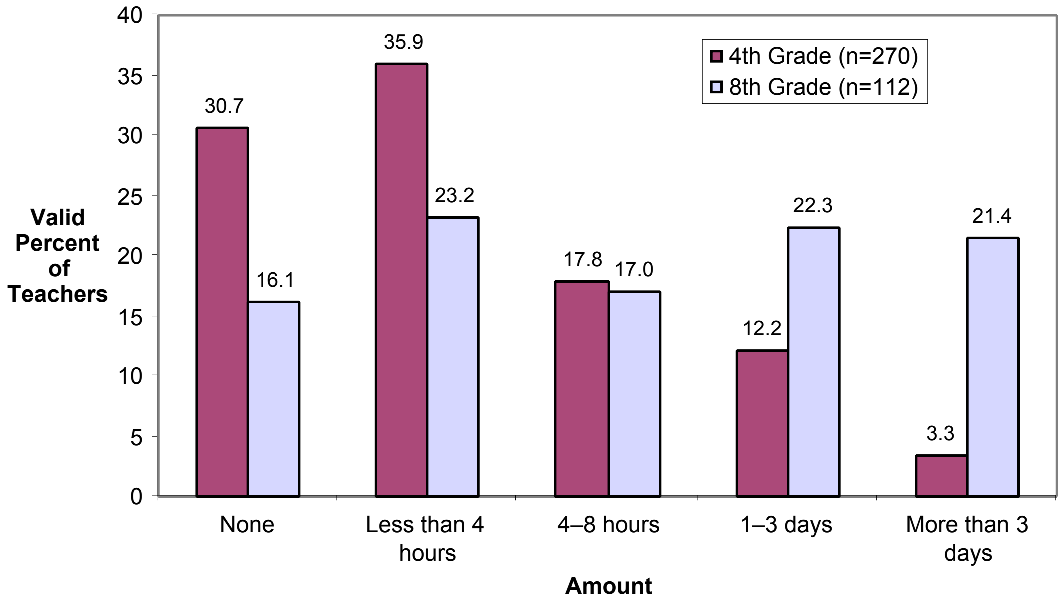
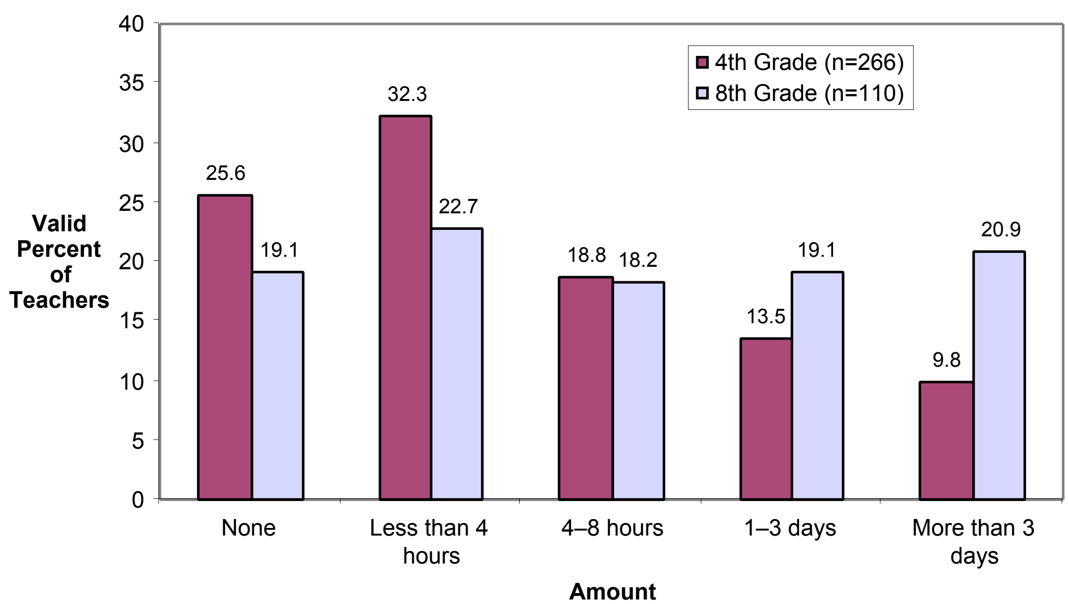
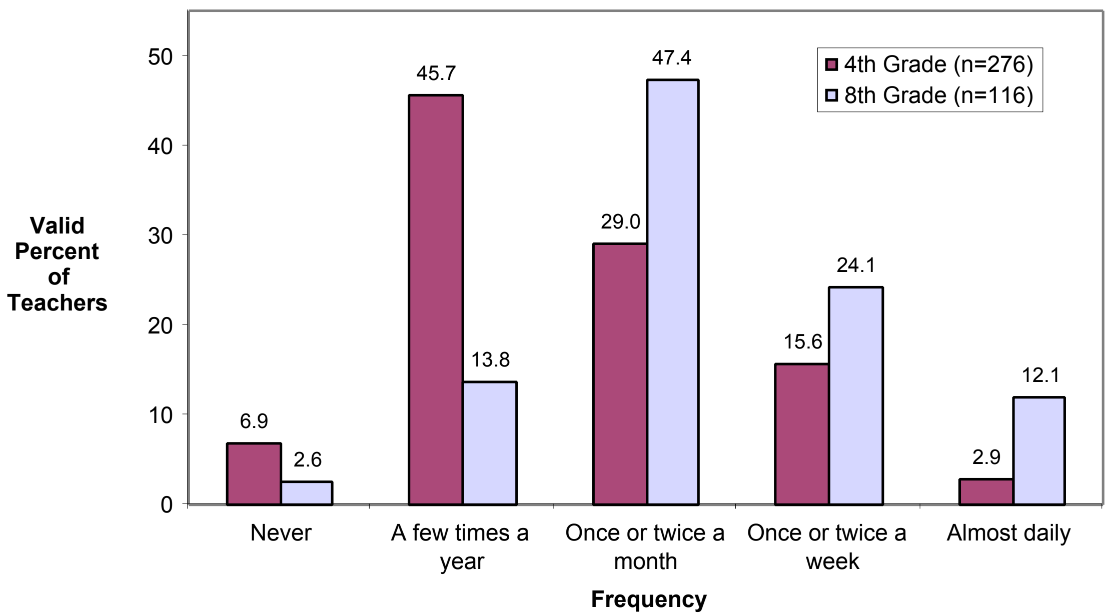


Figure 7.5
Reported Amount of Professional Development in Mathematics Instructional Techniques or Strategies
January 1998–Spring 1999



As exemplified by the speaker of the preceding quote, lack of opportunities to collaborate with other teachers was yet another professional-development-related obstacle cited by some teachers both in interviews and on the survey. Figures 7.6, 7.7, and 7.8 show the frequency in which teachers reported engaging in three different types of collaboration at their schools: sharing ideas about mathematics instruction, working together to develop mathematics curriculum, and observing one another teaching mathematics.[2] As with the other types of professional development already discussed, it is apparent that in these areas, as well, the opportunities of the fourth-grade teachers have been more limited than those of the eighth-grade teachers.

Figure 7.6
Reported Frequency of Teachers Sharing Ideas About Mathematics Instruction



[2] The scale used for these types of activities was different than that used for the other types of professional development. Whereas the others asked respondents about amount of time spent (in hours or days) since January 1998, these asked about frequency (from “never” to “almost daily”), and thus were not limited to any particular period of time.

Figure 7.7
Reported Frequency of Teachers Working Together to Develop Mathematics Curriculum

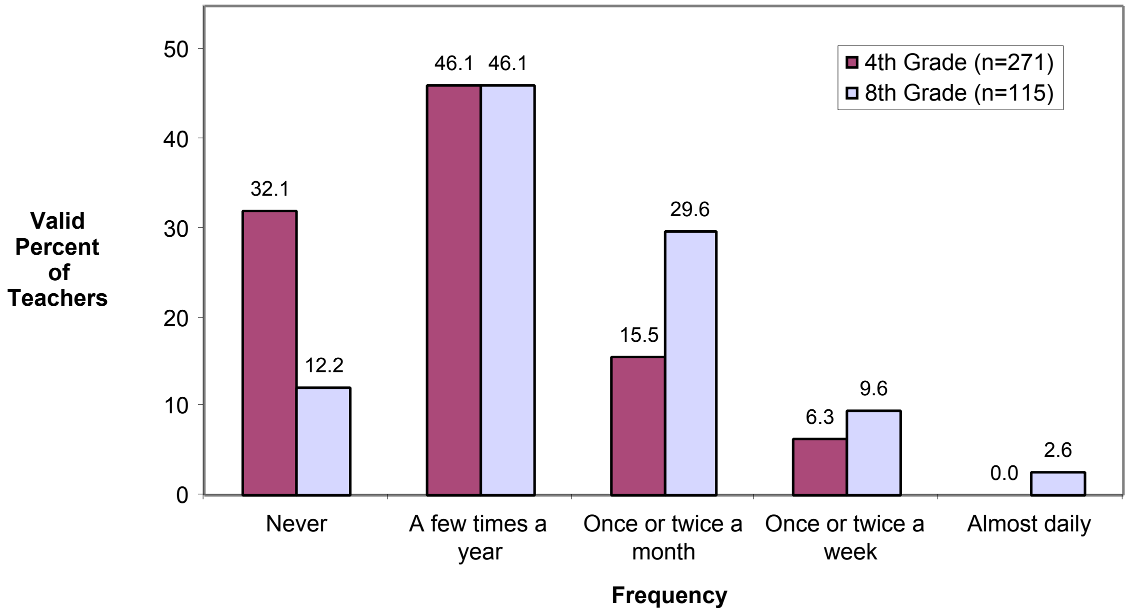
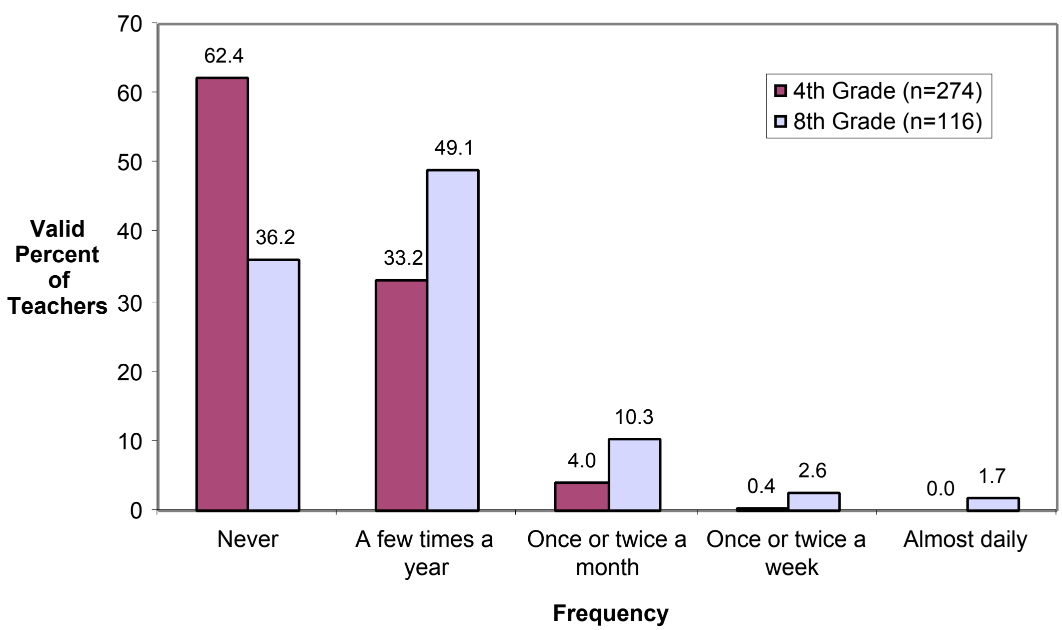


Figure 7.8
Reported Frequency of Teachers Observing One Another Teaching Mathematics



The Presence of Professional Development as a Help

Although several teachers did cite a lack of professional development as an obstacle to their teaching, there were more teachers who indicated that they *had* had professional development, and that it had helped them. Indeed, in response to the open-ended survey question, "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe," many teachers cited professional development/ teacher preparation. At the eighth-grade level, there were more responses in this category than in any other (33.9%); at the fourth-grade level, it was a close second—26.1% compared to 28.2% in the largest category (standards). About 15% of both fourth- and eighth-grade teachers also listed various types of professional development in their response to the question, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching/your effectiveness as a mathematics teacher?"

♦ Many teachers identified professional development as something that had helped their mathematics teaching. The specific types of professional development mentioned varied.

The specific types of professional development cited as being helpful ranged considerably, but each of the following was cited by 5 to 25 teachers (including both fourth-grade and eighth-grade respondents) on the survey:

- collaborations with other teachers (within the grade, school, or district) (See Figures 7.6, 7.7, and 7.8, above.)
- inservices/workshops on the use of particular curriculum materials
- other workshops/inservices
- attendance at professional conferences
- inservices on standards or assessment
- pursuit of advanced degree/college mathematics courses and other types of involvement with institutions of higher education
- a variety of specific mathematics professional development programs. (See the "District Spotlight" on the STEPSS program).

For instance, items cited on the survey as being helpful included:

> *Grade-level/department collaboration at site*
>
> *District has provided monthly workshops directed at teaching our text adoptions. These are vital to my teaching!*
>
> *Workshops to help me understand concepts and how to teach them*

NCTM Math conferences, publications

Inservices on how to adapt the new standards to the curriculum

USI monies have been helpful with district inservices on math background learning from college professors

In a former district, I participated in Math Matters and it has helped me immensely in the way I teach math.

The same types of things were mentioned by many of the teachers who were interviewed, in response to the question, "Do you have professional development opportunities related to math instruction?" For example:

[from an eighth-grade teacher] The district just sponsored a workshop on teaching algebra. I have attended a few other district workshops this year. They give me things to think about…. A recent one on writing rubrics made me think about how I measure kids.

I attended the NCTM conference in San Francisco. It was a great conference.

We have common planning time at school when we try to problem solve and discuss what's going well.

Some workshops were set up with the new math adoption…. The PD activities have helped me with getting ideas on how to expand the variety of ideas.

The district does in-services and minimum day workshops. I usually get some good ideas.

District Spotlight: A Professional Development Program That Is Making a Difference

In 1998, one of the study districts, in partnership with two local universities, started a comprehensive mathematics professional development program for elementary schools. The program, called Strategies for Teacher Excellence Promoting Student Success (STEPSS), is aimed at strengthening and enhancing the mathematics content knowledge and instructional expertise of teachers and administrators in selected district schools. The program is also designed to develop leadership and coaching capacity for the improvement of mathematics curriculum and instruction, and, ultimately, to improve student mathematics achievement throughout the district.

The five-year, $3.8 million program is supported by the National Science Foundation's Local Systemic Change program and has several components. These include a one-week intensive institute for all faculty from participating schools; an additional week-long "teacher leader institute" for administrators and for teachers seeking a greater leadership role at their school; inservices, demonstrations, and guided practices on peer coaching; and monthly on-site coaching visits from district coaches.

In addition, the teachers from participating schools have ongoing opportunities to visit the "demonstration classrooms" of teacher leaders, to engage in a variety of mini-institutes on a wide range of topics, and to attend conferences. Finally, each participating teacher is required either (1) to participate in at least 30 hours of mathematics content courses offered by the partnership universities or (2) to matriculate in a master's degree program with an emphasis in elementary mathematics education. Their tuition and fees are supported in part by grant monies.

Nine district elementary schools have participated in the STEPSS program in its first two years (five schools started in the first year, and four more were added in the second year). Of these nine schools, seven were participants in the Mathematics Implementation Study. Based on survey comments made by many of the teachers at these schools, it is clear that the STEPSS program is having an impact.

Five teachers from five different schools each mentioned the program by name in responses to the survey's open-ended questions. Four of them mentioned it in the response to the question about policies that have *helped* their mathematics teaching. Two of the four simply wrote the name of the program, while the other two made the following remarks:

> *The STEPSS grant our district received from the federal government has provided great inservice, coaching, and support for professional growth in math education. Teachers' math content knowledge is being increased dramatically.*

> *What I value most are workshops in math and sharing with other teachers. Our district is just starting a new math approach with training, whereby teachers work together with a colleague. It is called the STEPSS. I am retiring; I wish this had started sooner.*

The fifth teacher who mentioned the program by name was at one of the second-year-cohort STEPSS school and merely wrote, "My school staff will start a STEPSS program" in response to the survey's final catch-all open-ended question.

Although the other 10 teachers in participating STEPSS schools who returned the questionnaire did not mention the program by name, several of them did make comments that were very likely about the program. For example, three of them wrote the following in response to the survey question about helpful policies:

> *Ongoing training and peer meetings/coaching on math curriculum.*

> *Paying for college math courses.*

> *District recommendation to become math experts by pursing Masters in Math.*

Another three teachers made the following remarks in response to the question, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?":

> *Workshops with new and interesting tools with which to motivate students.*

[from one of the second-year-cohort STEPSS schools] I am desperately in need of more training which our school is scheduled to receive next year.

I am currently completing my masters in Curriculum and Instruction in Math. I feel the courses they are providing are helping me to be a more effective teacher.

Two teachers from one of the participating schools did comment that they were uncomfortable with the idea of peer coaching and that they felt the training was "excessive," taking them "out of the classroom too much." A third teacher at the same school indicated that pursing the master's degree while continuing to work full-time was hindering his mathematics teaching. However, two of these three teachers were among those who expressed their appreciation for the continuing education opportunities. Thus, based on the survey comments, it would seem that most of the participants are finding the STEPSS program to be valuable to their teaching in one way or another.

The Challenges of Providing Effective Professional Development

♦ Some teachers and principals discussed the importance of professional development being accessible and worthwhile.

Despite their general positive attitude about professional development, some teachers also talked about its limitations. Some discussed practical problems, such as the amount of time needed for professional development (particularly when it needs to be on the teachers' "own" time), or the cost of professional development (particularly when the money needs to come out of teachers' own pockets). The following comments were made by teachers who were interviewed:

Next year [the district] may not allow teachers to leave the classroom for conferences…so the professional development will have to be on their own time. I'm not sure how it will be under that system.

[At this site] professional development is on your own—at a University, and I'd have to pay for it myself.

In terms of PD I have access to a Math Matters session one time a month, and an actual support person to help me, and also we have three peer coaches who come out at least one time a month. I find it all very helpful but the hours interfere with teaching.

I would like to attend more conferences outside this area but there is no money.

Other teachers who were interviewed expressed concerns about the nature of the professional development itself, saying that although they had engaged in some professional development activities, they did not always find them very useful:

> *We educators do a pitiful job finding people to train us as educators. Professional development training tends to be boring.*
>
> *[District provided professional development days] are not all that helpful! We go over the same things time and time again.*
>
> *I've taken some [workshops] that were excellent, and some that were a total waste of time. And I guess that's why I'm reluctant to take them—because you never know ahead of time whether it's going to be good or not.*
>
> *[from a middle school teacher] The math [professional development] that is available for us is mainly…targeted toward elementary or high school, and there are very few workshops that are targeted towards the middle school student. And in that sense, I kind of feel that we're basically on our own as middle school math teachers, where we're caught in the middle.*
>
> *We had one day [of professional development] with follow-up. It introduced us to certain fun activities. But it was in English; at the time [early in the year] I was teaching in Spanish. I needed more of a demonstration.*

Several principals who were interviewed also talked about the importance of professional development being useful to teachers. One of the interview questions that was posed to principals was, "What do you think are the most effective kinds of professional development for your teachers in mathematics?" There were almost as many different types of answers given as there were principals interviewed, but the following were some of the responses:

> *The days that the people from the district came out, and did the training, the teachers loved those days. They got a lot of good strategies, a lot of good ideas. But without the follow-up, without the coaching element [where coaches from the district came out and went into the classrooms and observed and worked with the teachers], and the modeling in the classroom, we know it is not as effective….The follow-up, with the coaching, is critical.*
>
> *Teachers need continuous support so that the professional development does not just last for one day.*
>
> *The teachers have to have a hand in shaping the professional development; it has to meet their needs, otherwise they'll tune you out. They can't feel like it's a waste of their time. I don't mind being controversial, but I don't want the teachers to waste their time.*

- ♦ **District administrators acknowledged that providing effective professional development for all who need it is a major challenge.**

Several of the district-level mathematics administrators who were interviewed also discussed the difficulties involved in providing widespread, effective professional development. They all described the attempts their districts had made—some of which were moderately successful—but the obstacles they had came up against. Generally these were logistical in nature, having to do with the size of the districts, all of which were quite large, and the correspondingly large number of teachers that needed to be reached.

Reaching all of the elementary teachers was cited as a particular problem, since (as discussed above) mathematics is only one of the subjects taught by elementary teachers. One of the administrators talked about "trying to inservice" 5000 to 6000 elementary school teachers and concluded, "You can't do it. You can't do it, for math, and science, and language—I mean, you can't take the same 6000 teachers and try to provide the staff development that's needed for all the subject areas."

Moreover, some of the district administrators pointed out that much of the professional development is voluntary, especially for the K-6 teachers. One of these administrators said that many of the teachers who are most in need of professional development tend not to ask for it. Even when it is supposedly mandatory, teachers still may not participate; in one district where professional development is mandated for teachers in grades 7-8, there is a 30% no-show rate, according to the administrator who was interviewed there.

- ♦ **Site-based professional development and moving to a specialist model at the elementary school level were among the solutions proposed by district administrators.**

The district administrators did propose some possible solutions to the professional development problem. One solution that was mentioned is to have more site-based professional development, since even a strong centralized program cannot reach all of the teachers in a large district. In such a site-based program, sites would need to be supported so that they could define their own needs and work at improving their own capacity to meet those needs. Some of the principals who were interviewed did indicate that some on-site professional development opportunities had been useful to teachers. However, on-site activities may not work for all types of professional development, such as those aimed at strengthening teachers' mathematics content knowledge.

Another idea that was mentioned by administrators in two different districts is to move to a team-teaching, specialist, or departmentalized model for mathematics at the elementary school. In such a model, resembling what is done at higher grade levels, elementary teachers specialize in certain subjects, such as mathematics and science, and mainly teach only those subjects, instead of teaching all subjects. As one administrator suggested, moving to such a model might cut down on the amount of preparation that elementary teachers would need to do, and, in terms of professional development, would allow them to focus on their particular subjects.

In the Next Chapter

Moving to a specialist model for mathematics at the elementary level would be a major structural change to instruction. Other structural influences on instruction, such as policies relating to use of time and to class size, are discussed in the following chapter. Also discussed in the next chapter is how students themselves affect instruction, for example as a result of their preparation and skill level or of their behavior and motivation.

Chapter 8

Structural and Student-Related Influences on Instruction

Highlights of Findings

- **Several teachers identified structural factors, such as those relating to time and class size, as obstacles to their instruction.**
  Time-related factors, including disruptions, lack of planning time, schedule configurations, the need to teach other subjects, and the breadth of the curriculum, are perceived by some teachers as obstacles to effective mathematics instruction. Class size was another structural factor that was discussed by many teachers. However, teachers' concerns about class size appear to be as much about variation in student ability as about large classes *per se.*

- **Students' skill levels, attitudes, home lives, and language abilities may also influence instruction.**
  Students' lack of preparation—particularly in basic mathematics skills—presents a major obstacle for many teachers. Poor student behavior and low student motivation are also perceived as instructional obstacles by a large number of teachers, especially at the eighth-grade level. Some teachers identified factors having to do with parents and student home life as being a challenge, and a few also mentioned students' language differences. However, the proportion of teachers who indicated that language differences presented a major obstacle to their mathematics teaching was relatively small.

Background

In addition to materials, standards, assessment, and professional development, several other important influences on teachers and on their instruction became apparent in the analysis of qualitative data (open-ended survey comments and interviews). These included some that were structural, such as time and class size. Others were related to student characteristics such as preparation and skill level, behavior and motivation, parents and home factors, and language differences.

Numerous state, district, and school policies have bearing on these types of structural and student-related influences on instruction. For example, recent state policies and legislation touching on such matters have included:

The Class Size Reduction Program. California's Class Size Reduction (CSR) Program was established in 1996 to improve student achievement, particularly in reading and mathematics, in the primary grades. The CSR Program is a voluntary incentive program in which the state provides districts with additional per pupil funding for each child in grades K-3 who receives instruction in a class of 20 or fewer students. In 1998-1999, the third year of the program, 99% of California school districts participated.

Pupil Promotion and Retention Legislation. Three pieces of related legislation, all signed by the Governor in 1998, relate to the promotion—or lack thereof—of students from one grade level to the next. AB 1626 required each school district to "approve a policy regarding the promotion and retention of pupils" between certain grade levels based on "pupils' level of proficiency" in reading, English language arts, and mathematics. AB 1626 also required the Superintendent of Public Instruction to recommend, and the State Board of Education to adopt, minimum levels of performance on the assessments in the STAR program for the determination of student proficiency.[1] AB 1639, meanwhile, requires districts to offer supplemental instructional services to retained students through summer school, after-school, Saturday, and/or intersession instruction. SB 1370 appropriated funding for this supplemental instruction.

Proposition 227. Proposition 227, known prior to its passage as the Unz Initiative, was enacted by California voters in June 1998. It requires that all children in California public schools be placed in "English language classrooms," defined as classrooms "in which the language of instruction used by the teaching personnel is overwhelmingly the English language, and in which such teaching personnel possess a good knowledge of the English language." The proposition also specified that English language learners are to be placed in "sheltered English immersion" for no more than one year. However, parents may request waivers so that their children can be placed in "classes where they are taught English and other subjects through bilingual education techniques or other generally recognized educational methodologies permitted by law." Schools where 20 or more students at any given grade level have received waivers are required to offer such classes.

---

[1] As of the publication of this report, no such recommendation had yet been made, largely out of a concern that the determination of student proficiency be based on standards-aligned assessments. When the STAR augmentation (Standards-Based Test) has been deemed valid and reliable and is included as a measure on the state's Academic Performance Index (API), then the Superintendent may proceed with the recommendation. Until then, districts are free to make their own determinations of minimum levels of student proficiency, and have been encouraged by CDE to base the determinations on multiple measures of student performance. (R. Anderson, CDE, personal communication, May 23, 2000).

Along with these and other state programs and policies, many district and school policies also are related to structural and student influences on instruction. For example, some districts may have policies affecting how much time may be spent on mathematics instruction (e.g., versus other subject areas), whether students may be grouped by ability, or what happens to students whose behavior repeatedly disrupts the learning of other students.

An in-depth analysis of all of these various policies and their effects on mathematics instruction—not to mention on student achievement—was well beyond the scope of this study. However, teachers' comments made it clear that such policies can and do exert a strong influence, and that mathematics instruction must be considered in the context of such policies.

Time

- **Several teachers said that time-related factors, such as disruptions, lack of planning time, schedule configurations, the need to teach other subjects, and the breadth of the curriculum, presented obstacles to their instruction.**

On the survey, approximately 16% of teachers at both fourth and eighth grade levels identified factors having to do with *time* as being among the biggest obstacles to their mathematics teaching. However, not every teacher shared exactly the same time-related concern. The most common concerns included:

Frequent disruptions to instruction. In the interview question, "Is there anything that gets in the way of your effectiveness as a math teacher?" one eighth-grade teacher replied, "Scheduling—there are so many interruptions and other things going on." A fourth-grade teacher in the same district said, "Yes, anything that takes time away from time on task. The school schedule changes a lot because of assemblies and different events; this takes time away from instruction and what we can get done." On the survey, an eighth-grade teacher in a different district remarked, "Anything that takes away from instruction time is a disservice to our students (assemblies, special days, excessive testing, etc.)" Indeed, as discussed in the chapter on assessment, several other teachers also commented on the problem of testing taking time away from instruction.

Lack of time to plan and prepare. This was particularly an issue at the fourth-grade level. As one teacher who was interviewed said, "As a fourth-grade teacher, we don't have prep time." Several other fourth-grade teachers, on both the survey and in interviews, made similar comments about lacking planning/preparation time.

Schedule configuration. Some eighth-grade teachers indicated on the survey that schedule configuration factors interfered with the effectiveness of their mathematics teaching:

> *Teaching in 45 minute blocks, too limiting*
>
> *Periods too short to do an adequate job of presentation*
>
> *Too long a day which results in tired students and teachers.*
>
> *Block scheduling (one really long day, one really short day, only 4 days total for each student in math)*

Unlike this writer of this last remark, however, other teachers spoke positively about block scheduling.[2] In the answer to the survey question about policies that have helped mathematics instruction, one teacher replied, "Longer periods twice a week. I believe there should be less electives and longer periods of math." A teacher in a different district remarked in an interview, "Two hour blocks would be great once a week so we could do longer activities rather than having them last for four to five days."

Amount of time for mathematics as compared with other subjects. This, meanwhile, was obviously more of an issue at the fourth grade level. The following comments, each from a teacher in a different district, were made in response to the obstacles question on the survey:

> *The time during the day to effectively teach math with many other curriculum areas to cover.*
>
> *Time! I could use about 1 1/2 hours each day just for math.*
>
> *Time. As an elementary school teacher I must also teach other subjects. If a person wants to teach a subject in depth or for understanding it takes TIME.*

The matter of time for mathematics as compared for other subjects was a particular issue in a fourth district, where the district administration had recently mandated a daily three-hour "literacy block" for all elementary students as part of a strong district focus on literacy. "In this district this year," commented the district mathematics coordinator, "there's been no push in mathematics. Everything is literacy." He thought that although some teachers may have used the emphasis on literacy to avoid teaching mathematics, others did continue to teach it.

The fourth-grade teachers from this district who returned the survey did indicate that, on average, they spent as much time on mathematics instruction as teachers from the other

[2] On the eighth-grade survey, 21 teachers indicated a clear block-scheduling arrangement in their answers to questions about minutes per day and days per week of mathematics instruction. Other respondents may also have had block scheduling but not indicated this in their responses.

surveyed districts. However, of the 20 teachers from this district who opted to answer the open-ended survey questions, 8 of them commented that the district's literacy emphasis was having a negative effect on mathematics instruction. Some of the comments were as follows:

> *[cited as obstacle] Time, because our district requires too much time for other subjects… [cited as hindering policy] [District's] implementation of the literacy program.*

> *This year our district is requiring 3 hrs/day of literacy instruction. It is extremely hard to teach all other subjects including math…. The literacy program implemented in our district this year doesn't allow me to teach math when I need to, or spend as much time as I want to.*

> *[cited as hindering policy] Math is second fiddle to reading—and I think it will be that way for the next couple years!*

Lack of time to adequately cover the whole mathematics curriculum. As discussed in the chapter on standards, many teachers commented that they feel the new standards are too ambitious in terms of the amount of material they covered. Concordantly, time to "fit everything in" was a problem cited both by fourth-grade teachers and eighth-grade teachers. Among the fourth-grade survey comments on this topic were the following:

> *[cited as obstacle] Not enough time to cover all strands well.*

> *[cited as obstacle] Increasing the content to be taught, but not the time to be spent teaching. Do I ensure depth of understanding or go on to the next topic to fit it all in?*

> *I am unable to teach all of the new standards to mastery while also teaching long division/fractions and decimals. Plus I need to have it done by April! This leads to poor teaching practices—drill without understanding because of time constraints.*

> *Math—at any elementary level—seems to require too much to be covered. Little time for long projects.*

Eighth-grade teachers' survey comments were similar. They included:

> *[cited as obstacle] Lack of time (classtime) compared to amount of curriculum demanded.*

> *Too much material to cover, not enough time!*

> *[cited as obstacle] Trying to accomplish too much in the time frame allowed.*

Time to meet the needs of individual students. Finally, a few teachers' concerns about time had to do with a lack of time to meet the needs of individual students. For example, one fourth-grade teacher wrote on the survey that her biggest obstacles were "meeting everyone's individual needs" and "time to do this." Another wrote, "Classes with 32 students in them don't allow enough time to meet individuals' remediation or acceleration needs." As demonstrated by this last remark, these types of concerns about time are closely related to teachers' concerns about class size and ability range, discussed in the following section.

Class Size and Ability Range

♦ **Teachers do have concerns about class size, but these concerns appear to be as much about variation in student ability as about large classes *per se.***

One of the questions on the survey asked, "How many students are enrolled in your class?" The mean for all 281 fourth-grade teachers was 29.56; individual district means ranged from 27.43 up to 33.17. Four districts had a mean above 30. For eighth-grade, the mean across all eleven districts (n=116) was 30.27. Individual district means ranged from 28.0 up to 35.6[3]; six districts had a mean above 30. The means for the different eighth-grade course types were comparable to one another.[4]

Perhaps not surprisingly (given that the statewide class size reduction initiative has been for grades K-3, stopping just short of fourth grade), many fourth-grade teachers complained about large class sizes. In fact, large class size/ability range was identified on the survey by more than 25% of responding fourth-grade teachers as being among the biggest obstacles to their mathematics teaching, forming the second largest category (behind curriculum materials) of responses to the obstacles question.

In response to the obstacles and hindrances questions on the survey, 28 fourth-grade teachers gave responses such as "large class size" or "too many students." However, almost half of these teachers *also* included something in their response such as "and too wide a range of abilities." Moreover, *an additional 35* teachers did not mention large class size *per se*, but did discuss wide ability range. Sample responses to the obstacles question, each from a different district, include:

> *Having children who are 2-3 years below grade level, grade level and above grade level. All with different needs.*
>
> *Having 34 students, each at different levels. Having to create lesson plans to challenge the higher students, but that do not frustrate and confuse lower students.*

[3] The 35.6 was unusually high. The next highest figure was 32.33.
[4] The mean class size for problem solving courses, at 33.13, was a bit larger than for the other course types, which ranged only from 29.0 to 30.59. However, this may be a function of a relatively small sample size for the problem solving courses (n=8) and the fact that all of these courses were clustered in a district with one of the higher district means (31.87).

[Students'] skills and concepts are all over the board creating multiple needs that are difficult to address when 33 students are in a class.

Thus, it would seem that for most teachers, the concern about class size is not really a concern about large classes *per se,* but rather is about the wide range of abilities within the class. Logically, the larger the class, the more likely there is to be a wide range of abilities within the class, and the more difficult it may be for teachers to meet all students' needs.

Indeed, another survey question asked teachers to describe their class in terms of variation in student ability; nearly 75% of teachers checked the box that said, "heterogeneous with a mixture of two or more ability levels." (The other three options were "fairly homogeneous and low in ability," "fairly homogeneous and average in ability," and "fairly homogeneous and high in ability."

The same findings generally held at the eighth-grade level, but on a slightly lower scale. At the eighth-grade level, responses having to do with class size/grouping practices formed the third largest category of responses to the obstacles question, at 19.4%. Representative comments (again, each from a different district) include:

The range of student abilities: from 2^{nd}-3^{rd} grade levels to high school ability all in one class.

Wide range of ability of students

Large classes with varying abilities and student prep.

I find it hard to meet the needs of my students in a class with such a wide range of abilities and needs.

Many of these types of remarks came from teachers of Math 8 courses—perhaps not surprising, given that Math 8 courses might be more likely than other course types to include students with a wide range of ability. In response to the survey question about variation in student ability, 54.7% of the eighth-grade teachers—including 79.2% of the Math 8 teachers—indicated that the class for which they were completing the survey was "heterogeneous with a mixture of two or more ability levels." About 25% checked "fairly homogenous and high in ability. Of the 29 teachers who checked this box, 19 (65.5%) were teaching algebra, and 5 (17.2%) were teaching integrated math. None of the teachers who checked this box were teaching Math 8.

[text continues on the next page]

Student Preparation and Skill Level

♦ **Students' lack of preparation—particularly in basic mathematics skills—presents another major obstacle for many teachers.**

Teachers' concerns about the wide range of ability within their class relate closely to another major concern: that too many students come to them unprepared or below grade level. On the "obstacles" survey question, approximately 12% of fourth-grade teachers, and 14% of eighth grade teachers, gave responses such as "students unprepared," "students below grade level," or "students behind from previous year."

One eighth-grade teacher who was interviewed, when asked "Is there anything that gets in the way of your effectiveness of a mathematics teacher?" replied:

> *Kids that come in underprepared—kids that come in that are way behind. Especially in math. If you go to other subjects, it's not really that critical, like in history, it's not critical that you know ancient history in order to know U.S. history. You can pick up wherever. But in math, it's like, what are you going to do? If mean, if the kid doesn't know how to add and subtract integers, you've got a problem. That definitely gets in the way. Because, then you have a decision to make. You know, do you get them caught up, at the expense of the people who are ready to move on, or do you not teach them, and they get lost, and then you go on and teach the people who are ahead? So either way, you're kind of losing a group. It's tough to manage.*

This teacher's reference to some students' apparent inability to "add and subtract integers" suggests his perception that the preparation deficit tends to be in the area of basic skills. This perception was shared by a great many teachers. Although a few survey respondents did comment that students lacked sufficient conceptual understanding and problem-solving ability, many more teachers indicated that students' lack of preparation was primarily in the area of basic computational skills and knowledge of "math facts" (e.g., multiplication tables). In fact, on the survey, about 10% of teachers at both grade levels identified "students lacking basic skills" as being among their biggest obstacles. Representative survey comments included:

> *[from a fourth-grade teacher] Students who come to 4^{th} grade without computational skills in the basics!*

> *[from a fourth-grade teacher] The children do not come to me knowing their basic facts, addition, subtraction, and multiplication. I have to reteach everything!*

> *[from a fourth-grade teacher] Students not remembering their +, -, division, x facts*

[from a fourth-grade teacher] Students come not having basic skills of + and -, except to use their fingers.

[from an eighth-grade teacher] Students don't know basic skills—things they should have learned in elementary school.

[from an eighth-grade teacher] A few students lacking basic arithmetic skills.

The new trends in state and district policy toward the implementation of grade-level standards and toward ending social promotion may, in the long run, help alleviate some of these concerns. If teachers at all grade levels have a clear understanding of what students should know by the end of the year, and students who have not sufficiently mastered the expected content do not go on to the next grade, teachers should, at least in theory, experience less of a problem with students coming to them unprepared.

One district mathematics coordinator was optimistic about this, saying that historically, schools have been free to "do their own thing," but that the new emphasis on student outcomes, standards-based instruction, and the end of social promotion have brought about a "push" toward greater uniformity, which she felt is for the best. However, she acknowledged that until the curriculum is aligned with the standards and teachers have really adopted the new standards, the desired effect may remain elusive. And about social promotion, an accountability administrator in a different district commented, "The notion that we're going to punish kids, and hold them over, when they haven't had access to quality instruction, isn't right." The point made by both of these administrators is that for legislation to be effective, it must be accompanied by substantial capacity-building activities.

Student Behavior and Motivation

- **Poor student behavior and low student motivation are also perceived as major instructional obstacles by a large number of teachers, especially at the eighth-grade level.**

In addition to student preparation and skill level, other student factors—such as poor behavior, low motivation, and low attendance—were also cited by many teachers as being among the biggest obstacles to their mathematics teaching. In fact, at the eighth grade level, such factors were the *most commonly cited* obstacle to mathematics teaching, with 32.3% of teachers listing them. At the fourth-grade level, such factors were cited only by 6.8% of teachers, so this appears mainly to be a middle school issue.

For some, the main problem was student behavior or disciplinary problems. "Student discipline—too much time is wasted dealing with tardies and other violations of school rules," wrote one eighth-grade teacher. Many of these types of responses seemed to attribute the problems to the students themselves. For example, one eighth-grade teacher who was interviewed gave the following response to the question, "Is there anything that gets in the way of your effectiveness as a math teacher?"

> *Some days the kids are a little whiny, and some have a little attitude, or sometimes the discipline problems that do occur. That greatly affects my teaching, because it's very hard to run a class where the kids are looking for trouble.*

Along the lines of "running a class," however, some teachers cited their own struggle with classroom management—often related to student behavior—as an obstacle to their effectiveness. One eighth-grade teacher who was interviewed commented:

> *Just classroom management, apart from the math itself, is a major factor in regards to effectiveness. I mean, I think someone could be very good at math, but if the classroom management isn't there, then it doesn't really matter what the math curriculum is. So that's been a major factor that we've been working on this year. Just kind of on my own personal level of working with the different classes to develop a classroom management that works.*

A few teachers also related student disciplinary problems to school or district policies. In response to the "hindering policies" survey question, one teacher remarked, "Policies that continue to allow students with serious behavior problems back in the classroom." A teacher from a different district wrote similarly, "The unwillingness of the district and the state to deal strictly with the small 'hard core' group of disruptive students (or to allow our school to deal strictly with them)."

Perhaps related closely to the issue of student behavior and classroom management is the matter of student motivation. Low student motivation was the other student-related factor that was cited as an obstacle by many eighth-grade teachers on the survey, as indicated by the following representative remarks:

> *Students with low interest/desire to succeed*

> *Student who don't try and don't care*

> *Lack of student desire to learn*

> *Apathy both in students and parents—an attitude that it's okay to fail.*

Again, similar comments were made in interviews. Although these kinds of comments are by no means new, and the problems of student behavior and motivation will probably never completely vanish, they may not be unrelated to other aspects of mathematics instruction.

For example, for some teachers, altering the instructional approach may increase student motivation, which may in turn bring improved student behavior.

Indeed, in some of the mathematics lessons that were observed, observers did note problems with student behavior and discipline, and often they attributed these problems to the nature of instruction. For example, one observer wrote the following about an observed fourth-grade class:

> *The lack of engagement of students plus their inability to follow what the teacher was teaching led to ongoing disciplinary problems… [The teacher] was reteaching what the high students already knew so they were not paying attention, … and the lower students were lost.*

Another observer wrote about an eighth-grade class in a different district:

> *Behavior "problems" (e.g., students not paying attention, talking, being restless) grew towards the end of the class, most likely signifying students' lack of interest in and engagement with the material, and their increasing boredom.*

On the other hand, observers also witnessed several classes at both grade levels where student behavior was not a problem at all. These tended to be classes in which the teachers seemed to have a good rapport with the students and/or in which the mathematics instruction was kept lively and interesting.

Parent and Home Factors

♦ **Some teachers identified factors having to do with parents and student home life as being a challenge.**

Another obstacle that was cited on the survey more at the eighth grade level than at the fourth grade level relates to students' parents and home life. Parent and home factors were cited as an obstacle by about 16% of eighth-grade teachers, but only by 6% of fourth-grade teachers. In interviews, however, parent-related concerns were mentioned by more fourth-grade teachers than eighth-grade teachers.

Lack of parent support or reinforcement (for example, with homework) and lack of parent involvement were two of the specific concerns cited. As one eighth-grade teacher put it on the survey, "Lack of parent commitment to assisting their students in being successful. They are unable to even check whether or not student has done homework."

Another parent-related concern that was mentioned by some of the fourth-grade teachers had to do with negative attitudes about mathematics. For example, one teacher wrote that one of her biggest obstacles was, "Students believing what they hear from parents, other teachers, etc. that math is 'hard' or 'boring'." Similarly, a teacher at a different school wrote, "Parents that tell their children, 'I was always bad in math.'"

As with student behavior and motivation, some might assume that these parent-related obstacles are ever-present, insurmountable, and unrelated to mathematics instruction. However, there may be programs and policies that can help. One fourth-grade survey respondent did mention an activity involving parents as being a policy that had *helped* her mathematics teaching: "Family Math nights." An eighth-grade teacher who was interviewed also identified Family Math as being one of the major things that would help him improve his mathematics instruction. Increased communication with parents and other types of programs aimed at fostering increased parent knowledge about and involvement in their children's mathematics education might also be successful.

Language Differences

♦ **Remarkably few teachers indicated that language differences presented a major obstacle to their mathematics teaching.**

Some teachers at both grade levels did express a concern about dealing with students' language differences. "Most students speak limited English; they can't read word problems," put one eighth-grade teacher as an obstacle on the survey; a fourth-grade teacher, meanwhile, wrote, "English language use with LEP students in an all-English class."

However, given the high proportion of English language learners in the surveyed districts and the passage of Proposition 227, the number of teachers who indicated that language-related factors were among their biggest obstacles—3.8% of fourth-grade teachers and 5.4% of eighth-grade teachers—was remarkably small. The relative scarcity of teachers' comments about language barriers was not a result of English language learners being underrepresented in the classes of responding teachers; to the contrary, English language learners were quite well represented in the survey sample. In 9 of the 11 districts for fourth grade and 7 of the 11 districts for eighth grade, the average percentage of English language learners in the responding teachers' classes[5] exceeded the average for the district as a

[5] These figures were based on teachers' self report on the survey, dividing the number of English language learners they reported being in their class by the total number of students they reported being in their class. Only teachers who gave counts for both were included in the calculations.

whole.[6] Moreover, the average percentage of English language learners reported by responding teachers across all 11 surveyed districts slightly exceeded that of the state as a whole.[7]

Most teachers who were interviewed indicated that they do attempt to address the needs of English language learners during mathematics instruction in some way. For example, they said that they speak slowly, repeat directions, make extensive use of visuals, attend particularly to vocabulary, or provide assistance as needed on an individual basis.[8] Others said that they have translators or bilingual aides who help the English language learners; some of the teachers said they themselves are able to translate for the students when necessary, or that they allow the students to write or speak in their native language. In addition, a few of the observed classes were taught partially or primarily in students' native language, these students having received waivers from Proposition 227. On the other hand, some teachers who were interviewed said that their English language learning students were sufficiently English-proficient to need no special provisions during mathematics instruction.

In the Next Chapter

This chapter, along with several of the preceding chapters, identified some of the challenges that teachers face in their efforts to implement effective mathematics instruction. We have also seen that there do not appear to be any "magic bullets" for the improvement of student mathematics achievement. The next chapter builds on all of the findings presented in this report to discuss implications and recommendations for policy.

---

[6] From the Education Data Partnership web site

[7] The average for the classes of responding fourth grade teachers was 33%, and the average for the classes of responding eighth grade teachers was 28%. In the state as a whole, 27.4% of students are reported as being English language learners. All of these figures are for the 1998-1999 school year, when the survey was conducted.

[8] Classroom observers, however, were not always able to confirm that such strategies were in place or that English language learners' needs were truly being met.

(This page intentionally left blank.)

Chapter 9

Recommendations and Conclusions

The purpose of this study was to investigate mathematics policies and instructional practices in California and their effects on student achievement. More specifically, this study was designed to address three questions.

1. What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

2. To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

3. What influence do state and local policies have on instructional practices?

For each of the three questions, a summary of the findings, and the recommendations that emerge from the findings, are presented in the following sections.

Factors Influencing Achievement: Findings and Recommendations

What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

A critical component of this study was to investigate the degree to which student achievement (as measured by the SAT-9) was associated with instructional practices and other factors. Neither instructional practices nor teacher background characteristics, when other variables were controlled, bore other than a minimal relationship to student achievement. In sum, the study did not identify specific, powerful classroom instructional practices, instructional materials, or professional development activities that might explain higher mathematics achievement.

What conclusions can be drawn from this? One possibility is that no particular practice is best at raising student achievement across the wide range of educational settings—in other words, it may be that no one type of practice works for all students in all situations at all times. To the contrary, it appears that masterful teachers pick and choose from a variety of practices to maximize their effectiveness. Indeed, many teachers indicated that they need a broad repertoire of instructional approaches that are consistent with their teaching style to meet the needs of their students.

> *Recommendations:* As this study did not identify particular instructional methods likely to improve student mathematics achievement, the State should exercise caution regarding the endorsement of instructional methodologies in mathematics. The State Board should support a "balanced" approach to mathematics curriculum and instruction, but should avoid advocacy of particular types of practices, through the adoption of curriculum materials and professional development programs. To the extent that the *Mathematics Framework* adopted in 1998 supports the concept of a balanced instructional approach, it may assist teachers in their implementation of such an approach, provided that it is accompanied by aligned materials and professional development.

Another possibility is that certain practices *do* have an effect on student achievement, but that the measures used in this analysis were not fine enough to adequately capture these relationships. For example, as discussed in Chapter 3, surveys are an imperfect measure of identifying instructional practices, as they are subject to inaccurate responses and do not lend themselves to assessments of *quality* of instruction or implementation of certain types of practices. Moreover, a longer time frame may be necessary to examine sufficiently the effects of student exposure to certain types of practices.

> *Recommendations:* Further research is needed to investigate the relationships between instruction and achievement. Such research should explore the use of alternate methodologies (i.e., in place of or in addition to teacher surveys), such as an enhanced classroom observation component in which the same teachers' classes are observed, and perhaps videotaped, multiple times. Moreover, further research should take a longitudinal approach, spanning at least five years. Care, however, must be taken to avoid overburdening teachers with research demands. The State Board and the Legislature should recognize the need for more in-depth, high-quality research and should commit the necessary funds.

Prevalence of Factors Influencing Achievement: Findings and Recommendations

To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

Since observed and reported instructional practices could not be linked with higher performing classrooms, it was impossible to assess the prevalence of such practices. Classrooms with higher performing students exhibited a broad array of instructional practices and teacher characteristics—as did classrooms with lower performing students. The study did not find prototypical high-performing or low-performing classrooms. As discussed above and in the body of the report, part of the problem may very well lie with the difficulty in conducting this kind of research. In particular, the SAT-9 itself is an incomplete measure and its limitations may render it inappropriate for assessing relationships between practices/characteristics and certain types of achievement.

> *Recommendations:* Future research investigating the relationships between instructional practices and student achievement should carefully define what is meant by "student achievement." If a broad definition is selected, the research methodology should employ a variety of measures to gauge this achievement. For instance, the SAT-9 may be valuable for assessing students' procedural and declarative knowledge, but may be less appropriate for assessing higher-order thinking skills. Thus, to the extent that higher-order thinking skills are deemed an important aspect of achievement, other measures supplementing the SAT-9 may be needed.

Moreover, because the districts that participated in this study were not a random sample of all districts across the state, the results presented herein may not be generalizable to all of the state's students and teachers. This is especially true for districts with small enrollments, as the districts that participated in this study were all relatively large.

> *Recommendations:* If prevalence throughout the state is a key concern, future research should employ a sampling design that selects districts with a wide range of demographic characteristics, such as size, geographic location, and student composition. However, such a design is likely to further raise costs, particularly if (as recommended above) repeat observations constitute a major part of the methodology, and should be weighed against a sampling design in which a greater proportion of the state's total student enrollment is represented (e.g., by sampling primarily from larger districts, as done by this study).

The Influence of Policy: Findings and Recommendations

What influence do state and local policies have on instructional practices?

The study yielded a great deal of information with bearing on this question; survey responses, classroom observations, and interviews with classroom teachers, school site administrators, and district personnel all provided a wealth of data on the influence of policies on instruction. Toward the end of the study, interviews conducted with a variety of other stakeholders on the policy implications of the study's findings lent additional points of view and in some cases provided context for the study's findings. Among those interviewed for this purpose were several policy makers, representing the State Board of Education, the legislature, influential mathematics educators, and organizations representing teachers, school boards, and administrators.

Findings and recommendations on the influences of policy are divided into the following subsections: standards, instructional materials, professional development, assessment, and classroom context. Frequent changes in policy direction and tone of the policy debate also are discussed.

Standards. Teachers generally reported that while they support the idea of standards, the proliferation of competing standards (e.g. district, state, NCTM) has caused confusion and a lack of clarity over what they are expected to teach. Many teachers believe that the current state standards encompass more than can be taught in a given year, and some also report concerns that particular standards may be inappropriate for their designated grade level. Policy makers should also be aware that, as of the 1998–1999 school year, standards appeared to have had less of an impact on classroom practices than had textbooks and assessments.

Recommendations: The State Board should establish a procedure for periodically reviewing the mathematics standards and framework in light of implementation problems. The Board should carefully and systematically evaluate student performance over time, and solicit the advice of classroom teachers who are attempting to implement the standards and framework.

Districts should take care to present teachers with a single standards document, rather than having separate state and district versions. While it is perfectly appropriate for districts to augment state standards with their own additions, these supplements should be merged with the state standards so that teachers can rely on one unambiguous set of standards. Moreover, to maximize the influence of standards on instruction, the standards document should be distributed to individual teachers. This dissemination must be an ongoing process, as new teachers are constantly entering the profession. Finally, teachers need access to performance standards to assist in their implementation of content standards.

If there is interest in assessing implementation of the standards on a system-wide level (as opposed to assessing individual student mastery), the State might consider exploring the development of a matrix sampling test. Such an assessment, which would not be taken by every student in the state but only by samples of students who would see different items, would be able to gauge the implementation of a significantly larger portion of the mathematics standards than would a single assessment administered to all students.

Instructional Materials. Teacher interviews and classroom observations indicated that textbooks are a primary determinant of what is taught. Many teachers find that a single curriculum program is inadequate to meet the range of needs of their students, and supplement the district-adopted text with other books and materials, some of which may not be on the state-approved adoption list. Some teachers in our sample were using texts from earlier adoption cycles. Because the average textbook contains far more lessons than most teachers cover in a school year, teachers pick and choose among the sections and chapters. Thus, even when they use state-adopted texts, there is no assurance that the curriculum actually covered will be congruent with state standards.

Recommendations: The State Board and the Curriculum Commission should ensure that the curriculum materials that are available to teachers are aligned with standards, accommodate the wide range of student needs, and enable the presentation of a balanced instructional approach.

If possible, districts and schools should purchase the materials in ways that are conducive to teacher and student use both in school and at home (e.g., not requiring an excessive amount of photocopying). To maximize the actual use of the materials and the effectiveness of their implementation, teachers should be provided with opportunities and incentives to engage in professional development related to the use of the materials.

Finally, until evidence of widespread implementation of adopted materials becomes available, caution should be exercised in attributing student achievement to the use of particular adopted materials, as adoption alone is no guarantee of actual use in the classroom.

Professional Development. The need for high-quality professional development was consistently indicated by all data sources. Survey results highlighted the particularly telling mismatch between fourth grade teachers' need for training in mathematics content and methodology and the amount provided. Teachers who addressed this point in the policy implications interviews were positive in their assessment of the California Mathematics Project, even though it may have had limited impact relative to statewide need. There also seemed to be a consensus among those interviewed toward the end of the study that the thrust of the Governor's initiative is on point. (The Governor's initiative proposes university-based professional development institutes during the summer, with follow-up instruction and professional feedback during the school year. The focuses are on teachers as learners, the teaching of mathematics content through a variety of instructional strategies, and meeting the needs of students.)

Recommendations: The State should continue to work to provide sufficient resources for every California teacher of mathematics to participate in high-quality, sustained professional development.[1] Professional development should attend both to mathematical content and to pedagogy; both are important. Key aspects of professional development should be the use of materials (as discussed above) and the instructional implementation of the standards and framework in the classroom.

Assessment. The SAT-9 appears to be the dominant driver of instruction. Since it measures only a portion of the standards, even with the augmentation, over time it will have the effect of narrowing the curriculum to what is tested, and the nature of the test may shape the way students are taught. Teachers report spending much time in test preparation, which takes time away from instruction. The current test is not necessarily aligned with grade level curriculum or textbooks, so some students are being tested on material that has not yet been taught.

Recommendations: The State Board should continue to improve and augment the STAR program so that its components are properly aligned with state standards. Were the STAR program fully aligned with the content standards, the emphasis on assessment might help bring about the effect of student mastery of the standards. As long as there is a lack of alignment, improvement in scores may not be truly indicative of the type of student improvement desired.

Classroom Context. Many teachers indicated that the greatest influences on their instruction were policies relating to class size, quantity of time for instruction, and student preparation and promotion. Clearly, the importance of such policies, and their relevance to mathematics instruction, should not be underestimated. These policies operate alongside those that appear more directly related to mathematics (such as those concerning standards or curriculum materials), and cannot be considered "separate" or "unrelated." At the level of the classroom, the effects of multiple types of policies are intertwined. Thus, it is crucial that the various policies be consistent with one another and, preferably, form a coherent whole.

[1] Some recently enacted legislation is a strong first step. In particular, AB 1331 (passed in 1998) appropriated funds for teachers of mathematics in grades 4–12 to participate in professional development that is aligned with the state standards and framework. (AB 2790, currently pending, would increase the available funds.) AB 2442, also passed in 1998, provides funds for teachers to take mathematics courses at accredited institutions of higher education.

> *Recommendations:* As mathematics instruction does not exist in a vacuum, mathematics policy must be placed in the context of the numerous other education-related policies that exist. The State Board and the Legislature should take care to ensure that all of the current state education policies are aligned with and support one another.

Frequent Changes in Policy Direction. Frequent changes in state policy direction tend to diminish the state's ability to influence the mathematics taught in California classrooms and may in fact impede teachers' efforts to raise student performance. State policy makers tend to call for dramatic changes in mathematics curriculum without assessing the actual level of implementation of the prior approach, without adequate evidence of the causes of the current level of student performance, and without sufficient evidence of the effectiveness of the new approach.

> *Recommendations:* The State should stay the course. Planning should take a long-term view, focusing on developing and revising policies based on feedback, rather than abruptly changing direction at the first hint of less-than-desired student performance. The state should also systematically gather evidence of what mathematics curriculum is being implemented and how it is being taught and seek causal relationships between actual practice and student outcomes. Anecdotal testimony may not accurately portray reality across more than 1000 California school districts.

Tone of the Policy Debate. Stakeholders interviewed toward the end of the study reported that the acrimonious debate associated with the recent changes in mathematics standards, framework, textbook adoption, and professional development has limited the willingness of teachers to participate in policy discussions. Failure to air differences of opinion and seek areas of agreement can lead to balkanization and an unstable agreement on what constitutes appropriate mathematics curriculum and instruction. Ultimate success of any mathematics program requires that teachers understand and support the underlying rationale and have the training and materials necessary to support successful implementation.

> *Recommendations:* The State Board should set a positive tone for professional discussion and policy debate. Representatives of all stakeholder groups should be "at the table," and a wide range of perspectives should be considered.

Conclusion

As this report has indicated, the difficulties of implementing state policy initiatives at the classroom level are substantial. Traditional policy tools, it seems, often are less effective than desired and may have unintended consequences. The State has a number of means by which it can influence mathematics instruction; the question is how to use them, if at all. The overarching message of this report is one of *caution:* caution in attributing reasons for low (or high) student achievement, and caution in making reforms that do not have a clear basis in research.

Nevertheless, as suggested by this chapter, there are a variety of actions the State can take to support teachers' attempts to raise student mathematics achievement. Indeed, there is strong evidence that teachers are dedicated to helping students achieve in mathematics and want to increase their own effectiveness as teachers of mathematics. However, they often feel thwarted in their attempts to be effective by the realities of their teaching situations, including everything from the need to photocopy materials to the lack of professional development funds to the multiple ability levels within their classrooms. Policies and reforms whose rationales may have not been clearly conveyed to teachers and which they may not have bought into—as well as the flux in policy—only add to the difficulties teachers face. Thus, the key will be to include teachers and all stakeholders in the reform process and to ensure that feedback from a wide variety of educators and community members helps guide efforts to improve the mathematics achievement of all of California's children.

References

Anderson, J. (1998). Letter to Yvonne Larsen, Chairman of the State Board of Education, on behalf of the members of the California Mathematics Council. November 10, 1998.

Anderson, N. (1998, December 11). State school board OKs back to basics for math. *Los Angeles Times*, Sec. A.

Becker, J. P. & Jacob, B. (2000). The politics of California school mathematics: The anti-reform of 1997–99. *Phi Delta Kappan, 81*(7), 529–537.

Boser, U. (1999, June 23). Study finds mismatch between California standards and assessments. *Education Week, 18*(41), 10.

California Department of Education. (1998). *Establishing district standards "at least as rigorous as" California's state standards.* Sacramento, CA: Author.

California Department of Education. (1999, February.) *Instructional materials in California: An overview of standards, curriculum frameworks, instructional materials adoptions, and funding.* Manuscript in preparation.

California State Board of Education (1999). *Mathematics content standards for California public schools: Kindergarten through grade twelve.* Sacramento, CA: California Department of Education.

Class size reduction for grades K–3. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/classsize

Criteria for evaluating mathematics instructional resources, adopted by State Board of Education December 1998. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/cilbranch/eltdiv/2001mathcriteria.html

Cohen, D.K., & Hill, H.C. (1998). *State policy and classroom performance*: *Mathematics reform in California* (CPRE Policy Brief). Philadelphia: Consortium for Policy Research in Education.

Ginsburg-Block, M.D., & Fantuzzo, J.W. (1998). An evaluation of the relative effectiveness of NCTM standards-based interventions for low achieving urban elementary students. *Journal of Educational Psychology*, 90, 560-569.

Guth, J. A., Holtzman, D. J., Schneider, S. A., Carlos, L., Smith, J. R., Hayward, G. C., & Calvo, N. (1999). *Evaluation of California's standards-based accountability system: Final report.* Sacramento, CA: California Department of Education. http://www.wested.org/wested/pubs/online/accountability/

Hartocollis, A. (2000, April 27). The new, flexible math meets parental rebellion. *The New York Times,* pp. A1, B5.

Hoff, D. (1999, June 23). California approves math, English textbooks tied to standards. *Education Week, 18*(41), 10.

Martinez, A. (1999, July 27). The great math divide: Dismal scores reveal how far California schools lag in achieving standards called among toughest in U.S. *San Jose Mercury News,* pp. A1, back page.

Martinez, J.G.R. & Martinez, N.C. (1998). In defense of mathematics reform and the NCTM's Standards. *Mathematics Teacher*, *91*(*9*), 746-748.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1985). Sacramento: California Department of Education.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1992). Sacramento: California Department of Education.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1999). Sacramento: California Department of Education.

Mathematics program advisory. (1996). Sacramento: California Department of Education, California Commission on Teacher Credentialing, and California State Board of Education.

Mayer, D. P. (1999). Measuring instructional practice: Can policymakers trust survey data? *Educational Evaluation and Policy Analysis, 21*(1), 29–45.

Mervis, J. (2000). Packard heir signs up for national "math wars." *Science,* 280 (11 February 2000), 956–959.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

O'Neil, J. (2000). Fads and fireflies: The difficulties of sustaining change. *Educational Leadership*, *57*(7), 6–9.

Pupil promotion and retention: Information and resources. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/ppr/

Stipek, D., Salmon, J.M., Givvin, K.B., Kazemi, E., Saxe, G., & MacGyvers, V.L. (1998). The value (and convergence) of practices suggested by motivation research and promoted by mathematics education reformers. *Journal for Research in Mathematics Education*, *29*(4), 465-488.

Unz, R.K, & Tuchman, G.M. (1997). *The Unz Initiative* (for June, 1998 California Ballot). http://www.catesol.org/unztext.html

U.S. Department of Education, Office of Educational Research and Improvement. (1997). Introduction to TIMSS: The Third International Mathematics and Science Study. In *Attaining excellence: TIMSS as a starting point to examine U.S. Education.* Washington, D.C.: Author.

Verschaffel, L. & DeCorte, E. (1997). Teaching realistic mathematical modeling in the elementary school: A teaching experiment with fifth-graders. *Journal for Research in Mathematics Education*, *28*, *577-601*.

Webb, N.M., & Palincsar, A.S. (1996). Group processes in the classroom. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 841-873). New York: Macmillan.

Wenglinsky, H. (1999). *Does it compute? The relationship between educational technology and student achievement in mathematics* (ETS Policy Information Report). Princeton, NJ: Educational Testing Service.

(This page intentionally left blank.)

RAND

Relationship of Classroom Practices to Student Mathematics Achievement

Vi-Nhuan Le, Daniel McCaffrey, Marika Suttorp, Laura Hamilton, and Stephen Klein

June 2000

At the heart of many efforts to improve student mathematics achievement is a focus on classroom practices that are thought to facilitate student learning. For this reason, professional development and the promotion of good instructional practices are imperative to the success of these efforts. Many of the promoted practices are based on documents such as the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), the *Mathematics Framework for California Public Schools* (California Department of Education, 1992, 1998), and the *Mathematics Content Standards for California Public Schools* (California Department of Education, 1997).

Earlier research has reported small, positive associations between achievement and some types of individual practices. Stipek, Salmon, Givvin, Kazemi, Saxe, and MacGyvers (1998) found that emphases on problem-solving and process-oriented solutions were related to higher scores on a mathematics test of conceptual understanding. Other studies have also found a positive relationship between the teaching of higher-order thinking and achievement (Martinez & Martinez, 1998; Ginsburg-Block & Fantuzzo, 1998). Research has also demonstrated the value of collaboration (Webb & Palincsar, 1996) and of embedding instruction in real-world contexts (Verschaffel & DeCorte, 1997). A study by Austin (1997), for instance, showed that students enrolled in an NCTM standards-based high school math curriculum that focused on application, cooperative learning, and open-ended problem-solving performed better on an end-of-the year test than those enrolled in a more traditional class. Similarly, Cohen and Hill (1998) found that teachers' use of practices consistent with the 1992 California Mathematics Framework was positively related to student achievement.

The goal of the present study is to further explore the relationships between student achievement and instructional practices. We also investigate how teacher familiarity with the NCTM standards, California Mathematics Frameworks, and various other standards documents is related to instructional practices.

This analysis is part of a broader study that investigates the instructional practices used in teaching mathematics in California and the influences of policy on instruction. The present analysis is supplemented with qualitative methods that examine the factors facilitating or impeding effective mathematics teaching. Case studies of teachers and interviews with state policy makers are used to explore the effects of curriculum materials, staff development, and local and state policies on instructional practices. Future policy implications are also considered.

Methods

Data from students and teachers were collected from 136 fourth-grade and 57 eighth-grade schools across 11 California school districts. Participating districts provided the student data, whereas teacher surveys provided most of the teacher data. The following sections present more details regarding the information obtained and the methodology used to analyze the data.

Sample Characteristics

District Sample. A purposive sample of 11 districts was selected. This sample contained districts with moderate to large total student enrollments. Districts were chosen to be geographically dispersed across California, and most had relatively large numbers of minority, low-income, and limited English proficient (LEP) students. We excluded districts that did not want to participate or could not provide the necessary student data files.[1] The sample includes five of the ten largest districts in the state. Taken together, the 11 districts contain 1.2 million students, which is 20.2 percent of all students in the state.

Because the participating districts are not a random sample of all districts, the results of this study may not be representative of all of the state's students and teachers. This is especially true for districts with small enrollments. However, results that pertain to such a large number of students and teachers are likely to be meaningful and any strong relationships found between teaching practices and student outcomes merit further consideration.

School Sample. We selected a random sample of schools within each district. The number of schools selected was designed to provide a target sample of teachers. In the largest district, the targets were 75 fourth-grade teachers and 38 eighth-grade

[1] Two large and four moderate sized districts declined to participate in the study. One moderate sized district agreed to participate, but was unable to provide the necessary student data.

teachers. The corresponding targets in the five other large districts were 50 and 25.[2] The targets were 40 and 20 in the remaining districts. Because eighth-grade teachers teach multiple classes, fewer eighth-grade teachers were needed to represent the same number of students. Hence, fewer eighth-grade teachers were targeted. However, because of difficulties in obtaining data on teaching practices for multiple classes per teacher, the final sample consisted of only those students from the teacher's first mathematics class during the day in which a majority of the students were eighth-graders.

For fourth grade, we estimated the number of teachers using the number of fourth grade teacher equivalents (FTE) listed in the 1997 California Basic Educational Data System (CBEDS) data.[3] This database does not provide the number of math teacher equivalents by grade. We therefore used the total number of math teacher equivalents in the school divided by the number of grades in that school to obtain an estimate of the number of eighth-grade math teachers. In several districts, all of the eligible schools were selected in order to meet the targeted number of teachers for the sample.

We used systematic sampling to select a diverse set of schools in terms of students' socioeconomic status, ethnicity, and language proficiency. Within each district, schools were sorted by the percent of LEP and the percent of students from families eligible for Aid to Families with Dependent Children (AFDC). Then starting with a random draw (between 1 and *k*) every *k*th school on the list was selected where *k* equals the number of eligible schools in the district divided by the number of schools in the sample. For instance, if the district has 70 eligible elementary schools and the sample size is 14 then k equals 5. See Cochran (1977) for details on systematic sampling.[4]

For the fourth-grade sample, eligible schools included all schools classified as elementary (ELEM) schools with 10 or more fourth-grade students in the 1997 CBEDS file. For the eighth-grade sample, eligible schools included all schools classified as elementary (ELEM), middle (MIDD), junior high (JRH) or high (HIGH) schools with 10

[2] The target sample sizes for fourth grade provide sufficient statistical power to detect small effects of approximately .10 standard deviation units.
[3] In some schools the number of fourth grade teacher FTE's was small relative to the number of teachers. In these schools we estimated the number of teachers by dividing the number of fourth-grade students by 35 rather than by the number of fourth-grade teacher FTE's.
[4] In the largest district, we selected a stratified systematic sample where schools were stratified by the number of teachers (1 or 2; 3 or 4; or 5 or more). We used a stratified sample to control for the variability in the number of teachers in sampled schools.

or more eighth-grade students in the 1997 CBEDS data. These criteria excluded alternative and community schools. In addition, to avoid excessive burden on teachers, elementary schools selected for the California Class Size Evaluation Projects were excluded from this study.

We augmented the original samples to include replacement schools for those that declined to participate. In large districts, the replacement school was the next school in the sampling frame used to select the systematic sample. In smaller districts, replacement schools included any school that was not included in the original sample.

The final sample of participating schools contained 136 elementary and 57 middle schools.[5] As shown in Table 1, the sampled schools are generally similar to the other schools in the 11 districts, although there were slightly fewer minority and AFDC students in our sample.

Table 1. Sample and District Characteristics

	Elementary Schools		Middle Schools	
	District	Sample	District	Sample
Number of Schools	867	136	181	57
Average Percent Minority Students	76%	63%	75%	65%
Average Percent LEP Students	40%	28%	28%	23%
Average Percent AFDC Eligible Students	27%	24%	24%	21%

Teacher Sample

The fourth-grade and eighth-grade samples contained 570 and 235 teachers, respectively. Overall, 310 (54.4%) fourth-grade teachers and 139 (59.1%) eighth-grade math teachers completed surveys. We excluded the surveys of fourth-grade teachers who

[5] The sample size for the participating schools is the total number of schools from which teachers actually returned the questionnaires, and does not represent the number of schools to which questionnaires were sent.

did not teach at least one class where one-third of the students were fourth graders (13), could not be matched to their students because they shared classroom responsibilities (10), did not teach at least half of the school year (3), or had students lacking test scores (3). This left us with a sample of 281 fourth-grade teachers.

For the eighth-grade sample, we excluded teachers who did not teach at least one class where one-third of the students were eighth graders (10), failed to have identifiable rosters (4), did not teach at least half of the school year (3), or had students lacking test scores (3). We also excluded a teacher who taught geometry to a class of gifted students because the study's results were overly sensitive to this teacher and her students' data. The final eighth-grade analyses included 118 teachers.

Student Data

The 281 fourth grade teachers had a total of 6,885 students with valid Stanford Achievement Test, Version 9 (Stanford-9) multiple choice test scores.[6] The 70 students in this sample who were missing demographic data were excluded from further analyses. Thus, the fourth-grade student sample consisted of 6,815 students from 281 classrooms. The 118 eighth-grade teachers had 3,063 students, but 30 were missing student demographic data. Thus, our final eighth-grade sample contained 3,033 students.

The following information was available for the students in both the fourth grade and eighth grade analysis samples: 1998 and 1999 Stanford-9 math scores, 1998 and 1999 Stanford-9 reading scores, and student background information, including gender, racial/ethnic group, home language, and whether the student participated in a gifted program, a special education program, and/or a free or reduced price lunch program.

Table 2 provides descriptive statistics for each student sample. At both grades, approximately 60 percent of the students are members of a minority group and nearly one-third are Hispanic. In addition, 26.7 percent of the fourth graders and 20.7 percent of the eighth graders are classified as LEP. Nearly half (47.0 percent) of the fourth-grade sample and over one-third of the eighth-grade sample are eligible for free and reduced price lunches.

[6] Scores of 0 and 999 on the base Stanford-9 test were treated as invalid. We did not analyze scores on the augmented items.

Table 2. Percentage of Students with Various Background Characteristics.

	Fourth Grade	Eighth Grade
Racial/Ethnic Group		
African-American	11.1	9.0
Asian	13.6	14.3
Hispanic	33.2	29.3
White	37.5	40.7
Other	4.6	6.7
Limited English Proficient	26.5	20.7
Eligible for Free or Reduced Price Lunches	47.0	36.7

Measures

Teacher Questionnaire

Teachers completed a questionnaire that inquired about the frequency with which they used various instructional practices, the amount and type of professional development activities they received, their opinions about teacher collaboration, and their familiarity with certain mathematics standards and frameworks documents. Most of the questions regarding the frequency of activities used a 5-point Likert scale. Teachers' scores could range from 1 ("never use this practice") to 5 ("engage in this practice almost daily"). Questions that solicited opinions used a variation of a 4-point Likert scale. These items typically ranged from 1 ("disagree strongly") to 4 ("agree strongly"), but teachers were also allowed to choose an "I don't know" response. The teachers also answered several questions about their demographic characteristics, including information regarding gender, racial/ethnic group, certification, highest degree received, coursework in mathematics, and years of teaching experience.

Questionnaire Scales

The questionnaire items were grouped into 12 scales. This was done using a combination of judgments about item content and empirical analysis. Specifically, we grouped questions that were intended to measure the same construct. We then evaluated these judgments with an empirical analysis involving item intercorrelations. We found that an item usually correlated more strongly with the other items on the scale to which it was assigned than it did with items on other scales. The final 12 scales are listed below:

1. Teacher-Centered Practices
2. Problem-Solving
3. Computational Practices
4. Applications
5. Group Work
6. Individual Work [7]
7. Computer Use
8. Familiarity and Influence of Mathematics Frameworks and Standards
9. Alignment with District Standards
10. Perceived Teacher Support
11. Perceived Teacher Collaboration
12. Professional Mathematics Development

Appendix A1 contains the items in each scale.

Curriculum Variables

The teacher questionnaire also contained a list of mathematics topics. Teachers were asked to specify which of these topics were not covered in their class, and which five topics were given the most emphasis. We then created a variable indicating the total number of topics taught that were also cited in the *Mathematics Content Standards for California Public Schools, Kindergarten Through Grade 12*. We also constructed variables that made distinctions among the emphasis given to each topic (specifically, no coverage, some coverage, and great coverage). For some concepts, there was not enough variation to examine differences between teachers who emphasized a given topic and

[7] It is important to note that the individual work and group work scales are not opposites of one another, and that teachers can engage in both types of activities and thereby receive high scores on both scales; i.e., if their students frequently work collaboratively as well as independently. Similarly, teachers can receive low scores on both scales if they frequently engage in other activities that are not represented on either scale.

those who taught it but did not make it their focus. In such cases, our analysis distinguished between teachers who covered the topic and those who did not.

Teacher Background Variables

To assess teachers' mathematics experience, we added the number of mathematics courses they said they took at the high school and college levels. The teachers were also asked whether they had a mathematics, general, or emergency/internship teaching credential.[8] We treated the credential categories as mutually exclusive by using the following decision rules: (i) teachers who possessed a mathematics credential and any another kind of credential were categorized as possessing a mathematics credential, (ii) teachers who possessed both a general and an emergency/internship credential were categorized as possessing a general credential, and (iii) all other teachers were classified as having an emergency/internship credential.

<u>Imputation of Missing Values</u>

In general, less than 3% of the responses on any given teacher questionnaire item were invalid or missing. Missing values on an item were imputed using a regression procedure that considered the responses to other items. A complexity arose in estimating values for the opinion items that contained an "I don't know" option because this response resulted in a non-continuous metric. This option was chosen frequently on two items concerning teachers' perceptions of whether their district was aligned with specific mathematics frameworks. For these two questions, we compared the characteristics of teachers who chose this option to those who did not. For the remaining items, we treated the "I don't know" choice as missing, and imputed a value based on responses to the other questionnaire items within the same scale.

At each grade, a small number of teachers were missing values on all the items comprising one or more of the scales. In addition, a small number of teachers were

[8] Mathematics credentials refer to those with single subject credentials in mathematics, standard secondary credential in mathematics, and/or supplementary authorization in mathematics. General credentials refer to teachers with: multiple-subject teaching, general or standard elementary, single subject credential not in mathematics, and/or standard secondary credential not in mathematics. Emergency/internship credentials refer to teachers with: emergency multiple subject teaching permit, emergency teaching permit in

missing values for some of the teacher background variables that were included in our models. We imputed these values using teacher responses on the other scales and background variables.

We also imputed missing 1998 Stanford-9 reading and math scores for students in a teacher's classroom. In fourth grade, about 18 percent of students were missing at least one prior year's test scores and in eighth grade roughly 14 percent of students were missing either the 1998 math or reading score.

A four-step process was used to impute missing student and teacher data. First, we imputed values for the missing test scores using student background variables, teacher background variables, and the scales completed by all teachers. The models also included district indicator variables. We imputed multiple values using Bayesian models for multivariate clustered data as described in Schafer (1997). We used the PAN software for Splus to fit the models and draw imputed values (Schafer, 1997). We created 10 sets of imputed values. Creating multiple sets of imputed values allowed us to adjust the standard errors of our estimates to account for missing data.

Next, we created teacher level data sets with one observation per teacher. These data sets included all the teacher scales and classroom averages for student variables including test scores. We included the imputed values in the classroom averages for test scores. We created one teacher level data set for each set of imputed test scores.

In Step 3, we imputed the missing teacher scales using a multivariate normal model. We used this model even for the missing education indicator variable. Although indicator variables do not conform to the multivariate normal model, previous research has shown that this approach to imputation does not tend to produce biased results. We used the NORM software (Schafer, 1999) to fit the models and draw imputed values. We drew one set of imputed teacher scales for each set of imputed test scores.

Finally, we used the observed student and teacher data and the imputed teacher scales to impute new sets of test scores. We generated one set of imputed test scores for each of the ten sets of imputed teacher scales. We again used Bayesian models for multivariate clustered data as described in Schafer (1997).

---

mathematics, internship credential (multiple subject), internship credential in mathematics, credential waiver, and/or other kinds of credentials.

Analysis

The primary purpose of this study was to investigate the degree to which student achievement was associated with differences in instructional practices. We explored these relationships using linear regression analysis. This approach enabled us to control for differences in student and teacher background characteristics. We fit these models using individual student data, with all the students from the same classroom receiving the same values on each of the teacher questionnaire scales, and we used an adjusted standard error estimate to account for possible correlation among responses from students with the same teacher (McCaffrey & Bell, 1997). We also standardized test scores and teacher scales so that the reported coefficient is the expected difference in test score standard deviation units for a one standard deviation unit increase in scale scores.

Distributions of Teacher Questionnaire Scales

Table 3 shows the mean, standard deviation, and reliability (coefficient alpha) of each teacher scale at each grade level. The table shows the same rank ordering of the instructional practices across grade levels. For example, at both grades 4 and 8, teacher-centered practices were used often while computers were used infrequently. Teachers were inclined to emphasize problem-solving and computational skills, but were less likely to focus on math applications. Group work was also emphasized more often than individual work.

Table 3. Mean, Standard Deviation, and Reliability Coefficient for Each Teacher Questionnaire Scale at Each Grade Level [9]

Scales[10]	Fourth Grade				Eighth Grade		
	Mean	SD	Alpha		Mean	SD	Alpha
1. Teacher-Centered	4.45	.51	.49		4.69	.39	.35
2. Problem-Solving	3.88	.46	.80		3.68	.44	.71
3. Computational Practices	3.56	.54	.59		3.45	.49	.52
4. Applications	2.85	.47	.53		2.73	.43	.43
5. Group Work	2.81	.71	.69		2.37	.59	.65
6. Individual Work	2.42	.74	.58		1.93	.58	.62
7. Computer Use	1.82	.75	.86		1.48	.55	.86
8. Familiarity and Influence of Mathematics Frameworks and Standards	2.54	.67	.78		2.70	.70	.82
9. Alignment with District Standards	3.20	.58	.70		3.35	.49	.50
10. Perceived Teacher Support	3.23	.51	.68		3.41	.49	.76
11. Perceived Teacher Collaboration	2.19	.56	.75		2.42	.50	.72
12. Professional Mathematics Development	2.23	.90	.87		2.86	1.04	.84

Most teachers believed their school was moderately aligned with district standards, but they tended not to know whether their district was aligned with either the NCTM standards or California Mathematics Frameworks. Teachers also believed such documents had little influence on their practices. They reported having a fair amount of support from the administration and their colleagues, but did not collaborate often with their peers. Additionally, teachers reported receiving little mathematics professional development.

[9] The descriptive statistics and reliabilities are based on the observed data and do not include imputed values.
[10] Scales 1-7, 11, and 12 used a 5-point Likert scale. Scale 8 used a 4-point Likert scale and scales 9-10 used a variation of the 4-point Likert scale.

There was considerable variation across schools in the teachers' reported use of particular instructional practices. This is undoubtedly due to a variety of factors, some of which were related to variables in our survey (e.g., teacher and classroom demographics) and some of which were not (e.g., preservice training, personal style, etc.).

Relationships of Student Characteristics to Instructional Practices

Teachers' decisions about instructional practices may be related to student characteristics. For instance, teachers with higher-ability examinees may focus on problem-solving more often than teachers with lower-ability students. To explore this and other scenarios, we used a regression analysis to predict instructional practices from student demographics.

We found that at the fourth grade, teachers with a higher proportion of gifted students were less likely to use computers or have students work individually. Teachers with a homogenous group of average ability students were more likely to use group work. Teachers with a higher proportion of gifted, LEP, and special education students were also less likely to focus on math applications.

Our regression models for the eighth grade were similar to those at the fourth grade, but we controlled for differences in courses.[11] Teachers with a homogenous group of high-ability students were more likely to incorporate computers in their lesson plans, while teachers with a homogenous group of low-ability examinees were less likely to engage in teacher-centered practices. Teachers with a higher proportion of female students reported emphasizing computational practices less frequently, but those with a higher proportion of Black students focused on computational practices more often.

Relationships of Teacher Characteristics to Instructional Practices

To investigate the role of teacher demographics, we examined whether a teacher's reported use of instructional practices was related to that teacher's ethnicity, gender, perceptions of teacher support and collaboration, hours of professional development time

[11] There were three course types: Math 8, algebra, and integrated math. Math 8 consisted of several mathematics courses, including pre-algebra, Math 7/8, Math 8, and problem-solving.

spent on specific mathematics-related activities, years of teaching experience, credential type, degree, and mathematics coursework.

At the fourth grade, teacher ethnicity and gender were related to instructional practices. Female teachers tended to focus on computational skills. Black teachers reported using group work less frequently, while Hispanic teachers reported engaging in individual work less often. Hispanic teachers were also less likely to emphasize applications and to use computers in instruction.

Fourth-grade teachers who collaborated with one another and whose instructional practices were influenced by national and state standards were more likely to emphasize group work, individual work, applications, and higher-order thinking skills. Greater collaboration was also positively related to computer use, as was more mathematics professional development. Additionally, teachers who had taken more mathematics courses tended to use group work more frequently.

At the eighth grade, greater influence of national and state standards on teaching practices and more mathematics professional development were positively related to problem-solving practices. Integrated math teachers were more likely than either Math 8 or algebra teachers to incorporate computers into their lessons, and were less likely to engage in teacher-centered practices.

Relationship between Teacher Characteristics and Student Achievement

After controlling for student demographics, teacher background characteristics (such as ethnicity, gender, certification type, degree, and mathematics coursework) were not related to student test scores. The one exception to this finding was that the total number of years teaching had a significant positive relationship with student outcomes. A one-unit standard deviation increase in years teaching was associated with a .074 standard deviation unit gain in scores at the fourth grade, and a .043 standard deviation unit gain in achievement at the eighth grade.

Relationship between Instructional Practices and Achievement

Our analyses of the relationships between the teacher questionnaire scales and student achievement controlled on some variables but not others. Specifically, we did not consider teacher background variables (such as ethnicity, gender, certification type, degree, and mathematics course work) because in preliminary analyses they were not related to student outcomes. For the same reason, we eliminated variables pertaining to the differences in the number of students per class, the amount of instructional time devoted to mathematics, and the number of topics taught that were consistent with the current mathematics standards for California.

To address the effects of specific mathematics concepts, we conducted analyses that controlled for the emphasis given to each topic. Differences in emphases tended to be unrelated to achievement, but at the fourth grade, some coverage of probability was positively associated with higher scores (i.e., a .088 standard deviation unit increase in scores). We retained this topic for further analyses, but eliminated the others.[12]

We explored the data using several regression models, some of which included the total number of years teaching as an independent variable. Although the total number of years teaching is positively related to test scores, it is also moderately related to instructional practices (i.e., correlations up to .35). Because the two variables are correlated, if we adjust for total years teaching, the effects of instructional practices on achievement will be reduced. For our final analysis, we used two models, one with the total number of years included, and one without.

Our independent variables for the fourth-grade models included: districts, student ethnicity, student gender, participation in a gifted program, participation in a special education program, free or reduced lunch status, LEP status, prior year scores in math and reading, and coverage of probability. Our independent variables at the eighth grade were virtually identical to those of the fourth-grade. However, we did not control for coverage of probability and instead controlled for course differences.

Figure 1 shows the estimated coefficients for our fourth-grade analysis that included number of years teaching. Figure 2 presents the results for the analysis that excluded this variable. Figures 3 and 4 show the eighth-grade regression results with and without total years teaching, respectively.

[12] At the eighth grade, increased coverage of some topics was negatively associated with achievement, but this counterintuitive finding appeared to be a result of teachers' efforts to tailor the curriculum to students' ability levels (i.e., teachers spending more time on some mathematical topics with lower-achieving students than with higher-achieving examinees).

For the fourth-grade models, participation in a gifted program was positively associated with test scores, as was being female or Asian. In contrast, African-American race/ethnicity and participation in a special education program were negatively related to achievement. Additionally, some exposure to probability was associated with higher scores.

The majority of the teacher scales at the fourth-grade level did not show a statistically significant relationship with outcomes. When controlling for total years teaching, only one scale, practices emphasizing applications, was related to achievement, such that a one-unit standard deviation increase on this scale was associated with a .036 standard deviation unit gain in scores. This very weak relationship, however, was not significant when we excluded total years teaching. Under the model that did not control

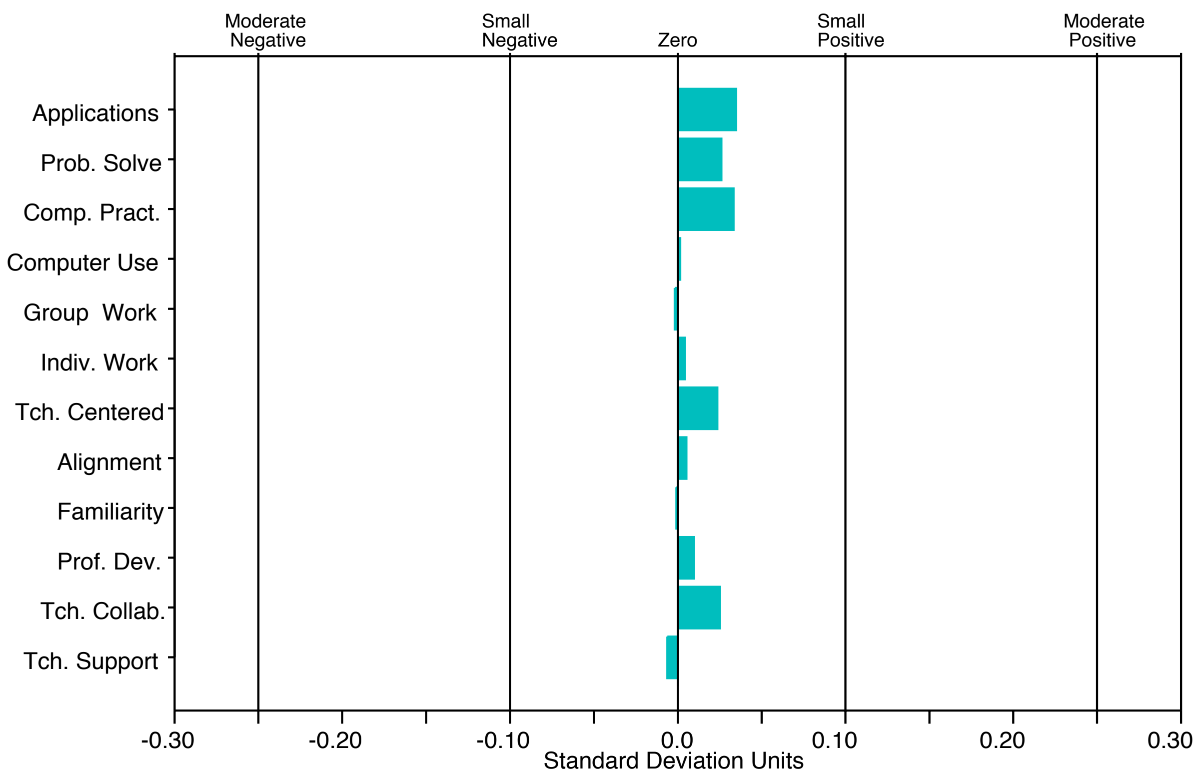


Figure 1: Regression Coefficients for Fourth-Grade Models with Total Years Teaching

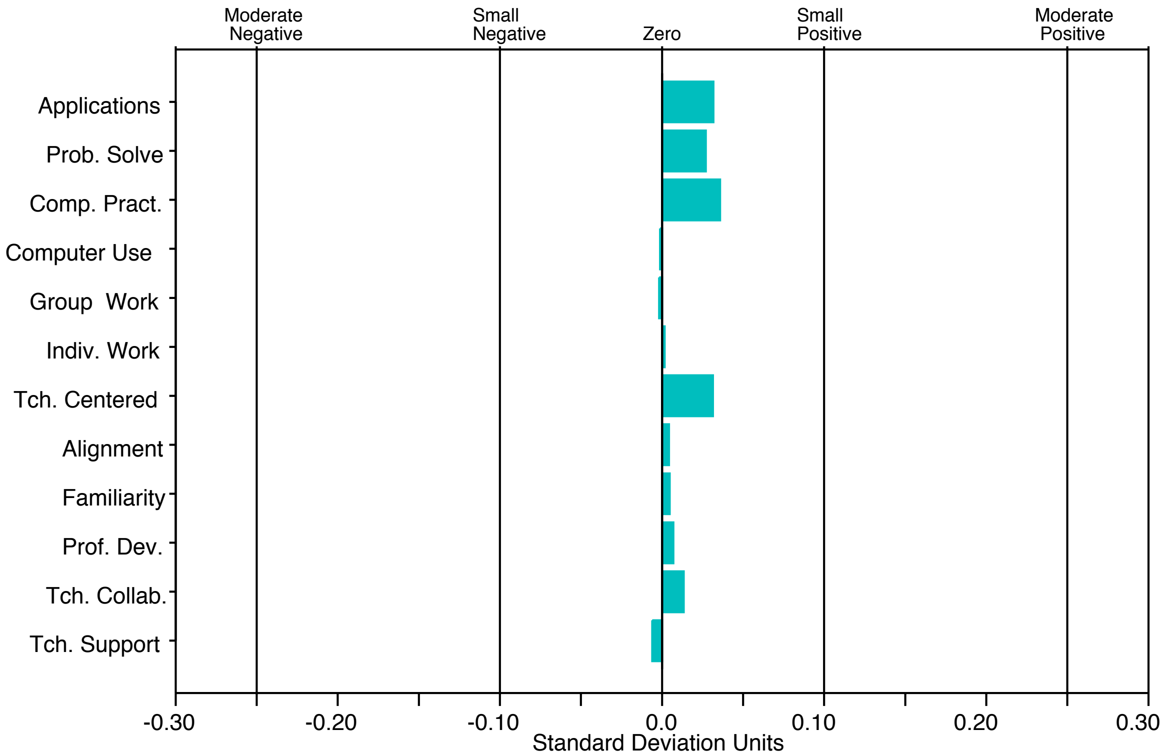


Figure 2: Regression Coefficients for Fourth-Grade Models without Total Years Teaching

for teaching experience, the use of computational skills was very slightly positively associated with achievement. But again, this effect was quite small (i.e., about the same magnitude as was found for the applications scale).

At the eighth grade, the regression models that controlled for total years teaching yielded similar results to models that excluded this variable. African-Americans, Hispanics, females, and Math 8 students received lower scores, whereas examinees participating in a gifted program received higher scores. Greater reported use of computers in instruction was negatively related to outcomes, but again, the effect was quite small—a one-unit standard deviation increase on the computer use scale was associated with a .041 standard deviation unit decrease in test scores. No other scale showed a significant main effect, but an interaction between the teacher-centered practices and course was found. Specifically, the teacher-centered scale was positively related to test scores for algebra courses, but such practices were unrelated to outcomes for Math 8 courses.

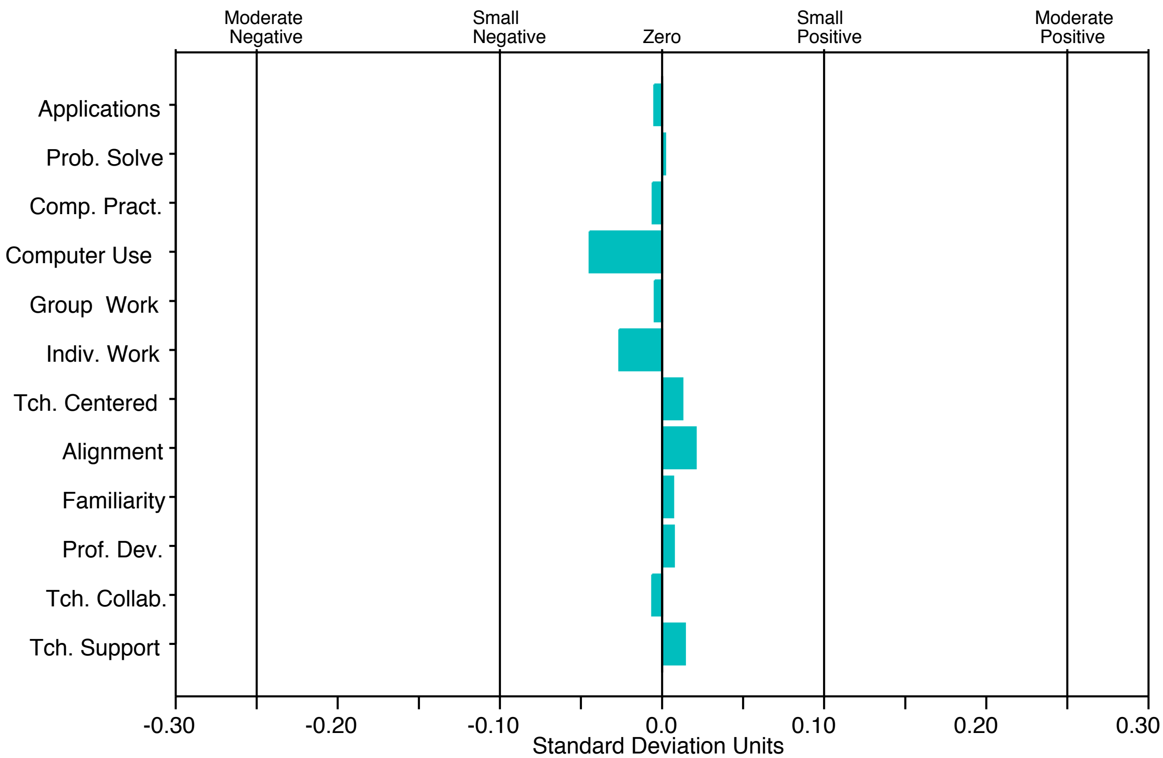


Figure 3: Regression Coefficients for Eighth-Grade Models with Total Years Teaching

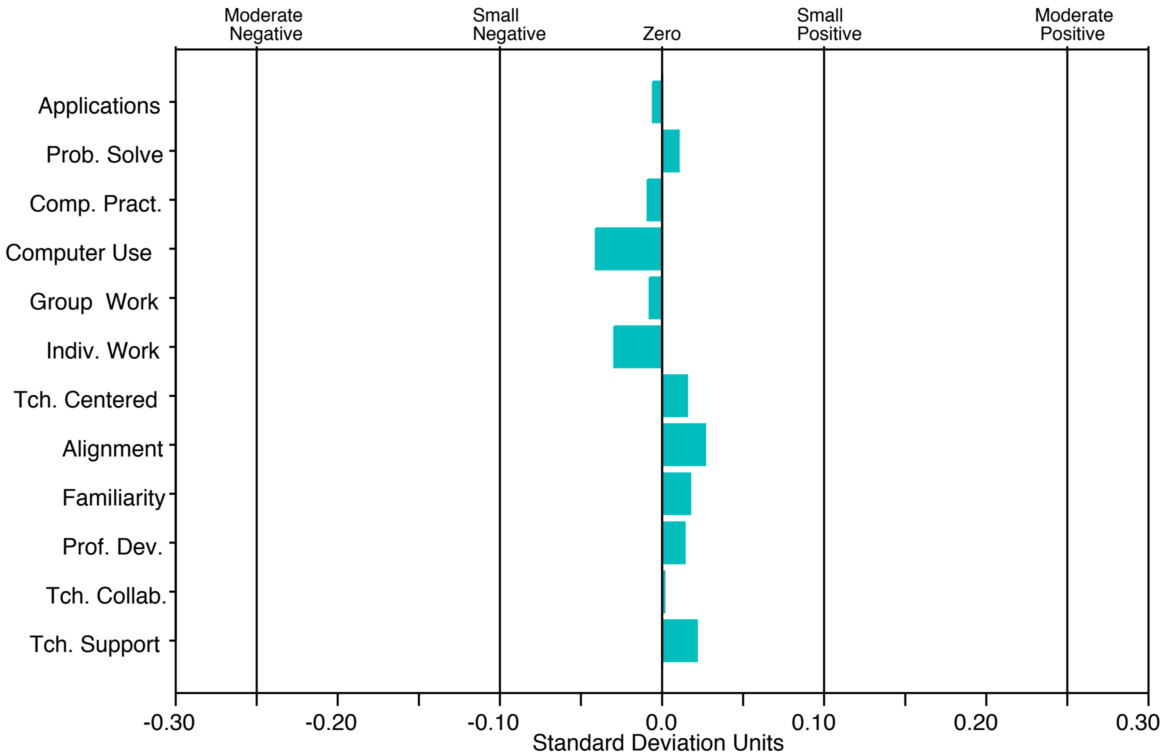


Figure 4: Regression Coefficients for Eighth-Grade Models without Total Years Teaching

Teacher Familiarity with Standards

Several questionnaire items asked teachers how familiar they were with the NCTM standards, California Mathematics Content Standards, California Mathematics Frameworks, California Mathematics Program Advisory, and their local district guidelines. Most teachers were very familiar with their own district standards, but were less knowledgeable about the state and national frameworks. Approximately 39% of fourth-grade teachers and 17% of eighth-grade teachers were unfamiliar with the 1989 NCTM standards. Furthermore, only 49% of fourth-grade teachers and 36% of eighth-grade teachers reported being aware of the California Mathematics Program Advisory. Teachers also said they were not familiar with the California Mathematics Content Standards and the California Mathematics Frameworks, particularly versions earlier than 1998. For instance, 15% and 14% of fourth- and eighth-grade teachers, respectively, were not familiar with the California Mathematics Content Standards. In a similar vein, 25% of fourth-grade teachers and 21% of eighth-grade teachers reported that "they had never heard of" the 1985 California Mathematics Frameworks. Given these numbers, it is not surprising that many teachers believed these frameworks had little influence on their teaching practices.

Nearly 44% of the fourth-grade and 25% of the eighth-grade teachers did not know whether their district standards were aligned to the NCTM standards. Similarly, 38% and 32% of the fourth- and eighth-grade teachers, respectively, indicated that they did not know whether the district had provided professional development workshops based on the 1992 California Mathematics Framework. Because teachers who know whether their district is aligned with the national and state standards are likely to be different from those who do not, we examined the characteristics of the two groups.

At the fourth-grade, teachers who did not know whether their district was aligned with the NCTM standards or the California Mathematics Framework had fewer hours of mathematics professional development and reported less collaboration. The teachers responding "I don't know" were also less likely to focus on individual work and problem-solving. Additionally, uncertainty of district alignment with the NCTM standards was associated with less frequent use of group work and a lower likelihood of possessing a general credential, while uncertainty of district alignment with the 1992 California Mathematics Framework was associated with fewer years of teaching experience. Considering that it has been 8 years since the 1992 California Mathematics Framework was published, the latter finding is not surprising.

We found similar results at the eighth grade. For example, teachers who were unsure of the influence of the NCTM standards and California Mathematics Framework on their district had less professional development and lower perceptions of teacher support.

Discussion

After controlling for student background characteristics, only a few instructional practices had statistically significant correlations with test scores. At the fourth grade, coverage of probability was positively associated with achievement, as were emphases on applications and computational skills. At the eighth grade, the use of computers in instruction was negatively related to outcomes. However, all of these effects were quite small, particularly in relation to other student characteristics such as race/ethnicity. Moreover, given the large number of variables investigated, some may actually be due to chance.

The finding that the probability, applications, and computational skills scales were positively related to student achievement is logical given the content of the Stanford-9, which includes many contextualized statistics items that require procedural and declarative knowledge. Because the test focuses on problems that are solvable via heuristics, it may not be the most appropriate measure to assess higher-order thinking skills. Thus, the failure to find a significant association between problem-solving practices and achievement might stem from limitations of the Stanford-9 as opposed to a lack of relationship per se.

The negative relationship between the use of computers and achievement may be attributable to several sources. Students who receive computer instruction may spend more time "playing with" the computer than actually using it to solve mathematics problems. In a related manner, teachers who use computers may need to devote more instructional time to logistics (e.g., explaining how to use the computer), which might translate to less time explaining mathematics concepts. Other research has shown that computers can have positive or negative effects on achievement, depending upon how they are used (Wenglinsky, 1998). Alternatively, the Stanford-9 items may not be sensitive to detecting the effects of computer instruction. Some mathematics problems that can be presented via a computer are less feasible on a paper-and-pencil test. It might be the case that students who receive computer instruction are encountering different kinds of mathematics problems in their classrooms than those presented on the Stanford-9. More information about the nature of computer instruction is needed to better explain the association between the use of computers and test scores.

The finding that teacher-centered instruction is positively related to scores for algebra but not for Math 8 merits further attention. This may be due to differences in the content of each course. Math 8 typically entails ideas that have been introduced in prior mathematics classes. In contrast, algebra tends to involve skills, concepts, and frameworks that are unfamiliar and qualitatively different from those previously learned.

Hence, teacher-centered practices, such as going over homework or demonstrating how to solve a problem, may be more beneficial with algebra than with Math 8. This interaction illustrates the importance of considering course content when evaluating the relationship between achievement and instruction, as particular practices may be more effective with one course than another.

Certain teacher characteristics were also associated with different kinds of classroom practices. Teachers who said their teaching was influenced by the NCTM standards or California Mathematics Frameworks were more likely to engage in instruction espoused by these documents, such as practices focusing on group work, applications, and problem-solving. As is consistent with previous research, teachers who reported more frequent collaboration with their colleagues were also more likely to engage in this kind of instruction with their students (McLaughlin & Talbert, 1993). Notably, these practices are typically identified by many current reform efforts as facilitating student learning. Such practices, however, are not solely dependent upon teacher characteristics, as variations in student demographics were also related to teaching style.

In comparison to those who had some knowledge of the NCTM standards and California Mathematics Frameworks, the teachers who were not familiar with these standards tended to have less teaching experience, participated in fewer professional development programs, and reported less collaboration. Perhaps as a result of their lack of exposure to the standards, these teachers did not engage as frequently in practices that have been endorsed by the NCTM standards or California Mathematics Frameworks. However, there are many other factors that influence teaching practices, and more research needs to be conducted in order to better understand why teachers choose to use (or not use) certain kinds of practices.

Limitations

There are several caveats that need to be considered when interpreting the results of this study. First, the teachers and students who participated in this study are not representative of others in the state. Consequently, the relationships (or lack thereof) that were found in this research cannot be generalized beyond our sample of students, teachers, and schools. Furthermore, because we did not use an experimental design, we cannot be certain that the observed relationships are attributable solely to classroom practices. There may be other systematic student, teacher, and schools variables that we did not measure but which nevertheless affect what teachers do and what students learn.

A second limitation of our study concerns the lack of information on what led teachers to use particular practices. Although we investigated the relationships between classroom instruction and teacher and student demographics, we have not explored the full range of factors that could influence practices, such as district policies or local community climate. Our initial intent was not to determine the reasons underlying teachers' use of practices, but this information would be helpful to those who are designing and implementing professional development programs and other interventions and policies.

The lack of significant relationships, particularly between many of the scales and test scores, should be interpreted cautiously because the low reliability of some of these scales makes it difficult to detect effects. More importantly, all the scales depended on the accuracy of teacher perception of what they did and this perception may be less than 100 percent.

Another possible explanation for the lack of effects stems from our focus on students' exposure to practices during a single academic year, which does not allow us to follow changes in teachers' practices or examine the effects of student exposure to these practices across several years. Some practices may have been implemented only a short time ago, in accordance with recently released standards (e.g., California Mathematics Framework, 1998). Teachers may need more time before they can effectively implement the practices, or students may need to be exposed to the practices for more than a single year before the effects of these practices on achievement become clearly evident.

As mentioned earlier, the content of the Stanford-9 may render it an inappropriate measure for assessing relationships between certain classroom practices and achievement. However, beyond its content limitations, there were concerns that its validity may have been compromised by efforts to "drill" students on the specific skills required by the exam. Approximately 71% of fourth-grade teachers and 81% of eighth-grade teachers strongly agreed with the statement that "There is a school-wide effort to improve student mathematics achievement on the Stanford-9." If teachers are indeed narrowing their curriculum to the topics found on the Stanford-9, serious questions arise regarding the inferences that can be drawn from the scores. This problem is likely to be exacerbated as the stakes attached to the Stanford-9 increase (Stecher & Barron, 1999).

Finally, the use of surveys is an imperfect method of assessing instructional practices. Like any such measure, the items are subject to inaccurate responses, particularly those that reflect social desirability. More importantly, the questions addressed only the frequency with which teachers used particular practices and did not address the way in which they were used or the overall quality of instruction. This problem is alleviated with classroom observations and teacher interviews, but this type of data collection is typically feasible only on a small-scale basis and the findings are not widely generalizable to other populations.

References

Austin, J.D. (1997). Integrated mathematics interfaced with science. *School Science and Mathematics*, *97*(1), 45-59.

California Department of Education. (1992). *Mathematics framework for California public schools*: *Kindergarten through grade twelve*. Sacramento, CA: Author.

California Department of Education. (1997). *Mathematics content standards for California public schools*. Sacramento, CA: Author.

California State Department of Education. (1998). *Mathematics framework for California public schools*: *Kindergarten through grade twelve*. Sacramento, CA: Author.

Cochran, W.G. (1977). *Sampling Techniques*. 3rd edition. New York: Wiley.

Cohen, D.K., & Hill, H.C. (1998). *State policy and classroom performance*: *Mathematics reform in California* (CPRE Policy Brief). Philadelphia: Consortium for Policy Research in Education.

Ginsburg-Block, M.D., & Fantuzzo, J.W. (1998). An evaluation of the relative effectiveness of NCTM standards-based interventions for low achieving urban elementary students. *Journal of Educational Psychology*, *90*, 560-569.

Martinez, J.G.R. & Martinez, N.C. (1998). In defense of mathematics reform and the NCTM's Standards. *Mathematics Teacher*, *91*(9), 746-748.

McCaffrey, D. & Bell, R. (1997). *Bias reduction in standard error estimates for regression analyses from multi-stage designs with few primary sampling units*. Paper presented at the Joint Statistical Meetings, Anaheim, CA.

McLaughlin, M.W. & Talbert, J.E. (1993). *Contexts that Matter for Teaching and Learning*: *Strategic Opportunities for Meeting the Nation's Educational Goals*. Stanford University: Center for Research on the Context of Secondary School Teaching.

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

Schafer, J.L. (1997). Imputation of missing covariates under a general linear mixed model. Technical report, Dept. of Statistics, Penn State University. Available at www.stat.psu.edu/~jls/#res

Schafer, J.L. (1999) NORM for Windows 95/98/NT Version 2.02. Available at www.stat.psu.edu/~jls/misoftwa.html#win.

Stecher, B. M., & Barron, S. I. (1999). Quadrennial milepost accountability testing in Kentucky (CSE Report 505). Los Angeles: Center for Research on Evaluation, Standards, and Student Testing.

Stipek, D., Salmon, J.M., Givvin, K.B., Kazemi, E., Saxe, G., & MacGyvers, V.L. (1998). The value (and convergence) of practices suggested by motivation research and promoted by mathematics education reformers. *Journal for Research in Mathematics Education*, *29* (4), 465-488.

Verschaffel, L. & DeCorte, E. (1997). Teaching realistic mathematical modeling in the elementary school: A teaching experiment with fifth-graders. *Journal for Research in Mathematics Education*, *28*, *577-601*.

Webb, N.M., & Palincsar, A.S. (1996). Group processes in the classroom. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 841-873). New York: Macmillan.

Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics* (ETS Policy Information Report). Princeton, NJ: ETS.

Appendix A1
Questionnaire Items in Each Scale

Teacher-Centered Practices
Go over homework with the class
Demonstrate how to solve a particular type of problem
Listen to teacher presentation of a new topic or procedure

Computer Use
Use a computer to present, simulate, or demonstrate concepts and techniques to the class
Use computers to run simulations or demonstrations
Use computers to practice basic skills
Use computers to learn concepts
Use computers to collect data
Use computers as an analytic tool (e.g., spreadsheets)
Use computers to play mathematics game

Problem-Solving
Make provisions for students to work at their own pace or level
Check for student understanding at the end of a lesson or class period
Assign special challenges/enrichment as homework
Justify their answer or explain their reasoning when giving an answer
Discuss different ways to solve a particular problem
Generalize from particular problems to other situations
Work on non-routine, higher-order problems
Use manipulative materials or models to solve problems or explore concepts
Work problems mentally
Engage in class discussion about mathematics or models to solve problems or explore concepts
Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)
Performance tasks for assessment purposes

Applications
Introduce/teach topics in the context of everyday situations
Do mathematics in conjunction with other subjects
View or participate in mathematics demonstrations or investigations
Watch mathematics-related films, filmstrips, videotapes, or television programs
Go on mathematics-related trips

Computational Practices
Practice computational procedures
Memorize mathematics facts, rules, definitions, or formulas
Read or work problems from a textbook
Complete worksheets
Read aloud from a mathematics textbooks
Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)
Tests made up of computational and/or word problems

Individual Work
Work on individual projects that take several days
Make individual presentations to the rest of the class
Write in a mathematics journal
Work individually at activity stations
Work individually at computers

Group Work
Work in pairs or small groups on mathematics problems/exercises
Work on group projects that extend for several days
Make group presentations to the rest of the class
Work in pairs or small groups at activity stations
Work in pairs or small groups at computers

Familiarity and Influence of Mathematics Frameworks and Standards
NCTM Curriculum and Evaluation Standards (1989)
NCTM Standards 2000 (1998 discussion draft)
California Mathematics Framework (1985)
California Mathematics Framework (1992)
California Mathematics Framework (1998)
California Mathematics Program Advisory (1996)
California Mathematics Content Standards adopted by the State Board (1998)
Local district mathematics content standards/curriculum guidelines

Alignment with District Standards
Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards
There is a school-wide effort to implement our district mathematics standards
There is a school-wide effort to improve student mathematics achievement on the Stanford-9
Our district has provided workshops/professional development based on our district mathematics standards
Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching

Perceived teacher support
Teachers in this school support one another in trying innovations in teaching mathematics
The school administration promotes innovations in mathematics education
My way of teaching mathematics is supported by school administrators
My way of teaching mathematics is supported by the parents of my students
I feel that I belong to a professional community of mathematics educators at a regional, state, or national level
I have some control over my mathematics teaching

Perceived teacher collaboration
Suggestions or ideas from other teachers in your school
Suggestions or ideas from a mathematics specialist at the school, district, or county office
Ideas from an in-service, workshop, institute, professional meeting, or conference
Teachers share ideas about mathematics instruction
Teachers observe one another teaching mathematics
Teachers work together to develop mathematics curriculum
Teachers work together to coordinate the mathematics content of different courses
A specialist in mathematics education works with teachers in this school

Professional Mathematics Development
Mathematics content
Mathematics instructional techniques or strategies
Use of particular mathematics curricula or curriculum materials
Use of technology in mathematics instruction
Mathematics standards
Mathematics assessment/testing

Survey of Mathematics Instructional Practices in California

4th Grade
Teacher Questionnaire

February 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers are being surveyed as part of this study.

<u>About this Questionnaire</u>

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in Your Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Gloria Guth, Project Director, WestEd, (650) 470-0403, gguth@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What grade(s) do you currently teach? ______________

2. To how many different classes per day do you teach mathematics? _______

3. Do you teach in a self-contained classroom (i.e., are you responsible for teaching all or most academic subjects to a single class)?

   ❑ yes ❑ no

II. Mathematics Instruction in Your Class*

4. How many days per week and minutes per day does your class meet for mathematics?

   a. Days per week *(check one):* ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

   b. Average minutes per day: _______ minutes

5. How many total students are enrolled in your class? _______

6. How many 4th grade students are enrolled in your class? _______

7. How would you describe your class in terms of variation in student mathematics ability? *(Check one.)*

   ❑ fairly homogeneous and low in ability
   ❑ fairly homogeneous and average in ability
   ❑ fairly homogeneous and high in ability
   ❑ heterogeneous with a mixture of two or more ability levels

8. How many students in your class are formally classified as each of the following? (Estimate if necessary.)

   a. English Learner/LEP _____ b. Special Education _____ c. Gifted and Talented _____

---

* Note: If you are a mathematics specialist and teach more than one mathematics class, please answer the questions in this section for ***your first mathematics class of the day in which at least half of the students are in 4th grade,*** and indicate here the class period during which this class meets: _______

9. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____% b. in pairs or groups? _____% c. individually? _____%

10. About how often do ***you*** do the following as part of mathematics instruction **in your class**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b.	Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c.	Make provisions for students to work at their own pace or level	1	2	3	4	5
d.	Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e.	Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f.	Assign homework for students to get practice	1	2	3	4	5
g.	Assign special challenges/enrichment as homework	1	2	3	4	5
h.	Go over homework with the class	1	2	3	4	5
i.	Demonstrate how to solve a particular type of problem	1	2	3	4	5
j.	Assess student progress to determine the need for additional instructional support	1	2	3	4	5

11. About how often do you ask **your students** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b.	Practice computational procedures	1	2	3	4	5
c.	Do mathematics in conjunction with other subjects	1	2	3	4	5
d.	Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e.	Read or work problems from a textbook	1	2	3	4	5
f.	Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g.	Discuss different ways to solve a particular problem	1	2	3	4	5
h.	Generalize from particular problems to other situations	1	2	3	4	5
i.	Complete worksheets	1	2	3	4	5
j.	Work on non-routine, higher-order problems	1	2	3	4	5
k.	Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l.	Work problems mentally	1	2	3	4	5

12. About how often do you ask **your students** to participate in each of the following **whole-class** activities as part of mathematics instruction? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b.	Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c.	View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d.	Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e.	Read aloud from a mathematics textbook	1	2	3	4	5
f.	Go on mathematics-related field trips	1	2	3	4	5
g.	Participate in class mathematics contests or games	1	2	3	4	5
h.	Other: ______________________________	1	2	3	4	5

13. About how often do you ask **your students** to participate in each of the following **group** activities as part of mathematics instruction? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work in pairs or small groups on mathematics problems/ exercises	1	2	3	4	5
b.	Work on group projects that extend for several days	1	2	3	4	5
c.	Make group presentations to the rest of the class	1	2	3	4	5
d.	Work in pairs or small groups at activity stations	1	2	3	4	5
e.	Work in pairs or small groups at computers	1	2	3	4	5
f.	Other: ______________________________	1	2	3	4	5

14. About how often do you ask **your students** to participate in each of the following **individual** activities as part of mathematics instruction during class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work individually on mathematics problems/exercises	1	2	3	4	5
b.	Work on individual projects that take several days	1	2	3	4	5
c.	Make individual presentations to the rest of the class	1	2	3	4	5
d.	Write in a mathematics journal	1	2	3	4	5
e.	Work individually at activity stations	1	2	3	4	5
f.	Work individually at computers	1	2	3	4	5
g.	Other: ______________________________	1	2	3	4	5

15. About how often do you ask **your students** to participate in each of the following **technology-related activities** as part of mathematics instruction (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

16. About how often do you test **your students** using each of the following types of **assessment** (for mathematics)? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of computational and/or word problems	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

17. On average, how often do **you** use each of the following in mathematics instruction in your class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

18. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in your class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	_______
b.	Increased awareness of real-world mathematical applications	_______
c.	Mastery of basic computational skills and facts	_______
d.	Development of problem solving/inquiry skills	_______
e.	Preparation for future mathematics courses	_______
f.	Attainment of state or district content standards	_______
g.	Preparation for use of mathematics in daily life	_______
h.	Increased interest in mathematics	_______
i.	Development of mathematical reasoning ability	_______
j.	Preparation for standardized tests	_______
k.	Use/application of mathematics in other subject areas	_______
l.	Other: ____	_______

19. Listed below are a number of topics that might be taught in 4th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 arithmetic (whole numbers)	☐ 10 measurement	☐ 19 relationships among operations
☐ 2 decimals	☐ 11 negative numbers	☐ 20 relationships between numbers
☐ 3 equations	☐ 12 operations properties	☐ 21 rounding
☐ 4 estimation	☐ 13 patterns & relationships	☐ 22 set theory
☐ 5 factors & multiples	☐ 14 percent	☐ 23 statistics/use of data
☐ 6 fractions	☐ 15 perimeter & area	☐ 24 use of variables
☐ 7 geometry & spatial sense	☐ 16 place value	other: ________________________
☐ 8 graphs, tables, & charts	☐ 17 polynomials	other: ________________________
☐ 9 mathematical symbols	☐ 18 probability	other: ________________________

20. a. Which of the following do you use as your **main curriculum resource** (for mathematics) in your class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____________________

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in your class?

Title ____________________

Publisher ____________________ Copyright Date (if known) ____________

21. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only class to which I teach mathematics.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in my other mathematics classes.

22. Are there any special circumstances or unusual conditions related to the teaching of mathematics in your class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

23. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

24. Indicate your opinion about each statement below. *(Circle one number on each line.)*

	Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a. Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b. Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c. The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d. The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e. There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f. There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g. Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h. Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i. Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j. Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k. The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l. The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m. The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

25. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

a. Estimated number of **total** math professional development hours: ______ hours

b. Estimated number of these hours **required by district**: ______ hours

26. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ______________________________	1	2	3	4	5

27. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

28. About how often does each of the following occur at your school? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Teachers share ideas about mathematics instruction.	1	2	3	4	5
b. Teachers observe one another teaching mathematics.	1	2	3	4	5
c. Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d. Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e. A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

29. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics

- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: ________________

College Mathematics

- ❑ Calculus
- ❑ Linear algebra
- ❑ Discrete mathematics
- ❑ Probability and statistics
- ❑ Other: ___________________

Mathematics Education

- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Mathematics for elem. sch. teachers
- ❑ Other: ______________________

30. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

Master's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

Doctoral Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

31. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❏ multiple subject teaching credential
- ❏ general or standard elementary credential
- ❏ emergency multiple subject teaching permit
- ❏ emergency teaching permit in mathematics
- ❏ internship credential (multiple subject)
- ❏ internship credential in mathematics
- ❏ credential waiver
- ❏ single subject credential in mathematics
- ❏ single subject credential *not* in mathematics
- ❏ standard secondary credential in mathematics
- ❏ standard secondary credential *not* in mathematics
- ❏ general secondary credential
- ❏ other: _______________________________

b. Do you have a supplementary authorization in mathematics? ❏ yes ❏ no

32. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____ d. at 4^{th} grade? _____

VI. Teacher Demographic Information

33. Are you: ❏ male ❏ female

34. Are you:

- ❏ African American (not of Hispanic origin)
- ❏ American Indian or Alaskan Native
- ❏ Asian or Pacific Islander
- ❏ Hispanic
- ❏ White (not of Hispanic origin)
- ❏ Other: ______________________

VII. Additional Comments (Optional)

35. What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?

____

____

____

____

36. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

37. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

38. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

39. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Survey of Mathematics Instructional Practices in California

8th Grade
Teacher Questionnaire

February 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers are being surveyed as part of this study.

About this Questionnaire

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in a Particular Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Gloria Guth, Project Director, WestEd, (650) 470-0403, gguth@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What grade(s) do you currently teach? ______________

2. To how many different classes per day do you teach mathematics? _______

3. Do you currently teach any subjects other than mathematics? ❑ yes ❑ no

   If yes, what other subject(s) do you teach? ____

II. Mathematics Instruction in a Particular Class

If you teach more than one mathematics class, please answer the questions in this section for *your first mathematics class of the day in which at least half of the students are in 8th grade,* and indicate here the class period during which this class meets: _______

4. What is the title of this class? ____

5. Which of the following best describes the duration of this class? *(Check one.)*

   ❑ year-long ❑ one-semester ❑ other: ___________________

6. How many days per week and minutes per day does this class meet (for mathematics)?

   a. Days per week *(check one):* ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

   b. Minutes per day: _______ minutes

7. How many total students are enrolled in this class? _______

8. How many 8th grade students are enrolled in this class? _______

9. How would you describe this class in terms of variation in student mathematics ability? *(Check one.)*

   ❑ fairly homogeneous and low in ability
   ❑ fairly homogeneous and average in ability
   ❑ fairly homogeneous and high in ability
   ❑ heterogeneous with a mixture of two or more ability levels

10. In this class, how many students are formally classified as each of the following? (Estimate if necessary.)

    a. English Learner/LEP? _____ b. Special Education? _____ c. Gifted and Talented? _____

11. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____% b. in pairs or groups? _____% c. individually? _____%

12. About how often do ***you*** do the following as part of mathematics instruction **in this class**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b.	Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c.	Make provisions for students to work at their own pace or level	1	2	3	4	5
d.	Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e.	Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f.	Assign homework for students to get practice	1	2	3	4	5
g.	Assign special challenges/enrichment as homework	1	2	3	4	5
h.	Go over homework with the class	1	2	3	4	5
i.	Demonstrate how to solve a particular type of problem	1	2	3	4	5
j.	Assess student progress to determine the need for additional instructional support	1	2	3	4	5

13. About how often do you ask **students in this class** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b.	Practice computational procedures	1	2	3	4	5
c.	Do mathematics in conjunction with other subjects	1	2	3	4	5
d.	Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e.	Read or work problems from a textbook	1	2	3	4	5
f.	Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g.	Discuss different ways to solve a particular problem	1	2	3	4	5
h.	Generalize from particular problems to other situations	1	2	3	4	5
i.	Complete worksheets	1	2	3	4	5
j.	Work on non-routine, higher-order problems	1	2	3	4	5
k.	Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l.	Work problems mentally	1	2	3	4	5

14. About how often do you ask **students in this class** to participate in each of the following **whole-class** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b.	Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c.	View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d.	Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e.	Read aloud from a mathematics textbook	1	2	3	4	5
f.	Go on mathematics-related field trips	1	2	3	4	5
g.	Participate in class mathematics contests or games	1	2	3	4	5
h.	Other: ____	1	2	3	4	5

15. About how often do you ask **students in this class** to participate in each of the following **group** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work in pairs or small groups on mathematics problems/ exercises	1	2	3	4	5
b.	Work on group projects that extend for several days	1	2	3	4	5
c.	Make group presentations to the rest of the class	1	2	3	4	5
d.	Work in pairs or small groups at activity stations	1	2	3	4	5
e.	Work in pairs or small groups at computers	1	2	3	4	5
f.	Other: ____	1	2	3	4	5

16. About how often do you ask **students in this class** to participate in each of the following **individual** activities during class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work individually on mathematics problems/exercises	1	2	3	4	5
b.	Work on individual projects that take several days	1	2	3	4	5
c.	Make individual presentations to the rest of the class	1	2	3	4	5
d.	Write in a mathematics journal	1	2	3	4	5
e.	Work individually at activity stations	1	2	3	4	5
f.	Work individually at computers	1	2	3	4	5
g.	Other: ____	1	2	3	4	5

17. About how often do you ask **students in this class** to participate in each of the following **technology-related activities** (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

18. About how often do you test **students in this class** using each of the following types of **assessment**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of computational and/or word problems	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

19. On average, how often do **you** use each of the following in your mathematics instruction in this class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

20. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in this class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	_______
b.	Increased awareness of real-world mathematical applications	_______
c.	Mastery of basic computational skills and facts	_______
d.	Development of problem solving/inquiry skills	_______
e.	Preparation for future mathematics courses	_______
f.	Attainment of state or district content standards	_______
g.	Preparation for use of mathematics in daily life	_______
h.	Increased interest in mathematics	_______
i.	Development of mathematical reasoning ability	_______
j.	Preparation for standardized tests	_______
k.	Use/application of mathematics in other subject areas	_______
l.	Other: ____	_______

21. Listed below are a number of topics that might be taught in 8th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 absolute value	☐ 12 irrational numbers	☐ 23 relationships among operations
☐ 2 arithmetic (whole numbers)	☐ 13 logarithms	☐ 24 relationships between numbers
☐ 3 decimals	☐ 14 mathematical symbols	☐ 25 rounding
☐ 4 equations & inequalities	☐ 15 measurement	☐ 26 sequences & series
☐ 5 estimation	☐ 16 negative numbers	☐ 27 set theory
☐ 6 exponents and roots	☐ 17 percent	☐ 28 simplification of expressions
☐ 7 factors & multiples	☐ 18 perimeter, area, volume	☐ 29 statistics/use of data
☐ 8 fractions	☐ 19 polar coordinate system	☐ 30 use of variables
☐ 9 functions & patterns	☐ 20 polynomials	other: ________________________
☐ 10 geometry & spatial sense	☐ 21 probability	other: ________________________
☐ 11 graphing	☐ 22 ratio & proportion	other: ________________________

22. a. Which of the following do you use as your **main curriculum resource** in this class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in this class?

Title ____

Publisher ___________________________________ Copyright Date (if known) _____________

23. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only mathematics class I teach.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in all of my other mathematics classes.
- ❑ My teaching in this class is representative of *some* of my other mathematics classes.

24. Are there any special circumstances or unusual conditions related to the teaching of mathematics to this class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

25. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

26. Indicate your opinion about each statement below. *(Circle one number on each line.)*

	Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a. Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b. Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c. The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d. The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e. There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f. There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g. Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h. Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i. Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j. Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k. The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l. The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m. The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

27. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

a. Estimated number of **total** math professional development hours: ______ hours

b. Estimated number of these hours **required by district**: ______ hours

28. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ______________________________	1	2	3	4	5

29. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

30. About how often does each of the following occur at your school? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Teachers share ideas about mathematics instruction.	1	2	3	4	5
b. Teachers observe one another teaching mathematics.	1	2	3	4	5
c. Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d. Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e. A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

31. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics

- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: __________________

College Mathematics

- ❑ Calculus
- ❑ Linear algebra
- ❑ Discrete mathematics
- ❑ Probability and statistics
- ❑ Other: _____________________

Mathematics Education

- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Mathematics for elem. sch. teachers
- ❑ Other: ________________________

32. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Master's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Doctoral Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

33. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❏ multiple subject teaching credential
- ❏ general or standard elementary credential
- ❏ emergency multiple subject teaching permit
- ❏ emergency teaching permit in mathematics
- ❏ internship credential (multiple subject)
- ❏ internship credential in mathematics
- ❏ credential waiver
- ❏ single subject credential in mathematics
- ❏ single subject credential *not* in mathematics
- ❏ standard secondary credential in mathematics
- ❏ standard secondary credential *not* in mathematics
- ❏ general secondary credential
- ❏ other: _______________________________

b. Do you have a supplementary authorization in mathematics? ❏ yes ❏ no

34. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____ d. at 8th grade? _____

VI. Teacher Demographic Information

35. Are you: ❏ male ❏ female

36. Are you:
- ❏ African American (not of Hispanic origin)
- ❏ American Indian or Alaskan Native
- ❏ Asian or Pacific Islander
- ❏ Hispanic
- ❏ White (not of Hispanic origin)
- ❏ Other: ______________________

VII. Additional Comments (Optional)

37. What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?

____

____

____

____

38. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

39. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

40. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

41. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Mathematics Implementation Study
Classroom Observation Protocol
Outline for Qualitative Write-Up[1]

1. **Content of Lesson.** Describe chronologically the main academic areas that were part of the lesson. Include a descriptive label, a brief description of the tasks for each mathematical area, the number of minutes spent on each task, the percentage of class time devoted to each task, and the amount of class time that was *not* spent on mathematics instruction (e.g., nonacademic time: taking role, etc.). Also discuss whether the teacher demonstrated an understanding of the content. Did the teacher appear confident in the material? Was the content accurate?

2. **Organization of Students.** Describe how the teacher organized the students during the course of the lesson. When and for how long did students meet as a whole class, divide into pairs or small groups, work individually at their seats, etc.? Describe the activities that students engaged in during each organizational "phase" of the lesson, the ways that the teacher interacted with students during each phase of the lesson, and the ways that students interacted with one another. For example, during group work, did the teacher circulate among all the groups, focus on just one or two of the groups, or remain at his or her desk? Did students work collaboratively, or were some students more active than others? During whole-class discussion, did a few students dominate the discussion, or did everyone participate?

3. **Purpose of Lesson.** Describe the primary purpose of the lesson (e.g., learning or practicing computational procedures, discovering underlying concepts, framing problems, making conjectures, looking for patterns, connecting math to everyday life or to other subjects, etc.)

4. **Representations, Tools, and Resources.** Identify the representations and tools used by teachers or students and mathematical ideas the representations were targeting.[2] Also identify other resources and materials used during the lesson (e.g., textbooks, worksheets, calculators, computers, etc.) Give specific titles if possible (e.g., textbook title, type of manipulative, software program).

5. **Assessment During Lesson.** Describe the extent to which the teacher attempted to monitor student understanding or engaged in assessment activities aimed at informing instruction and/or gaining knowledge about individual students. Examples include asking questions aimed at identifying students' thinking patterns, interviewing students individually to assess their knowledge, or having students write in a journal as a way to assess understanding.

---

[1] This protocol was adapted, with substantial modification, from the classroom observation protocol used by the Consortium for Policy Research in Education (CPRE) in their study "From Congress to the Classroom."

[2] Representations are anything used to convey some aspect of mathematics and include, but are not limited to, chalkboard drawings, concrete models, manipulatives, graphs, formulas, videos, classroom or household objects, etc.

6. **Focus of Classroom Discourse.** Identify the primary focuses of classroom discourse. To what extent did classroom discourse focus on "getting the right answers" or "doing it the right way"? To what extent did classroom discourse focus on "making sense" of mathematics? Give examples, and include a description of how the teacher stimulated the discourse (e.g., by posing questions or tasks that were "real" problems, by asking students to clarify and justify their ideas, having students talk to each other). Were students directed to or encouraged (either explicitly or implicitly) to a) initiate problems or questions; b) select or invent their own representations; c) select their own technological tools? If so, give examples, and discuss the extent to which students actually did a, b, or c. Also, how much "wait time" did the teacher leave for students to answer questions?

7. **Language Differences.** If applicable, describe the extent to which language differences appeared to play a role in patterns of interaction (teacher-student and student-student) during the class and during each phase of the lesson (e.g., group work, whole-class discussion, etc.) For example, did teacher interaction with LEP students appear to be different than with other students? Did students from all language backgrounds participate in the lesson more or less equally?

8. **Students with Other Special Needs.** Describe the extent to which the teacher attempted to address the needs of students having difficulty, gifted and talented students, and any other students appearing to have special needs. Were these students fully integrated in the lesson's main tasks or did they engage in different activities? Were they seated with the other students or were they physically separated? What accommodations (if any) were made for them, in terms of both materials/resources and in patterns of interaction (teacher-student and student-student) within the classroom?

9. **Behavior and Discipline.** Did student behavior or teacher disciplinary action appear to interfere with the effectiveness of the lesson or the understanding of particular students? If so, how?

10. **Other.** Did you observe anything else that seemed to be important but was not addressed in this protocol? Please describe with specific examples. Why was it important?

Mathematics Implementation Study
Interview Protocol: Teachers

[Record district name, school name, teacher name, and date and time of interview.]

Pre-Observation Interview

Thank you very much for filling out our questionnaire and for allowing me to come see you teach. Before the observation, there are just a few questions that I'd like to ask you.

1. What has the class been doing in math recently?

2. What do you anticipate doing in your math class today?

3. What do you hope students will learn from the lesson?

4. Is there anything in particular that I should know about the group of students I will be observing?

5. Do you have any LEP students in your class? How many? Can you tell/show me where they sit? Do you have anything special planned for them?

After the observation, I'd like to speak with you again and ask you some more questions, if that's okay.

Post-Observation Interview

Thanks again for allowing me to observe your classroom teaching and for speaking with me today. The purpose of this interview is to gain an understanding of your perceptions of the lesson that I observed and also to ask you some other questions related to your mathematics teaching. More specifically, we are studying how policies and reforms have influenced math instruction in your classroom.

[if taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

<u>Questions about the Observation</u>

First, I have some questions about the lesson that I observed.

1. Overall, how do you feel the lesson went?

2. Were there any ways in which the lesson was different from what you planned?

3. What did the lesson tell you about what the students are learning or still need to know in math?

4. What do you plan on doing tomorrow?

5. Would you say that today was a typical day? Why or why not?

<u>Math Instruction: Philosophy and Practice</u>

Now I'd like to ask you some general questions about your math teaching.

1. Can you briefly describe your general approach to teaching math with this class? *[E.g., basic skills, connection to daily life, preparation for SAT-9, etc.]*

2. What types of materials do you generally use when you teach math? Which do you use most often? How do you decide which materials to use? How do you acquire instructional materials within your school? How much input do you have in selecting instructional materials and resources? *[probe on who is involved in materials selection (e.g., teacher, school, district), accessibility to resources/materials, etc.]*

3. How do you decide generally if your students are progressing in math? How do you decide when a student needs special help or extra help, and what kind of help is provided?

4. *[If applicable]* What do you do to address the needs of English language learners in your classroom during math instruction?

<u>Math Instruction: Influences</u>

The next few questions are about things going on in math education today, what you think of them, and what influences your math instruction.

1. Are you particularly aware of any recent national, state, or district developments in math education? If so, can you summarize these developments in your own words and tell me what you think of them?

2. What documents and/or policies have had the greatest impact on your teaching? In what ways, if any, have policy decisions from the state of California (State Board, legislature, California Department of Education) influenced what and how you teach? How about policy decisions from your district?

3. These days there is a lot of talk about accountability. How would you describe your district's accountability system? Are there ways in which it influences your teaching?

4. How do you decide what mathematics to teach? What types of interactions do you have with other teachers or administrators in your building in terms of curriculum planning and development for math instruction? How do curriculum decisions get made in your school? *[Probe for who is involved]*

5. Do you have professional development opportunities related to math instruction? *[Probe for professional communities and teacher networks as well as staff development/in-service.]* If so, do these professional development activities enhance your effectiveness in teaching math? How?

6. Do you have access to people or resources that can help you with your math instruction? *[Probe on specific resources, e.g., curriculum specialists, Title I, special education]*

7. Is your school currently participating in any special programs or initiatives related to math instruction? If so, how does this influence your practice?

8. Did you do anything special to help your students prepare for this year's SAT-9 (mathematics)? If so, what, and for how long prior to the test? If not, are there any ways in which the SAT-9 influences your math teaching?

<u>Effectiveness in Teaching Math</u>

My final few questions are about how effective you feel your math teaching is.

1. What kinds of indicators do you use to gauge your effectiveness in teaching mathematics?

2. How comfortable do you feel teaching math at this grade level? Why?

3. Is there anything that gets in the way of your effectiveness as a math teacher? If so, what?

4. What, if anything, would help you improve your math instruction?

5. Is there anything else you would like to talk about that we haven't covered?

Thank you for your time; you've given us some really valuable information. I really appreciate it and have enjoyed talking with you.

Mathematics Implementation Study
Interview Protocol: Principals

[Record district name, school name, principal name, and date and time of interview.]

Thank you very much for authorizing your school's participation in this study, for allowing us to come observe here and talk with some teachers, and for speaking with me today. The study that I am working on is about the kinds of school and classroom practices that contribute to high mathematics achievement, and the influence of state and local policies on mathematics instruction.

[If taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

1. Tell me about your school's mathematics instructional program. *[Probe for underlying philosophy, scope and sequence (e.g., grade levels the same across schools in district, articulation, etc.)]*

2. Has the school undertaken any new initiatives recently that seem likely to have an effect on mathematics instruction? *[Probe for details on status of, changes in, and reasons for:*

   - *changes in curriculum materials and assessment*
   - *differentiated curriculum and instruction for students with special needs (LEP, special education, Title I, GATE, etc.)*
   - *the way teachers' time is organized to facilitate planning, professional development, collaboration, or other goals*
   - *school time or structure*
   - *the way students are scheduled and organized*
   - *student support services]*

3. To what extent has district policy required, encouraged, and/or supported these changes? What kinds of resources and assistance does the district make available to you?

4. How much discretion does the school have in determining its math curriculum? math textbooks and other instructional materials? curriculum coverage and pacing?

5. How much discretion do individual teachers have in these areas? Are there any committees within the school that make decisions about these issues?

6. What factors do you think exert the greatest influence over mathematics instruction in this school? *[Probe for state and district policies, SBE and district standards, SAT-9, other assessments, national influences (e.g., NCTM standards), professional development, teacher preparation, student demographic characteristics, etc.]*

7. What role does the school play in providing professional development in mathematics instruction for teachers? Do you have any particular priorities and goals for professional development in math? *[Probe for whether teachers are required to participate, how often, whether they have any choices, compensation, who sponsors, and who provides PD.]*

8. What do you think are the most effective kinds of professional development for your teachers in mathematics?

9. What factors do you think exert the greatest influence over *student achievement* in mathematics in this school? [*Probe for professional development, instructional strategies, school characteristics, student characteristics, parent involvement, etc*.]

10. What measures do you use to assess student mathematics achievement in your school? [*Probe for local state and national assessments, percentage of students meeting grade levels standards, etc*.]

11. Generally speaking, how would you rate student mathematics achievement in your school as a whole? *[Probe: what makes you think so?]*

12. Thinking about your school as a whole, what changes do you think are needed to improve math instruction? *[Probe for changes in how teachers work together, funding and other material resources (e.g., technology), parent involvement, and district or state policies.]*

13. These days there is a lot of emphasis placed on accountability. Have you felt that your school has been held accountable? If so, what have you been held accountable for and to whom? What impact, if any, has the state or district accountability system had on your school (not just in math instruction, but in general)?

Thank you so much for your time; you've given us some really valuable information. Can I get copies of the following materials you mentioned? Is there anyone else I should talk to in your school to get a perspective on the kinds of things that we have talked about?

Mathematics Implementation Study
District Curriculum Coordinator/Math Specialist
Interview Questions

[Record district name, interviewee's name, interviewee's title, and date and time of interview.]

Thank you very much for speaking with me today. The study that I am working on is about the kinds of instructional practices that contribute to high mathematics achievement, and the influence of state and local policies on mathematics instruction.

[if taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

1. **Description of Instruction.** Tell us about your district's mathematics program.

    - *[Probe for underlying philosophy, scope and sequence (e.g., is it district-wide, K-12 articulated, etc.), when it was adopted/revised, any recent changes and reasons for changes, materials adopted, etc.]*
    - How much discretion and authority do schools and teachers have in determining curriculum? instructional methods? textbook and other instructional materials (e.g., calculators, manipulatives, etc.)? curriculum coverage and pacing?

2. **Influences.** Tell us about the factors influencing what mathematics gets taught—and how it gets taught—in this district.

    - What major policies does the district use to guide curriculum and instruction in mathematics?
    - In what ways, if any, have state actions or policies influenced the nature of mathematics instruction in your district? *[Probe for the 1998 SBE standards, the Mathematics Frameworks, program advisories, SAT-9, Prop. 227, CSR, Social Promotion, etc.]*
    - What other influences have helped shape district mathematics instruction? *[Probe for national influences (e.g., NCTM), local influences, research findings, assessments, professional development, teacher preparation, student demographic characteristics, etc.]*
    - What people/groups have been, and are currently, involved in shaping district mathematics instruction?
    - Which of the influences shaping district mathematics instruction would you describe as the most important?
    - Are there any incentives or disincentives for schools and teachers to follow district and/or state decisions regarding mathematics instruction? (e.g., schools

get less money if they depart from the textbooks or materials adopted by the district, or laws require schools to make the decisions)

3. **Content Standards.** Tell us about the use of mathematics content standards in your district.

   - Has the district developed local content standards for math? When? Who was involved? Are there any plans to create/revise them? In what grades? Do they differ from the state content standards, and if so, how and why? How are standards used in the district?
   - What, if anything, does the district do to assist schools and teachers in understanding and implementing the math content standards?
   - What assessments does the district use for math? How were they selected?
   - Do you think district standards, curriculum-planning documents, instructional materials, and assessments are well aligned with each other? Why or why not?

4. **Professional Development.** Tell us about mathematics professional development in your district.

   - What professional development does the district provide for teachers and/or school administrators in mathematics instruction? Do you have any particular priorities and goals for professional development in math? *[Probe for whether teachers/administrators are required to participate, how often, whether they have any choices, compensation, who sponsors, and who provides PD.]*
   - What do you think are the most effective kinds of staff development for teachers/administrators in mathematics? *[Probe: what makes you think so?]*
   - What financial resources do you have available for professional development? *[Probe for Eisenhower, other grants, etc.]*

5. **Student Achievement.** Tell us about student mathematics achievement in your district.

   - Generally speaking, how would you rate student mathematics achievement in the district as a whole?
   - What factors do you think exert the greatest influence over student achievement in mathematics in the district? *[Probe for professional development, instructional strategies, school characteristics, student characteristics, parent involvement, etc.]*
   - What measures do you use to assess student achievement across the district and to evaluate your overall mathematics program? *[Probe for local, state, and national assessments, percentage of students meeting grade level standards, etc.]*

6. **Strengths and Weaknesses.** Tell us about what you see as being the strengths and weaknesses of your district mathematics instruction.

- What do you think are the strengths and weaknesses of mathematics instruction in your district? Do you feel that all students across the district have access to quality math instruction? *[Probe for evidence.]*
- What do you see as the biggest challenges to improving student mathematics achievement in your district? *[Probe for shortage of math certified teachers, teacher preparation, instructional materials, student characteristics, etc.]*
- Thinking about your district as a whole, what changes do you think are needed to encourage improvement in math instruction and achievement? *[Probe for changes in how schools/ teachers work together, funding and other material resources (e.g., technology), and district or state policies.]*
- Specifically, what assistance or additional resources, and from whom, would help? *[Probes: if funding, how would it be spent? If time, how would the time be allocated?]*

7. **Accountability.** Tell us about accountability in your district.

- What influence has the state accountability system (including standards and testing) had over mathematics instruction in your district?
- How do you interpret and use data?
- Are these good indicators for determining student achievement?
- What are the major issues and challenges with this performance data?

Thank you so much for your time; you've given us some really valuable information. Can I get copies of the following materials you mentioned? Is there anyone else I should talk to in your district to get a perspective on the kinds of things that we have talked about?

Mathematics Implementation Study
Policy Implications Interview Protocol

General Background
What is your opinion of the current level of mathematics achievement of California students? On what is your opinion based?

What do you see the two or three most important factors explaining the level of mathematics achievement among CA students?

Appropriate State Role
What is the appropriate role of state policy makers in improving mathematics instruction in CA? (Be specific about each entity: legislature, Governor/secretary of education, SPI/CDE, State Board of Education)

How should state government's role be related to the roles of local superintendents/school boards, high school mathematics educators, elementary classroom teachers, and teacher training institutions?

Appropriateness of State Strategy
What is (your understanding) the current (or near term future) state strategy for improving the level of mathematics achievement among CA students?

What is your opinion of the likely outcomes of the current state strategy? Why?

Over the past decade which state interventions have been <u>most helpful</u> in improving mathematics education in CA public schools?

Over the past decade which state interventions have been <u>least helpful</u> in improving mathematics education in CA public schools?

Specific Findings

Standards
Survey respondents support the notion of standards. They also believe standards are important in helping improve mathematics instruction. However, many reported that the new math standards were too ambitious and that there were often competing sets of standards—which generated confusion. Also many respondents reported that too much reform was occurring too fast—that there was insufficient time to assimilate all the changes. What is the appropriate state policy response to these concerns?

Respondents also reported that standards were less powerful in driving the math curriculum than was the SAT9. Several expressed resentment about the powerful impact of testing on the curriculum. What state policies are appropriate for shifting the emphasis to the standards.

A common finding from survey respondents is that there is a lack of alignment between state standards, frameworks, texts, and the SAT9. How can the state best address this concern?

Instructional Materials
Inadequate or insufficient instructional materials (including textbooks) were identified as biggest hindrance to mathematics instruction by 4th grade teachers. Recently, sufficient dollars have been appropriated by the state for the purchase of instructional materials. What, if anything, should the state do to enhance the quality and relevance of these materials?

Instructional Practice
Overall, there appears to be high degree of consensus on objectives for math instruction but little consensus on what constitutes effective math instructional practice. Is there an appropriate state policy role on this issue. If so, what is it?

Professional Development
Survey respondents also reported professional development activities and teacher preparation as important forces but found an inadequate connection between standards and professional development activities. 4th grade teachers want more math professional development. 8th grade teachers reported that math professional development was very helpful. Is professional development an appropriate state role? If so, how can the state most effectively create professional development opportunities for local teachers?

Teacher Involvement
Many respondents felt they were inadequately involved in the development of standards, tests, and instructional material. A common sentiment across all levels (school, district & state) is that teacher buy-in is necessary for reform to work. How can/should the state go about gaining teacher support for its reforms? Do you perceive this as a problem? If so, how should the state go about resolving it?

Survey of Mathematics Instructional Practices in California

10th Grade
Teacher Questionnaire

Pilot Test Version

November 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd
935 El Camino Real
Menlo Park, CA 94025

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers have already been surveyed as part of this study. This questionnaire is part of an exploratory research and development effort about mathematics teaching at the tenth-grade level.

About this Questionnaire

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in a Particular Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Tania Madfes, Project Director, WestEd, (415) 615-3103, tmadfes@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What courses do you currently teach? ________________________ ________________________

   ________________________ ________________________

2. To how many different classes per day do you teach mathematics? _______

3. Do you currently teach any subjects other than mathematics? ❑ yes ❑ no

   If yes, what other subject(s) do you teach? ____

II. Mathematics Instruction in a Particular Class

If you teach more than one mathematics class, please answer the questions in this section for *your first mathematics class of the day in which at least half of the students are in 10th grade,* and indicate here the class period during which this class meets: _______

4. What is the title of this class? ____

5. Which of the following best describes the duration of this class? *(Check one.)*

   ❑ year-long ❑ one-semester ❑ other: ___________________

6. How many days per week and minutes per day does this class meet (for mathematics)?

   a. Days per week *(check one):* ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

   b. Minutes per day: _______ minutes

7. How many total students are enrolled in this class? _______

8. How many 10th grade students are enrolled in this class? _______

9. How would you describe this class in terms of variation in student mathematics ability? *(Check one.)*

   ❑ fairly homogeneous and low in ability
   ❑ fairly homogeneous and average in ability
   ❑ fairly homogeneous and high in ability
   ❑ heterogeneous with a mixture of two or more ability levels

10. In this class, how many students are formally classified as each of the following? (Estimate if necessary.)

    a. English Learner/LEP? _____ b. Special Education? _____ c. Gifted and Talented? _____

11. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____% b. in pairs or groups? _____% c. individually? _____%

12. About how often do ***you*** do the following as part of mathematics instruction **in this class**? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b. Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c. Make provisions for students to work at their own pace or level	1	2	3	4	5
d. Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e. Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f. Assign homework for students to get practice	1	2	3	4	5
g. Assign special challenges/enrichment as homework	1	2	3	4	5
h. Go over homework with the class	1	2	3	4	5
i. Demonstrate how to solve a particular type of problem	1	2	3	4	5
j. Assess student progress to determine the need for additional instructional support	1	2	3	4	5

13. About how often do you ask **students in this class** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b. Practice computational procedures	1	2	3	4	5
c. Do mathematics in conjunction with other subjects	1	2	3	4	5
d. Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e. Read or work problems from a textbook	1	2	3	4	5
f. Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g. Discuss different ways to solve a particular problem	1	2	3	4	5
h. Generalize from particular problems to other situations	1	2	3	4	5
i. Complete worksheets	1	2	3	4	5
j. Work on non-routine, higher-order problems	1	2	3	4	5
k. Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l. Work problems mentally	1	2	3	4	5

14. About how often do you ask **students in this class** to participate in each of the following **whole-class** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b.	Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c.	View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d.	Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e.	Read aloud from a mathematics textbook	1	2	3	4	5
f.	Go on mathematics-related field trips	1	2	3	4	5
g.	Participate in class mathematics contests or games	1	2	3	4	5
h.	Other: ____	1	2	3	4	5

15. About how often do you ask **students in this class** to participate in each of the following **group** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work in pairs or small groups on mathematics problems/ exercises	1	2	3	4	5
b.	Work on group projects that extend for several days	1	2	3	4	5
c.	Make group presentations to the rest of the class	1	2	3	4	5
d.	Work in pairs or small groups at activity stations	1	2	3	4	5
e.	Work in pairs or small groups at computers	1	2	3	4	5
f.	Other: ____	1	2	3	4	5

16. About how often do you ask **students in this class** to participate in each of the following **individual** activities during class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work individually on mathematics problems/exercises	1	2	3	4	5
b.	Work on individual projects that take several days	1	2	3	4	5
c.	Make individual presentations to the rest of the class	1	2	3	4	5
d.	Write in a mathematics journal	1	2	3	4	5
e.	Work individually at activity stations	1	2	3	4	5
f.	Work individually at computers	1	2	3	4	5
g.	Other: ____	1	2	3	4	5

17. About how often do you ask **students in this class** to participate in each of the following **technology-related activities** (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

18. About how often do you test **students in this class** using each of the following types of **assessment**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of short problems to solve	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

19. On average, how often do **you** use each of the following in your mathematics instruction in this class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

20. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in this class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	________
b.	Increased awareness of real-world mathematical applications	________
c.	Mastery of basic computational skills and facts	________
d.	Development of problem solving/inquiry skills	________
e.	Preparation for future mathematics courses	________
f.	Attainment of state or district content standards	________
g.	Preparation for use of mathematics in daily life	________
h.	Increased interest in mathematics	________
i.	Development of mathematical reasoning ability	________
j.	Preparation for standardized tests	________
k.	Use/application of mathematics in other subject areas	________
l.	Other: ____	________

21. Listed below are a number of topics that might be taught in 10th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 absolute value	☐ 12 logarithms	☐ 23 sequences and series
☐ 2 binomial theorem	☐ 13 matrices	☐ 24 set theory
☐ 3 complex numbers	☐ 14 negative numbers	☐ 25 similar figures
☐ 4 congruent figures	☐ 15 polyhedra	☐ 26 simplification of expressions
☐ 5 coordinate geometry	☐ 16 polar coordinate system	☐ 27 statistics
☐ 6 deductive reasoning	☐ 17 polynomials	☐ 28 systems of equations
☐ 7 equations and inequalities	☐ 18 probability	☐ 29 trigonometric functions
☐ 8 exponents and roots	☐ 19 proofs	☐ 30 trigonometric identities
☐ 9 functions	☐ 20 quadratic equations	other: ________________________
☐ 10 inductive reasoning	☐ 21 quadratic formula	other: ________________________
☐ 11 irrational numbers	☐ 22 rational numbers	other: ________________________

22. a. Which of the following do you use as your **main curriculum resource** in this class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in this class?

Title ____

Publisher ___________________________________ Copyright Date (if known) _____________

23. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only mathematics class I teach.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in all of my other mathematics classes.
- ❑ My teaching in this class is representative of *some* of my other mathematics classes.

24. Are there any special circumstances or unusual conditions related to the teaching of mathematics to this class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

25. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

26. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b.	Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c.	The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d.	The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e.	There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f.	There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g.	Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h.	Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i.	Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j.	Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k.	The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l.	The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m.	The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

27. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

    a. Estimated number of **total** math professional development hours: ______ hours

    b. Estimated number of these hours **required by district**: ______ hours

28. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ______________________________	1	2	3	4	5

29. **Over the past five years**, which of the following have you participated in? *(Check all that apply.)*

- ❑ California Math Project
- ❑ Urban Systemic Initiative
- ❑ Local Systemic Initiative
- ❑ MathMatters
- ❑ Math Renaissance
- ❑ MRK12
- ❑ Woodrow Wilson Workshops
- ❑ Other: __________________
- ❑ none

30. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

31. About how often does each of the following occur at your school? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Teachers share ideas about mathematics instruction.	1	2	3	4	5
b. Teachers observe one another teaching mathematics.	1	2	3	4	5
c. Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d. Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e. A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

32. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics

- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: ________________

College Mathematics

- ❑ Calculus (# of smstrs: _______)
- ❑ Linear algebra
- ❑ Modern algebra
- ❑ Discrete mathematics
- ❑ Real analysis
- ❑ History of mathematics
- ❑ College geometry
- ❑ Computers in mathematics
- ❑ Probability and statistics
- ❑ Other: ____________________

Mathematics Education

- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Other: ______________________

33. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

Master's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

Doctoral Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: _________________

34. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❑ multiple subject teaching credential
- ❑ general or standard elementary credential
- ❑ emergency multiple subject teaching permit
- ❑ emergency teaching permit in mathematics
- ❑ internship credential (multiple subject)
- ❑ internship credential in mathematics
- ❑ credential waiver
- ❑ single subject credential in mathematics
- ❑ single subject credential *not* in mathematics
- ❑ standard secondary credential in mathematics
- ❑ standard secondary credential *not* in mathematics
- ❑ general secondary credential
- ❑ other: _______________________________

b. Do you have a supplementary authorization in mathematics? ❑ yes ❑ no

35. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____

VI. Teacher Demographic Information

36. Are you: ❑ male ❑ female

37. Are you:

- ❑ African American (not of Hispanic origin)
- ❑ American Indian or Alaskan Native
- ❑ Asian or Pacific Islander
- ❑ Hispanic
- ❑ White (not of Hispanic origin)
- ❑ Other: ______________________

VII. Additional Comments (Optional)

38. What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?

____

____

____

____

39. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

40. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

41. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

42. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Appendix C

Profiles of Selected Top-Quartile Classes

Fourth-Grade Observed Top-Quartile Classes

Eighth-Grade Observed Top-Quartile Classes

Fourth-Grade Observed Top-Quartile Classes: Profile #1

Classroom Profile

School 1999 API Ranking: 1 (statewide); 2 (similar schools)
Class Size (according to questionnaire): 29 fourth-grade students
Classroom Composition (according to STAR data): Of 25 test-takers, 32% African American, 68% Hispanic; 48% LEP, 92% Free/Reduced Lunch; 8% Sp. Ed.
Mathematics SAT-9 Average Scaled Scores: 594 in 1999, up from 547 in 1998

The lesson observed in this classroom focused on equivalent fractions and the reduction of fractions to their simplest form. During the 30 minutes of observation time, the teacher engaged in instruction with the class as a whole. She appeared confident with the material and fluent with the use of manipulatives, which she modeled constantly to demonstrate how fractions "look" and to help students make sense of this mathematical concept.

The primary level of discourse in this classroom was between student and teacher. Class participation was initiated and maintained by the teacher calling on a variety of students to solve problems, both teacher-generated and textbook-derived. Individual students were asked to compute a problem on the board while the other students were working individually in their seats. After asking the student at the board to explain his/her answer, the teacher surveyed the class by asking students to raise their hands if they thought the problem on the board was solved correctly. If the answer was correct, the entire class applauded.

At times, the teacher would ask students individually to provide short answers to questions such as, "When you cut something in half, you divide by what?" Some wait time was used; however, if a student did not respond fairly quickly, the teacher would ask another student. One real-world application was used, in making a reference to a pie and eating portions of it.

During the lesson, the teacher circulated throughout the room to observe each student's work. Students were attentive and focused on the lesson.

In this classroom where approximately half of the students are LEP, the teacher used English when speaking with the class as a whole. The use of mathematical terminology was emphasized: the teacher used math terms frequently while posing questions to students, and students were asked to use the terminology in their explanation of how they arrived at an answer. The use of synonyms to describe concepts and the repetition of clear and concise terms were methods used by this teacher to address remedial needs. The teacher also "checked in" with particular students to see if they had questions or were unclear about something. During the interview, the teacher noted that the manipulatives are helpful in overcoming language barriers, and that she works one-on-one with two students who have very limited English skills.

Fourth-Grade Observed Top-Quartile Classes: Profile #2

Classroom Profile

School 1999 API Ranking: 4 (statewide); 10 (similar schools)
Class Size (according to questionnaire): 31 fourth-grade students
Classroom Composition (according to STAR data): Of 23 test-takers, 100% Hispanic; 91.3% LEP, 100% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 631 in 1999, up from 571 in 1998

The lesson observed in this classroom dealt with computational exercises, with a focus on the conversion of measurements. The teacher seemed to have a good understanding of and confidence in mathematics. For the first quarter of the lesson (25 minutes), the students worked on problems individually. During this time, the teacher circulated among the students. Following this was a whole-class review of the problems using an overhead projector (another 25 minutes of the lesson), during which the teacher questioned students about methods used to solve the problems.

The teacher then proceeded to provide instruction in measurement conversion, for another 20 minutes, through reviewing equations and applying them in sample problems which involved real-world examples (i.e., converting Shaquille O'Neil's height from feet to inches, and a baby's height from inches to feet). She then introduced, gave instructions, and did a demonstration for an activity where students were to figure out their own height in inches. For 15 minutes, students worked in pairs using rulers to measure each others' heights in feet and inches and then convert their height into inches. Following this, for 15 minutes, the teacher guided a whole-class graphing activity using data derived from the student measurements to create a histogram.

The focus of classroom discourse was on getting the right answers. There were some instances where some sense was being made of the mathematical concepts. In the second component of the lesson, the teacher exhibited equitable treatment for all segments of the class (e.g., gender, language ability, ethnicity) and provided students with ample wait time when they were called upon to respond to questions. To encourage all students to focus on the problems, while also providing LEP students the opportunity to hear and simultaneously see the problems, the teacher had students read the problems on the board aloud before addressing how they solved them. In addition, students were allowed to interpret for each other.

Assessment took place when the teacher interacted with students individually to monitor their understanding of a problem, and when she posed questions to students while reviewing their work.

The students in this classroom were very well behaved, and most seemed engaged and on-task. When asked in a follow-up interview to attribute the reasons for her students' success on the SAT-9, the teacher replied:

> *I really believe that once you've introduced a new concept in math, whether it be addition or subtraction, you can't just introduce it, work on it for a couple of weeks, and expect the children to have acquired the knowledge… It's not possible for them—they need time to practice. So, I essentially begin with addition, and begin to build. So, once I have completed addition, and move on to subtraction, I'll have subtraction problems daily, but I also have addition-subtraction. So it's like building a house. I lay the foundation, and I don't take away that foundation, I begin to build on top of that foundation. We never take away anything. So math gets progressively longer as the year goes on, because there's a lot more to do…. I never let go of a concept that has been taught prior to the new concept. And so by the end, they feel so comfortable, and they know exactly what to do, in every circumstance, because they've had months to practice…. I never stop reviewing—it's like a daily thing.*

Fourth-Grade Observed Top-Quartile Classes: Profile #3

Classroom Profile

School 1999 API Ranking: 4 (statewide); 7 (similar schools)
Class Size (according to questionnaire): 28 fourth-grade students
Classroom Composition (according to STAR data): Of 24 test-takers, 100% Asian; 50% LEP, 16.7% GATE, 87.5% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 658 in 1999, up from 629 in 1998

During this classroom observation, the teacher began the lesson with 10 minutes' worth of teacher-directed warm-up exercises involving number "puzzles." In the first one, the teacher wrote "4-1=5-1=6-1=7-1=8" on the board and asked, "Is this true?" He then related the puzzle to the number of sides of various polygons that would be generated if a corner were to be cut off. For the second exercise, the teacher asked, "If we cut a cake three times, what is the greatest number of pieces you can get? Imagine." In response, a few students went up to the board to draw diagrams producing 6 "pieces" and then 8 "pieces."

Following these puzzles, the teacher used the board and spent three minutes modeling how to solve equations involving fractions. (As the teacher sat on a stool, several students were unable to see the board because they were blocked by the teacher's body.) He then involved students in an interactive activity involving fractions, where students holding fraction cards were asked to pair up with fellow students holding a card with the same value, and then pair up with other fellow students to add up to 1. When students made mistakes, the teacher probed to a limited extent. About 3/4 of the students participated in this activity at first, during which time those who remained seated seemed to pay attention but the teacher did not involve them. The teacher brought up to the board one group that was having difficulty, and asked one student if he knew why 1/3 + 1/3 + 2/6 = 1. When the student replied "no," the teacher said that he would talk with him later. To address the dilemma that one group of students had refrained from participating in the activity, the teacher asked the group to come to the front of the room so that other students could help them do the activity. When the two groups changed places, those who returned to their seats spent the time socializing.

The teacher then proceeded to model and review some problem-solving techniques on the board, which included drawing pictures and reviewing the meaning of the symbols for "more than" and "less than." Students were then given a worksheet that involved comparing fractions and recognizing equivalent fractions. Most students began working on the worksheet. During this time, the teacher brought a student up to the board and showed him how to solve a problem, explaining the concepts in Chinese.

The students did not ask questions during the lesson. The discourse in this classroom was limited to the teacher asking closed-ended questions at several points during the lesson. The students were all extremely well-behaved.

Fourth-Grade Observed Top-Quartile Classes: Profile #4

Classroom Profile

School 1999 API Ranking: 8 (statewide); 10 (similar schools)
Class Size (according to questionnaire): 31 students total; 15 fourth-grade students (4/5 combo)
Classroom Composition (according to STAR data): Of 13 fourth-grade test-takers, 7.7% Hispanic, 92.3% white; 23.1% Free/Reduced Lunch; 7.7% Sp. Ed.
Mathematics SAT-9 Average Scaled Scores: 664 in 1999, up from 624 in 1998

At the beginning of this observation, the class was starting the group lesson after spending 30 minutes doing their daily *Excel* worksheet. The lesson began as a whole-class discussion which focused on percentages and used about 1/3 (17 minutes) of the observation time. The purpose of the lesson was for students to gain a better understanding of what fractional parts look like. The teacher first elicited ideas about how to find the area of a rectangle without counting the boxes inside. This led to a discussion of how one might shade a percentage of the box. The teacher called on many students during the discussion in an attempt to determine their level of understanding prior to the activity. When questions were posed, many students were allowed to explain their reasoning, and the teacher often probed for clarity or deeper understanding. She made generous use of "wait time." The discussion introduced and included instructions for the activity that followed.

In the remainder of class time (33 minutes), students worked in pairs to draw different shapes and shade a percent of each one. Students were allowed to choose their own representations of percents. During this time, the teacher circulated throughout the room. Within and between groups, students discussed and shared ideas and explanations. The two LEP students in the class were paired together so they could work with the classroom aide.

Assessment was ongoing through the lesson. The teacher called on many students during the discussion, and during the activity she visited each group and monitored understanding, asking students to explain their thinking. Students were asked to reflect on what they learned: as homework, students were to describe in their journal what they know about size and percent. The class was well-behaved and respectful.

During the interview, the applicability and relevancy of the lesson became apparent. The teacher explained that the students had been doing math surveys and will need to graph their results, and she feels they will be able to interpret their results with more understanding if they have a clear conceptual understanding of fractions and percent.

Eighth-Grade Observed Top-Quartile Classes: Profile #1

Classroom Profile

School 1999 API Ranking: 7 (statewide); 6 (similar schools)
Class Size (according to questionnaire): 36 eighth-grade students
Classroom Composition (according to STAR data): Of 31 test-takers, 9.7% African American, 12.9% Asian, 22.6% Hispanic, 51.6% white; 19.4% LEP, 19.4% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 689 in 1999, up from 659 in 1998
Course: Math 8

The purpose of the lesson observed was to extend the concept of combining like terms when adding polynomials. This included checking homework for the first l4 minutes of class. After the homework review was finished, a worksheet was handed out and the teacher modeled several problems using the overhead projector. He told those who understood to continue alone or with a partner while he continued to model more problems. The organization of the class remained the same throughout the period: the teacher remained at the overhead and demonstrated problems while the students worked at their desks. The teacher encouraged students to draw models to simplify the problems but there was no dialogue around the models. Most of the work was practice of a procedure.

The teacher monitored student understanding throughout the lesson by asking individual students to talk him through a problem or by asking for a show of hands from those who either did or did not understand. He did not probe for students to explain their thinking but asked questions that elicited simple responses (e.g., “Which one should I do?” “What is the answer?”)

The teacher was very organized and his expectations were very clear. The students seemed very comfortable with the class—even those who were struggling.

Eighth-Grade Observed Top-Quartile Classes: Profile #2

Classroom Profile

School 1999 API Ranking: 3 (statewide); 4 (similar schools)
Class Size (according to questionnaire): 28 eighth-grade students
Classroom Composition (according to STAR data): Of 23 test-takers, 26.1% African American, 39.1% Hispanic, 8.7% white, 26.1% other; 4.4% LEP, 21.8% GATE, 56.5% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 690 in 1999, up from 676 in 1998
Course: Integrated Math 1

The lesson observed in this classroom focused on building student understanding of factoring binomial expressions.

This teacher-guided, demonstration lesson built upon students' previous work with solving algebraic equations. With the use of Algebra tiles, students connected the abstract distributive property to the concrete by relating the dimensions of the rectangle formed with Algebra tiles to the area of the entire rectangle. Following some vocabulary review, the class used the tiles to "work backwards" to find common factors in the area of the rectangle to come up with the dimensions of the rectangle. Students extended this process to factor more complex binomial expressions.

The class began with a five-problem warm-up displayed on the overhead. The students worked on the problems and then the teacher explained the solutions to the problems using traditional algebraic algorithms.

Next a transparency was used to display the answers to the previous day's assignment. The teacher responded to questions and explained procedures. At one point, a student corrected an error the teacher made and was rewarded with a piece of candy.

The teacher then reviewed how Algebra tiles can be used to find areas (the distributive property) and segued into how the tiles can be used to factor (undo the distributive property). The teacher provided examples of expressions and asked for common factors. She provided one factor and asked students to find the others. Students were engaged as they worked on these examples—some worked independently and asked for harder problems while others clearly needed the assistance being provided by the teacher.

At the end of the period, the teacher used the previous day's homework as the base for a short quiz. She put the numbers for five of the homework problems on the board and asked students to copy their solutions to these five problems on a separate sheet of paper.

The teacher seemed both confident and competent in her teaching, using terminology such as "numerical coefficients" accurately and describing processes correctly. She guided the students at a seemingly quick pace, asked questions that required short answers, and did not encourage discussions or student explanations (which may have been due to this being a review). The classroom discourse was primarily teacher directed.

Eighth-Grade Observed Top-Quartile Classes: Profile #3

Classroom Profile

School 1999 API Ranking: 3 (statewide); 3 (similar schools)
Class Size (according to questionnaire): 34 eighth-grade students
Classroom Composition (according to STAR data): Of 27 test-takers, 100% Hispanic; 96.3% LEP, 81.5% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 650 in 1999, up from 628 in 1998
Course: 8^{th} Grade Math Bilingual

The purpose of the lesson observed was to introduce students to the use of tree diagrams in solving probability problems.

At the beginning of the period, the students worked individually on warm-up problems while the teacher moved around the room checking homework and talking with students about individual problems. The warm-up problems involved supplying the missing measures of angles and sides in right triangles when the length of two sides was given. When the warm-up problems were completed, the class discussed them as a whole.

A brief presentation by the teacher on tree diagrams preceded the main class activity. In the remainder of the class the students worked through two extensive examples of tree diagrams: one involved the various combinations of three different types of dolls and the other had to do with a three-color spinner and a coin. For each example, the students constructed the tree diagram by starting as a class and then finishing it individually. They then answered several questions about probabilities based on the diagram, such as "What is the probability of spinning red and flipping heads?" Some students used calculators.

Throughout the activity, the teacher assessed student understanding by questioning students and listening carefully to their answers. When students provided an incorrect answer, the teacher probed for understanding and led the students to the correct answer. Later on, when one student said he didn't understand something, the teacher provided an explanation.

The students appeared to be comfortable answering questions, discussing answers, correcting each other, and asking questions. The entire class was conducted in Spanish. The teacher was confident and inspired confidence on the part of her students. During the interview she said, "Anybody is able to do mathematics, as long as they put the effort in."

Eighth-Grade Observed Top-Quartile Classes: Profile #4

Classroom Profile

School 1999 API Ranking: 6 (statewide); 6 (similar schools)

Class Size (according to questionnaire): 35 students total; 23 eighth-grade students (7/8 combo)

Classroom Composition (according to STAR data): Of 24 eighth-grade test-takers, 12.5% Asian, 41.7% Hispanic, 33.3% white, 12.5% other; 16.7% GATE, 45.8% Free/Reduced Lunch

Mathematics SAT-9 Average Scaled Scores: 699 in 1999, up from 672 in 1998

Course: Algebra Topics

The primary purpose of the lesson observed was for students to learn that there may be more than one way to approach a problem and that for some problems there may be multiple solutions. The specific focus was on the use of diagrams as a tool for solving problems.

The first few minutes of the period were spent on taking roll and preparing for the homework review. Students checked their homework problems as the teacher provided the correct answers. Whenever a student had a question, the teacher would work the problem using the overhead projector; other students would assist the teacher as she solved the problem. One problem involved pattern recognition and estimation as a way to save time in finding the correct answer. The teacher had students guess a number she had picked to show how high and low estimations were used to inform subsequent estimations. She likened the estimation process to the game show "The Price is Right." The homework review lasted 20 minutes.

The next activity was a game where students formed four groups of 6 to 8 students each. Each person was to join hands with another non-adjacent person in the group. When all connections were completed, the group was to untangle itself to form a circle. When the game ended, the teacher explained that how quickly a group got untangled was a function of how the arms were joined and not a function of how smart they were. She also noted that in each group someone usually emerges as a leader.

Following the group-building exercise, the class focus was on solving story problems from the textbook. The teacher, with student input, demonstrated how to approach some of the problems using the overhead projector. These problems had more than one possible solution and involved the use of diagrams. Then students worked individually on the remainder of the problems as homework.

The teacher appeared confident and knowledgeable about the material. She could easily explain mathematical concepts in a variety of ways to help students understand.

In terms of making sense of mathematics, the teacher was good at providing alternative examples and real world applications for students, yet never required students to come up with their own examples.

When asked in a follow-up interview to attribute the reasons for the success of this class, the teacher commented that previously, the students had not been challenged, having been in classes that had not been "stretching their abilities." She also mentioned her 30 years of teaching experience and the inclusion on the SAT-9 of many of the topics covered in the class. The school principal, when asked the same question, discussed efforts made by the mathematics department as a whole:

> *The year before, the students [in the school] didn't do well on computation and context. As a department, the math teachers got together, and put more emphasis on computation as well as the other concepts, and it paid off…We gained about 13 percentile points in math. So, it was just working with the students, taking them from where they are, and moving from that point to get them to succeed. It was a schoolwide phenomenon.*

Indeed, the other class observed in this school also fell into the top achievement quartile.

Eighth-Grade Observed Top-Quartile Classes: Profile #5

Classroom Profile

School 1999 API Ranking: 10 (statewide); 5 (similar schools)
Class Size (according to questionnaire): 32 students total; 22 eighth-grade students (7/8 combo)
Classroom Composition (according to STAR data): Of 22 eighth-grade test-takers, 45.5% Asian, 13.6% Hispanic, 36.4% white; 40.9% GATE
Mathematics SAT-9 Average Scaled Scores: 751 in 1999, up from 747 in 1998
Course: Integrated Math 1

The lesson began with a 13-minute warm-up exercise that connected the concept of volume to the story of *Gulliver's Travels.* The students worked individually and then the entire class reviewed the problems. Next, the teacher asked if there were any questions about the homework from the previous night. There were none, so the next homework assignment was discussed for a few minutes.

The remainder of the period focused on building a conceptual understanding of volume and the relative volumes of various three-dimensional shapes (prism, cone, and pyramid). A review of the names of the shapes took place and then the students were asked to guess how many of the cones could fit into a cylinder (with bases of the same diameter). Two student volunteers then filled the cylinder and cone with water to determine the relative volumes of each container. Then the class discussed the relative volume of different sized-cones. This activity involved work on two problems displayed on a transparency: one concerning two cones with the same size base but one of twice the height; the other was about two cones having the same height but one having a base with half the radius of the other.

Next the students worked in groups of four where each student had a specific role. They concentrated on a problem from the textbook about the relationship in volume between a pyramid and a rectangular prism where they needed to construct each type of shape using stiff paper, scissors, and tape and use rice to compare volumes. Most of the students were engaged in the activity and interacted collaboratively within their groups and with other groups. During this time, the teacher circulated, monitoring the activity and addressing student questions. The students did not finish the exercise, largely due to an error that nearly all of the groups made in constructing their shapes. At the end of the class, students put their materials away and were told they would talk about what went wrong tomorrow. The class ended with a brief discussion of question, "What would you *expect* for the volume of the pyramid as compared to the prism?"

Classroom discourse focused on making sense of mathematics and the students were invited to hypothesize about answers to problems.

Appendix D

Findings from the Grade 10 Exploratory Study

Preliminary Findings

Major Issues

Recommendations

Preliminary Findings

The sample used in this exploratory study was very small—four teachers and two school sites within a single district—and thus the data cannot be generalized at all to the larger population of high school mathematics teachers. Nonetheless it is interesting to note several themes that emerged through interviews of the teachers, their department chairs, and principals:

- ♦ Articulation is an important issue for high school mathematics teachers. Teachers are concerned with vertical articulation, such as how middle schools prepare students for success in high school mathematics and how content flows from course to course within the high school program. Teachers' decisions about pacing and emphasis of topics are also affected by horizontal articulation stemming from departmental agreements about scope and sequence of individual courses.
- ♦ A great deal of collaborative planning and sharing of materials exists within mathematics departments.
- ♦ Professional development opportunities are valued as long as they do not take teachers away from their classrooms; the previously funded staff development days are missed.
- ♦ Teachers' practices have been greatly influenced by national forces such as the NCTM Standards, listserves for calculus teachers, and the online Math Forum at Swarthmore.
- ♦ High school teachers are familiar with the pressures of several accountability forces: WASC accreditation, college entrance requirements, the mathematics portion of the Scholastic Aptitude Test (SAT), Golden State Exams, the state's STAR program and SAT-9, the upcoming high school exit exam, and teachers of the next course.
- ♦ The ninth-grade class size reduction policy has had a positive impact on Algebra classes.
- ♦ High school mathematics teachers are quite articulate when describing how they decide what they are going to teach in a course and how they determine the emphasis to be placed on particular content or processes.

Major Issues

A major issue for conducting a study at the high school level is whether to focus on the grade level, such as tenth grade, or on a single course. If the focus were to be on tenth grade, then the study would provide a snapshot of the various mathematics courses in which tenth grade students enroll and the data from the mathematics portion of the tenth-grade (base)

SAT-9 could be used. In such a study, however, specific teacher attribution for student achievement would not be possible because the test does not reflect the curriculum of individual courses. If the focus of the study were to be on a course in which many tenth-grade students are enrolled, then data concerning teacher practice, materials, and policy influences are easier to compare. Also, student data from the augmented portion of STAR might be useful for relating student achievement to instruction. However, the augmented tests are not norm-referenced, and the (base) SAT-9 would still not be useful for correlating instructional practice to achievement.

Another issue for a grade 10 study involves the growing number of high schools that use some variation of block scheduling and whether to include or exclude them from the sample. In schools where an entire yearlong course is completed in one semester, a number of issues arise concerning teacher practice and timing of the SAT-9. In such a school, some students would have completed the entire geometry course before taking the SAT-9 in spring and others would only be halfway through the course. In such a school, teacher practice may be quite different than in schools with more traditional yearlong courses.

Recommendations

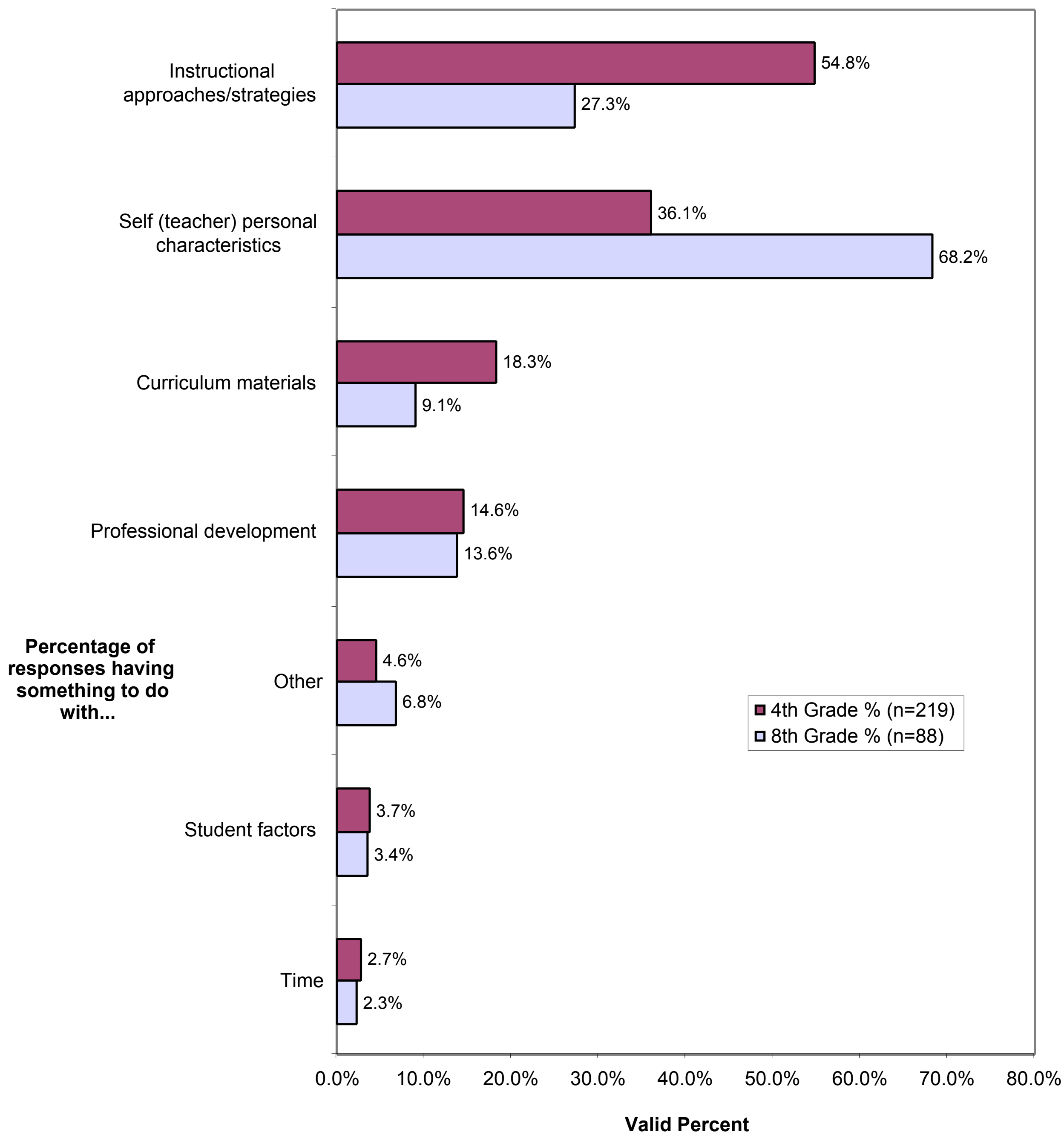
As previously discussed, several issues are involved in a study that uses student achievement data from the SAT-9 to look at the relationship between student achievement in mathematics and teacher practice, instructional materials, and policy at the high school level. One possibility for dealing with these issues is to consider a study that focuses on entire mathematics departments instead of individual teachers. A mail survey similar to that used in the fourth- and eighth-grade study could be conducted using a revised teacher survey instrument. A subset of schools would be chosen for further data collection through interviews and classroom observations that would help form a more complete profile of mathematics departments. Student achievement scores in mathematics for ninth- through twelfth-grade students could then be analyzed in relation to the influence of the mathematics department as an entity.

(This page intentionally left blank.)

Appendix E

Additional Figures

Figure E1
Responses to "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?"[1]



[1] On the eighth-grade questionnaire, the question was, "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"

Figure E2
Responses to "What are the biggest obstacles to your mathematics teaching?"

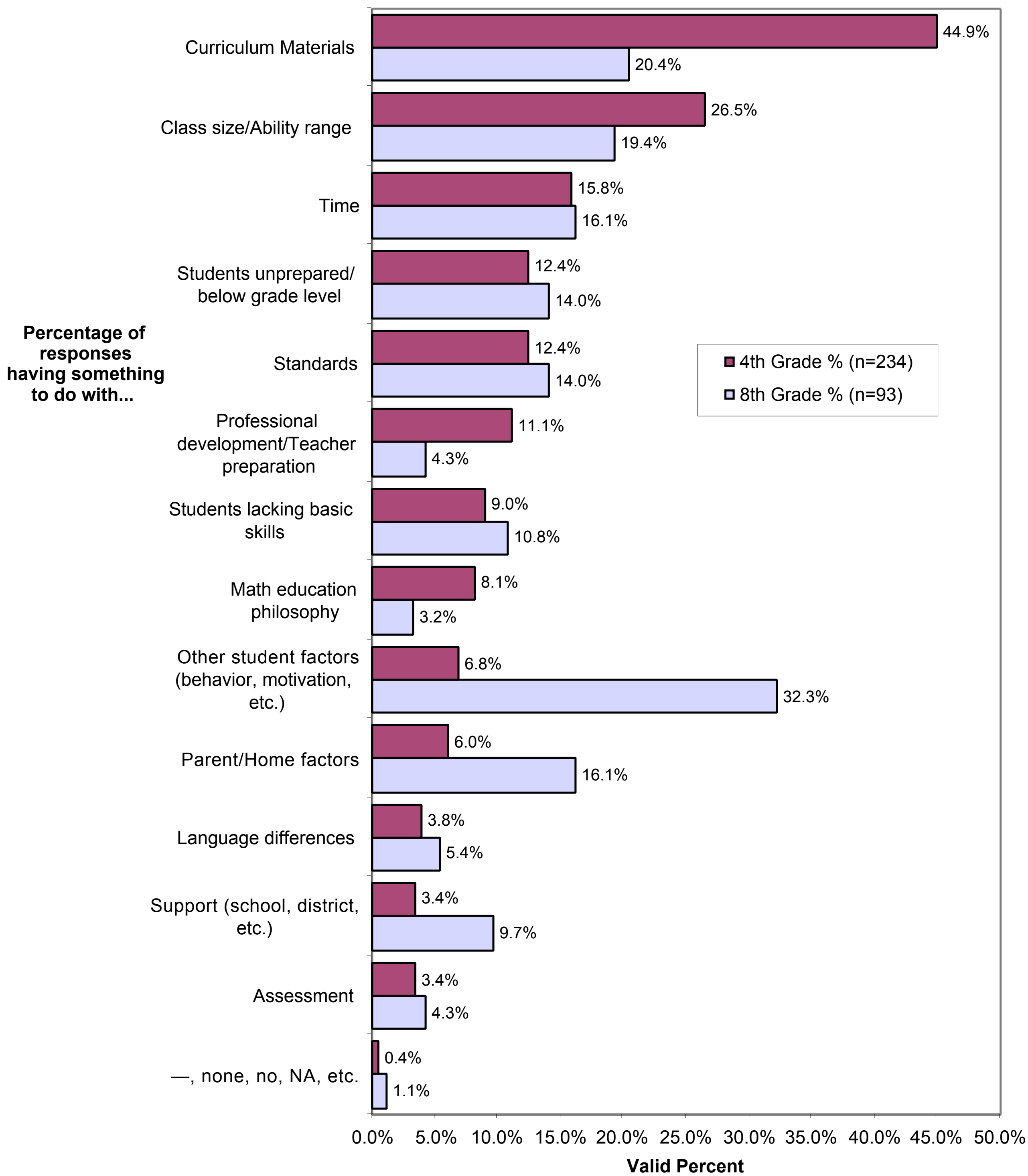


Figure E3
Responses to "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe"

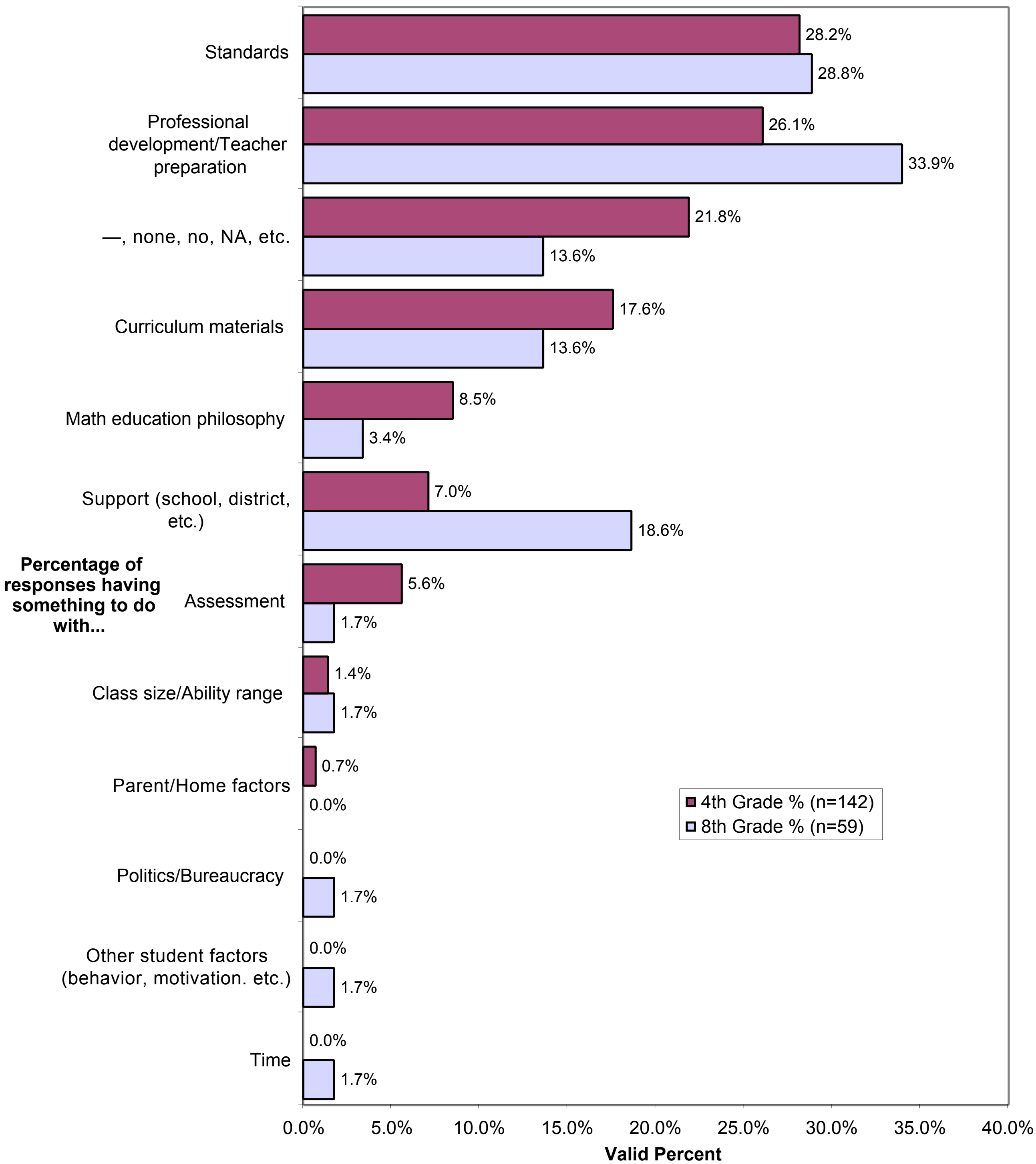
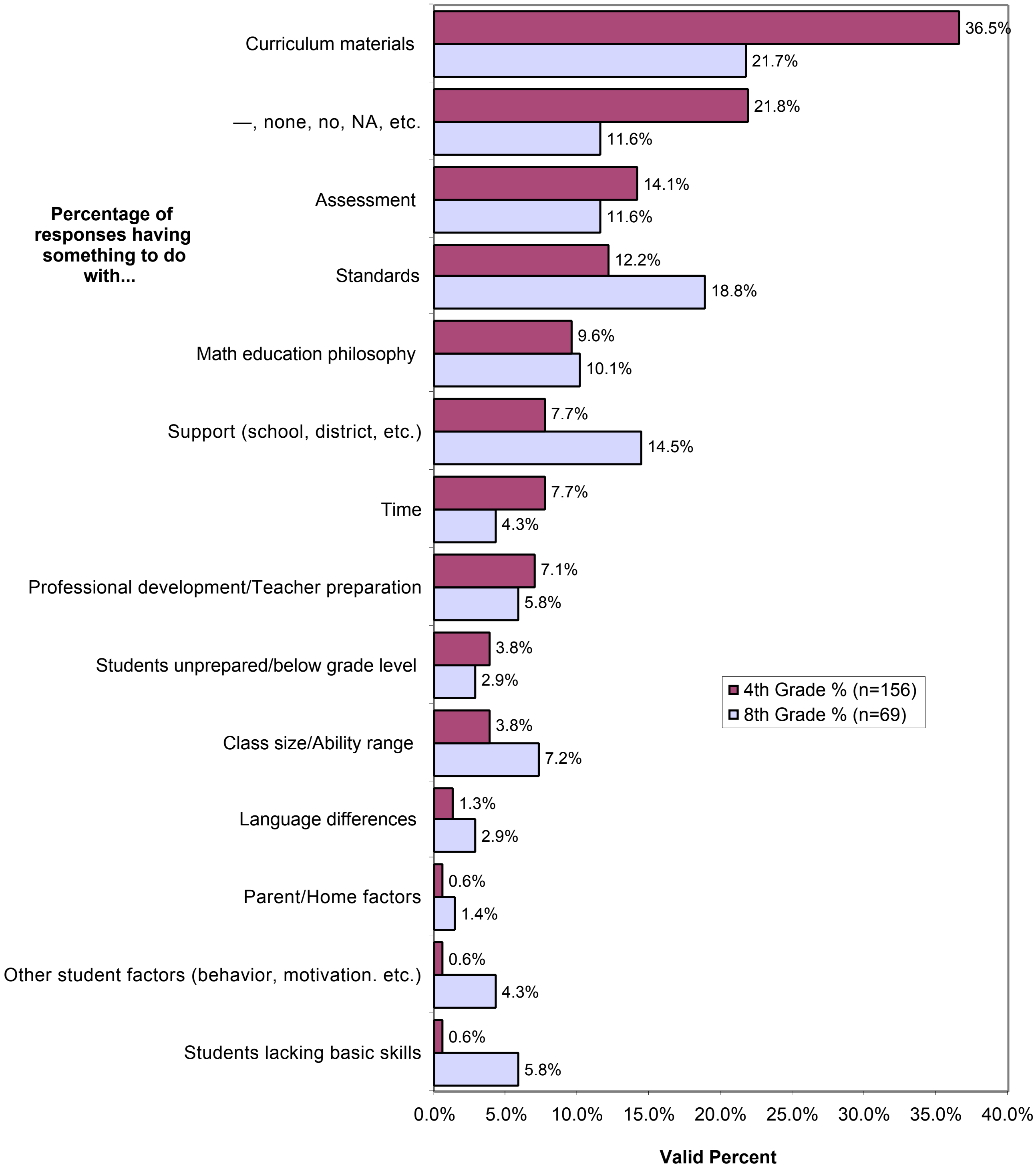


Figure E4
Responses to "If there are specific state, district, or school policies that have *hindered* your mathematics teaching, please describe"



(This page intentionally left blank.)

Mathematics Implementation Study

Final Report

June 2000

Deborah J. Holtzman
Tania J. Madfes
Steven A. Schneider

Vi-Nhuan Le
Daniel McCaffrey
Marika Suttorp
Laura Hamilton
Stephen Klein

James R. Smith
Gerald C. Hayward
Naomi Calvo

California Department of Education

Delaine Eastin, State Superintendent of Public Instruction
William Padia, Director, Office of Policy and Evaluation
Larry Boese, Contract Monitor, Office of Policy and Evaluation
http://www.cde.ca.gov/ope/

Research Team

WestEd
Deborah J. Holtzman
Tania J. Madfes
Steven A. Schneider

935 El Camino Real
Menlo Park, CA 94025
(650) 752-1400
http://www.wested.org/

RAND
Vi-Nhuan Le
Daniel McCaffrey
Marika Suttorp
Laura Hamilton
Stephen Klein

1700 Main Street
Santa Monica, CA 90407
(310) 393-0411
http://www.rand.org/

Management Analysis and Planning, Inc. (MAP)
James R. Smith
Gerald C. Hayward
Naomi Calvo

508 2nd Street, Suite 205
Davis, CA 95616
(530) 753-3130
http://www.edconsultants.com/

Advisory Group

Joan Akers
Mathematics Researcher

Judy Anderson/Ruth Cossey
California Math Council

Nicholas Branca
San Diego State University

Maria Carroll
Oakland Unified School District

Kathlan Latimer
Fairfield-Suisun Unified School District

Robert Manwaring
Office of the Legislative Analyst

Donna O'Neil/Chris Westphal
San Juan Unified School District

Special thanks to Gloria Guth, Brenda Hamilton, Jeanne Elliott, Patty Armstrong, Ann Muench, David Ditman, Pam Tyson, Marianne Smith, Lori Riehl, Jackie Vargo, and all others who assisted with the project and the preparation of this report.

The research reported in this document was supported by a contract to WestEd from the California Department of Education, Office of Policy and Evaluation (Contract #7398, "Mathematics Implementation Study"). The views expressed in this report are those of its authors and are not necessarily shared by the California Department of Education.

Table of Contents

(This page intentionally left blank.)

List of Figures

(This page intentionally left blank.)

Executive Summary

Background

In the spring of 1998, the California Department of Education (CDE) awarded a contract to WestEd, in partnership with the RAND Corporation and Management Analysis and Planning, Inc. (MAP), to study mathematics instruction in California. The study was designed to examine the instructional practices used in teaching mathematics in grades 4 and 8, the relationship between instructional practices and student achievement, and the influence of state and local policies on instruction. In addition to instructional practices, primary focuses of the study included curriculum materials, standards, assessment, professional development, and structural and student influences on instruction.

The key data-collection activity of the study was the spring 1999 administration of an extensive survey about teachers' mathematics instructional practices, professional development, and professional background to 800 fourth-grade and eighth-grade teachers in 11 California school districts. Researchers then statistically correlated the survey responses with mathematics achievement data of the responding teachers' students to look for associations between practice and achievement, controlling for prior year achievement and demographic factors. The student mathematics achievement data were from the Stanford Achievement Test, Version 9 (SAT-9). Classroom observations and interviews conducted with teachers, school administrators, and district personnel supplemented the quantitative analysis by providing depth to and context for the findings.

Major Findings

Instructional Practices and Effectiveness. The analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found very few relationships between specific instructional practices and student achievement, and those that were found were very weak. Classroom observations, similarly, found a wide range of practices among teachers of both higher-achieving classes and lower-achieving classes. While these findings do not necessarily prove that no strong relationship between practice and achievement exists, they do suggest that at the very least, the relationship is complex and not easily identified. There does not appear to be a particular instructional method that, even if widely implemented, would improve student mathematics achievement throughout the state.

Teachers themselves identified several different types of practices—and the use of a variety of practices *per se*—as contributing the most to their instructional effectiveness in mathematics. Most teachers appear to value an approach that balances computational mastery and conceptual understanding, and they seek further ideological and practical support for the implementation of this type of balanced approach.

Curriculum Materials. Although curriculum materials often play the major role in shaping instruction, many teachers expressed grave concerns about the programs their districts have adopted and said that they often use other programs—such as those from earlier adoptions or materials intended to be supplementary—instead of or in addition to the adopted programs. Teachers' main concerns about the adopted programs (most of which were from the state's 1994 adoption list) were that they are difficult to use, lack balance between computational skills and conceptual thinking, or are not aligned with current standards and assessments. Teachers who had engaged in materials-related professional development were more likely to use the adopted materials.

Standards. While most teachers liked the *idea* of standards as a guide to instruction, many thought that the currently adopted state standards are too ambitious. Teachers' familiarity with particular standards documents was highly variable, and there was considerable confusion, and some frustration, about different sets of standards (e.g., district, state, national). In general, as of the 1998–1999 school year, content standards had not yet made a consistent, significant impact on instruction at the classroom level.

Assessment. In contrast to standards, the SAT-9 has made a significant impact on schools and teachers, frequently appearing as a major driver of instruction. The test has, however, been the cause of much anxiety at the school level, partly because of a perceived lack of alignment with content standards and with curriculum. Many teachers feel that they are being compelled to "teach to the test" and think that this may not be in students' best long-term interests.

Professional Development. Unsurprisingly, fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers. Moreover, very few fourth-grade teachers who were surveyed reported having strong background in mathematics, and some identified a lack of familiarity with mathematics as being an obstacle to their instructional effectiveness. Many teachers at both grade levels indicated that professional development activities had helped their mathematics teaching, and said they would like more professional development and collaborative opportunities. Providing effective professional development for all teachers of mathematics is, however, a major challenge.

Structural and Student-Related Influences on Instruction. Many teachers identified structural factors, such as those relating to time and class size, as obstacles to their instruction. Teachers' concerns about class size, however, appeared to be as much about variation in student ability as about large classes *per se.* Additional factors identified as obstacles included students' lack of preparation, particularly in basic mathematics skills, poor student behavior and motivation, and lack of parent involvement or support.

Recommendations

The main recommendations that emerge from the findings are as follows:

1. At present, the State Board should not attempt to support a particular methodological approach through its selection of professional development activities or curriculum materials, other than a general advocacy of a "balanced" instructional program. Further research, preferably taking a longitudinal approach and using multiple measures of achievement, is needed to investigate the relationships between instruction and achievement. The State Board and the Legislature should recognize the need for more in-depth, high-quality research and should commit the necessary funds.

2. The State Board should establish a procedure for periodically reviewing the mathematics standards and framework in light of implementation problems, with input from classroom teachers. Districts should provide all teachers with a single set of unambiguous standards, including both content standards and performance standards.

3. The State Board and the Curriculum Commission should ensure that the curriculum materials that are available to teachers are aligned with standards, accommodate the wide range of student needs, and enable the presentation of a balanced instructional approach. To maximize the actual use of the materials and the effectiveness of their implementation, teachers should be provided with opportunities and incentives to engage in professional development related to the use of materials.

4. The State should provide sufficient resources for every California teacher of mathematics to participate in high-quality, sustained professional development. Professional development should attend both to mathematics content and to pedagogy. In addition to the use of materials, professional development should relate to the instructional implementation of the standards and framework in the classroom.

5. The State should continue to improve and augment the STAR program so that its components are properly aligned with state standards.

6. The State should "stay the course." Planning should take a long-term view, focusing on developing and revising policies based on feedback and research; the first hint of less-than-desired student performance should not be considered cause for an abrupt change of direction. The State Board and the Legislature should also take care to ensure that all of the current state education policies are aligned with and support one another.

7. The State Board should set a positive tone for professional discussion and policy debate. Representatives of all stakeholder groups should be "at the table," and a wide range of perspectives should be considered.

(This page intentionally left blank.)

Chapter 1

Introduction

In the spring of 1998, the California Department of Education (CDE) awarded a contract to WestEd, in partnership with the RAND Corporation and Management Analysis and Planning, Inc. (MAP), to study mathematics instruction in California. The study was designed to examine the instructional practices used in teaching mathematics in grades 4 and 8 and the influence of policy on instruction. The findings of the study, which was conducted from June 1998 through June 2000, are reported in this document. Implications for policy are presented as well.

The study focused on the following major research questions:

- What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

- To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

- What influence do state and local policies have on instructional practices? (e.g., policies relating to materials adoption, standards, assessment, etc.)

The original Request for Proposal (RFP) issued by CDE called for a highly comprehensive study at grades 2, 4, 8, and 10 with methods similar to those used in the Third International Mathematics and Science Study (TIMSS). However, the limited resources available necessitated a study somewhat more limited in scope and in the methods used. A detailed discussion of the employed methodology is provided in the following chapter. Key elements were a survey of 800 teachers about their instructional practices, a statistical analysis linking the survey responses with the mathematics achievement data of the responding teachers' students, and observations and interviews with 55 of the surveyed teachers. The study focused on grades 4 and 8 in 11 California school districts.

The RFP also discussed the importance of collecting baseline data about teachers' practices and the influences upon them prior to the emergence of new policies affecting mathematics education. However, several of these new policies were adopted prior to the study's main data collection activities, complicating the effort to establish a baseline. In fact, the study found that many teachers reported greater familiarity with the new policies—such as the California Mathematics Content Standards adopted by the State Board of Education in 1997 and the 1998 California Mathematics Framework—than with earlier policies and documents, such as the 1992 Framework. (Teachers' familiarity with these documents, and the extent to which the documents have influenced instruction, is further discussed in Chapter 5, "Content Standards.") The flux in policy—and the simultaneous existence of policies that sometimes appear contradictory—not only complicates research efforts, but also creates challenges for teachers, as this report reveals.

Subsequent chapters of this report are as follows:

Chapter 2, Methodology: Describes the study's research methodology and data collection instruments.

Chapter 3, Instructional Practices and Effectiveness: Presents and discusses quantitative and qualitative study findings on correlations between instructional practices and student achievement.

Chapter 4, Curriculum Materials: Presents study findings on the extent to which district-adopted curriculum materials are used by teachers and discusses teachers' concerns about instructional materials.

Chapter 5, Content Standards: Presents and discusses study findings on teachers' reactions to and familiarity with various standards documents, the impact of standards on instruction, and the alignment of standards with curriculum.

Chapter 6, Assessment: Presents and discusses study findings on the impact of the Stanford Achievement Test, Ninth Edition, Form T (SAT-9) and on perceived problems with this and other assessments.

Chapter 7, Professional Development: Presents and discusses study findings on the amount of professional development teachers reported having received since January 1998, the ways in which teachers report that professional development enhances their instruction, and the challenges of providing effective professional development on a wide-scale basis.

Chapter 8, Structural and Student Influences on Instruction: Presents and discusses study findings on the influences on instruction that are structural, such as those relating to time and class size, and that are student-related, such as those concerning student preparation, skill level, behavior, and motivation.

Chapter 9, Recommendations and Conclusions: Summarizes the study's primary findings in relation to the research questions, discusses policy implications, and presents recommendations based on the findings and implications.

To assist the reader, chapters 3 through 8 each begin with a box highlighting primary findings, followed by a section providing the recent historical background and policy context for the topics discussed in the chapter.

Chapter 2
Methodology

The classroom (grades 4 and 8) constituted the primary unit of analysis for this study. Researchers also focused some attention on the school, district, and state levels, primarily through interviews. A mix of quantitative and qualitative methods were employed. The key quantitative activity was the administration of an extensive survey about teachers' mathematics instructional practices, professional development, and professional background to 805 California teachers; researchers then statistically correlated the survey responses with the SAT-9 data of the responding teachers' students. On the qualitative side, researchers conducted classroom observations of and interviews with 55 teachers and interviewed the principals at the schools of these teachers. District- and state-level interviews were also conducted.

The study and its instruments were designed around a common core of topics based on the project's major research questions. Thus, the data yielded by the survey, interviews, and classroom observations could be triangulated to confirm and enrich the findings. Nevertheless, each of the data sources yielded some different information so as not to be completely redundant. All, however, addressed the important ideas embodied in the research questions.

Teacher Survey

A survey administered to fourth-grade teachers and eighth-grade mathematics teachers constituted one of the primary sources of data for this study. A total of 805 teachers in 11 California school districts were surveyed about their mathematics instructional practices, professional development, and professional background. The research staff sent out the questionnaires used in this survey on a rolling basis from February through May of 1999.

Selection of Districts. A purposive sample of 11 districts was selected. This sample contained six districts considered to have "large" total student enrollments, and five districts considered to have "moderate" total student enrollments. Districts were chosen to be geographically dispersed across California, and most had relatively large numbers of minority, low-income, and limited English proficient (LEP) students. Taken together, the 11 districts contained 1.2 million students—20.2% of all students in the state.

Selection of Schools. Within each of the 11 districts, a random sample of schools was selected. The number of schools selected was designed to provide a target sample of approximately 800 teachers, including (a) a higher proportion of teachers from the larger districts, since larger districts contain a higher proportion of students, and (b) more fourth-grade teachers than eighth-grade teachers, since eighth-grade teachers generally teach mathematics to multiple classes and thereby represent a greater number of students. In the largest district, the targets were 75 fourth-grade teachers and 38 eighth-grade teachers. The corresponding targets in the other five large districts were 50 and 25, and in the moderate-size districts they were 40 and 20.

A systematic sampling procedure was used to select, within each district, a diverse set of schools in terms of student socioeconomic status, ethnicity, and language proficiency. Schools with fewer than 10 fourth- or eighth-grade students were excluded, as were alternative and community schools. Elementary schools selected for the Evaluation of California's Class Size Reduction Program also were excluded, so as to avoid an excessive burden on teachers. The number of schools selected as candidates for participation totaled 168 elementary schools and 79 middle schools.

Once schools were selected, research staff contacted the principals of the selected schools to obtain their agreement to participate in the study. Several of the initially selected schools, however, declined to participate and, as possible, were replaced with other schools of similar demographic profile. The total number of schools ultimately included in the sample was 158 elementary schools and 68 middle schools.[1]

Selection of Teachers. Within each school in the sample, questionnaires were sent to all of the fourth-grade teachers and all of the eighth-grade mathematics teachers. (Teacher names were obtained from the school principal, and the questionnaires were mailed directly to each teacher.) In sum, questionnaires were sent to 570 fourth-grade teachers and 235 eighth-grade teachers.

Questionnaire Development. The questionnaire was based on other, pre-existing survey instruments of similar nature, namely: (1) the "Survey of Elementary Mathematics Education in California" questionnaire developed by the Center for Research on the Context of Teaching at Stanford University; (2) questionnaires developed by Horizon Research, Inc. for the National Science Foundation's Local Systemic Change Initiative, and (3) the "Reform Up Close" questionnaire developed by the Wisconsin Center for Education Research. Once drafted, the questionnaire underwent numerous rounds of revision based on feedback from project staff, Advisory Group members, and CDE staff.

Two different versions of the questionnaire were developed, one for the fourth-grade teachers and one for the eighth-grade teachers. Most items on the two versions were

[1] More detailed information on the school sampling procedure is included in the RAND report in Appendix A.

identical; however, there were some differences necessary given that while most fourth-grade teachers teach mathematics to only one group of students, eighth-grade teachers often teach multiple mathematics classes per day. Because any given teacher may use different practices in different classes taught, the eighth-grade version instructed respondents to fill out the practices questions for only one class: their "first mathematics class of the day in which at least half of the students are in 8^{th} grade." Teachers were then asked to indicate the class period for which they were filling out the questionnaire, and to write in the title of this class (e.g., Math 8, Algebra, Integrated Math, etc.).

Questionnaire Composition. The questionnaire was mainly composed of discrete-answer questions with a few open-ended response items. The items on the questionnaire were divided into the following topic areas:

- Current teaching situation: grade levels taught, number of classes per day taught, and subjects other than mathematics taught
- Mathematics instruction "in your class" (fourth-grade)/"in a particular class" (eighth-grade): amount of time for mathematics instruction, class size and class composition, frequency of use of a wide range of instructional practices (on a 5-point Likert scale, from "never" to "almost daily"), objectives for mathematics instruction, mathematics content topics taught, and curriculum materials
- Recent developments in mathematics education: familiarity with various standards documents, opinions about these documents, and ratings of school/district alignment with the documents (on a 4-point Likert scale, from "disagree strongly to "agree strongly," with a fifth option for "don't know")
- Professional development and support: amount of mathematics professional development (total and by certain topics) since January 1998, opinions about support, and frequency of teacher collaboration
- Professional background: mathematics courses taken, degree received, teaching credential, and years of teaching experience
- Teacher demographic information: gender and racial/ethnic background
- Additional comments: open-ended items about factors facilitating or impeding effective mathematics instruction.

The complete questionnaire (both fourth-grade and eighth-grade versions) is included in Appendix B.

Response Rate. Questionnaires were received back from 310 (54.4%) fourth-grade teachers and 139 (59.1%) eighth-grade teachers. However, 49 of these questionnaires were eliminated due to the following reasons:

- the respondent's class did not contain at least one-third students at the appropriate grade-level (fourth or eighth)
- the respondent had not been teaching for most of the school year

- the students of the respondent were lacking test scores
- at the fourth-grade level, the respondent was part of a team where different teachers shared or rotated students for mathematics instruction (meaning that students' test scores could not be linked to a particular teacher's instruction)
- the students in the respondent's classes could not be identified by project staff.

After these eliminations were made, questionnaires remained from 281 (49.3%) fourth-grade teachers from 136 schools and 119 (50.6%) eighth-grade teachers from 57 schools.[2]

Generalizability. Because the participating districts were not a random sample of all districts in California and because of the moderate response rate on the survey, the results of this study may not be representative of all the state's students and teachers. This is especially true for districts with small enrollments. Consequently, the relationships (or lack thereof) presented in this report cannot be generalized to the state as a whole. Nevertheless, due to the large number of students and teachers included in the sample, the results are likely to be meaningful and merit further consideration.

Student Achievement Data

The research design called for the linking of teachers' questionnaire responses with mathematics achievement data of their students to see if any correlations between practices and achievement existed. The student mathematics achievement data selected for use in this analysis were from the Stanford Achievement Test, Version 9 (SAT-9), a multiple-choice assessment administered to nearly all California students in grades 2–11. Students took this test in the spring of 1999, after they had been in the class of the participating teacher for most of the year.

Participating districts provided the data. Some districts were able to provide the student data given only teachers' names. Other districts required student identification numbers; in these districts, researchers obtained the class rosters of the teachers who had responded to the survey. A small number of rosters could not be obtained, so the questionnaires for these teachers had to be eliminated from the study.

The 281 fourth-grade teachers had a total of 6,885 students with valid SAT-9 scores. However, 70 of these students were missing demographic data and were excluded from further analyses, so the final fourth-grade sample consisted of 6,815 students. The 118 eighth-grade teachers included in the survey-test score linking analysis had 3,063 students,

[2] One of the 119 eighth-grade teachers filled out the questionnaire about a geometry class. Because this was the only geometry class in the sample, it was excluded from the analysis linking practices with test scores. However, this teacher was kept in the sample for most other analyses.

but 30 were missing demographic data, resulting in a final eighth-grade sample of 3,033 students.

The student demographic data included in the analysis consisted of gender, racial/ethnic group, home language, and whether the student participated in a gifted program, a special education program, and/or a free or reduced price lunch program. Students' 1998 SAT-9 mathematics scores and their 1998 and 1999 SAT-9 reading scores were included in the analysis as well. (See the RAND report in Appendix A for a description of how these data were used.)

School Visits: Classroom Observations and Interviews

In May and June of 1999, trained mathematics observers visited the classrooms of and conducted interviews with 55 teachers in the study. All of the teachers had filled out the questionnaire and were located in eight of the eleven districts participating in the study.

Selection of schools/classrooms for visits. Eight of the eleven study districts were selected for school visits. Within each district, the goal was to select two elementary schools and two middle schools to visit, and to observe and interview two teachers in each selected school, thereby yielding a sample of 64 classrooms observed. The procedure for selecting the visited schools/teachers was as follows:

- Within each district, all schools from which at least two teachers had returned the questionnaire were identified.
- If there were more than two such schools in the district, researchers randomly selected two from the list.
- The questionnaires from the teachers at the selected schools were screened (a) to make sure their classes consisted of at least half fourth or eighth graders and (b) to make sure that the observation sample as a whole would include a wide range of class types (e.g., at the eighth-grade level, not too many algebra classes; at both grade levels, not too many high-percentage LEP classes).
- For any school that did not have at least two teachers' classes meet the selection criteria, researchers randomly selected a replacement school and screened it similarly.
- The selected schools/teachers were contacted to request the visit. Schools that declined were replaced with others, using the same random selection and screening criteria. Teachers were offered a $25 honorarium for participation.
- For schools from which more than two teachers returned the questionnaire, two of the teachers were selected based on convenience factors (or, if possible, more than two teachers were visited/observed). At the eighth-grade level, efforts were made to

visit the exact class periods about which the teachers filled out the questionnaire, or, if this was not possible, to visit a "similar" class.

Fifty-five teachers—28 fourth-grade teachers from 14 elementary schools and 27 eighth-grade teachers from 14 middle schools—were visited and interviewed. The principals at 26 of the 28 schools also were interviewed.

The visited schools displayed a wide range of demographic characteristics and overall student achievement. For example, several different Academic Performance Index (API) rankings—both statewide rank and similar schools rank—were represented among the visited schools. Figure 2.1 shows the API rankings of the visited fourth-grade schools, and Figure 2.2 shows the API rankings of the visited eighth-grade schools.

Figure 2.1
Fourth-Grade Visited Schools' 1999 Academic Performance Index Rankings

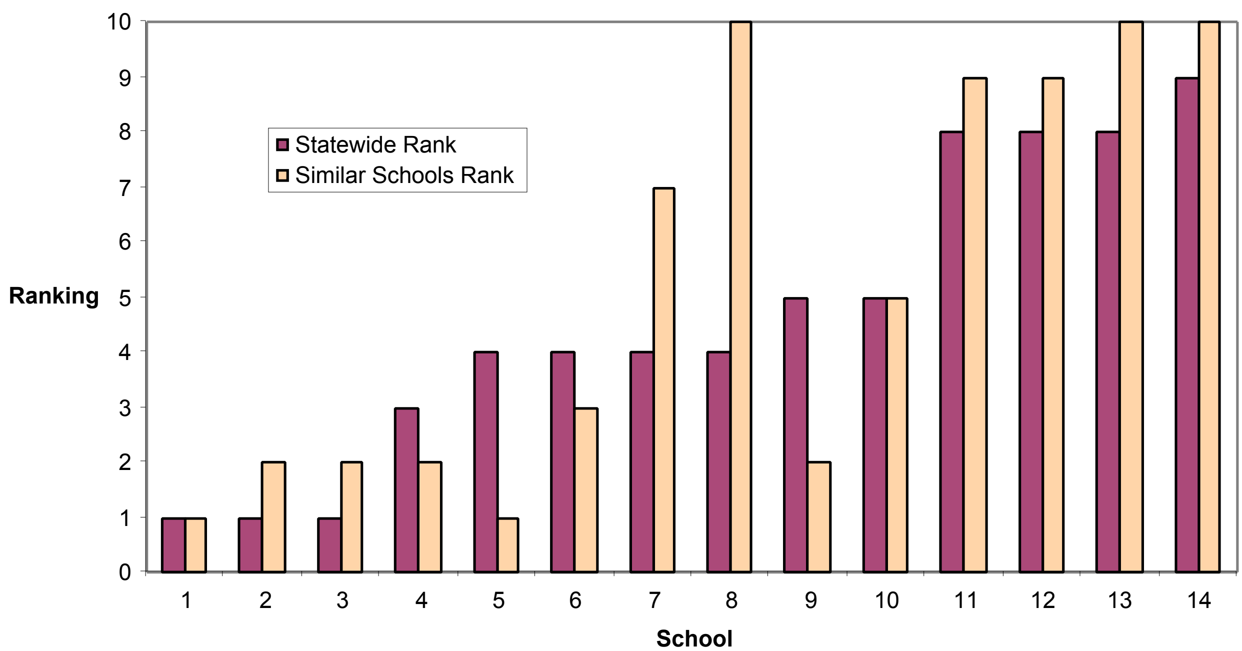
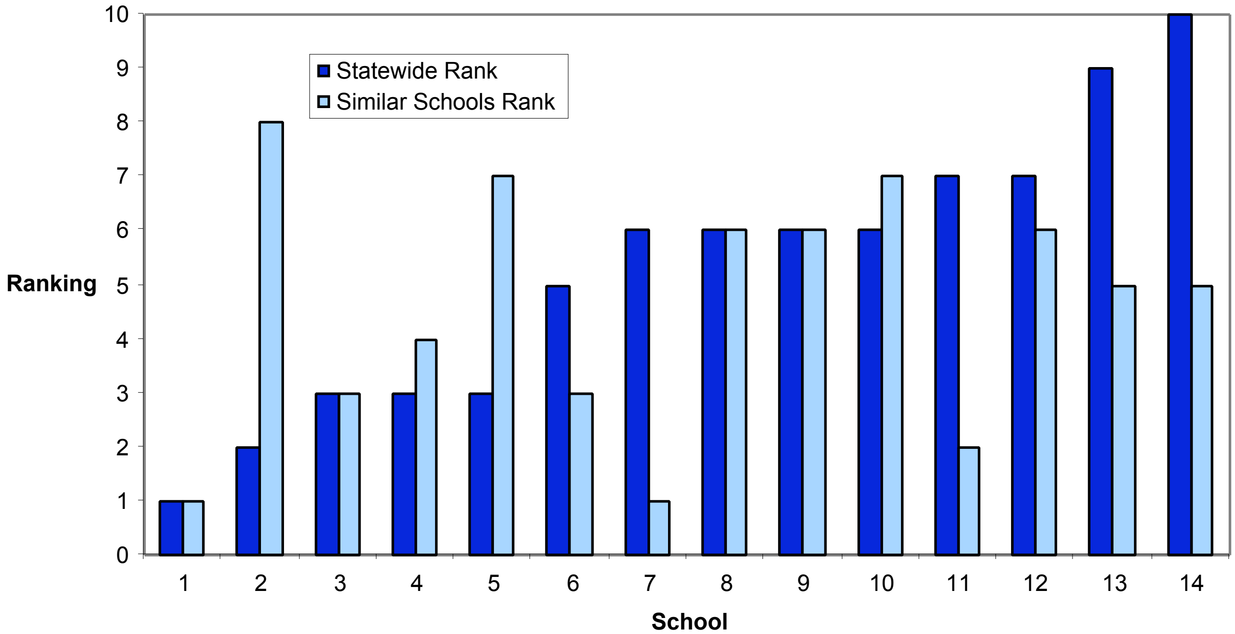


Figure 2.2
Eighth-Grade Visited Schools' 1999 Academic Performance Index Rankings



Classroom observations. Each teacher was visited only once, and only one mathematics lesson/class was observed.[3] In most cases the visit was made by a single observer, but in some cases two observers made the visit. Observers were asked to write up a summary of the observation, including attention to the content of the lesson; the organization of students; the purpose of the lesson; representations, tools, and resources used; assessment during the lesson; focus of classroom discourse; language differences; students with special needs; and behavior and discipline. The complete protocol for this write-up is included in Appendix B.

Observers were also asked to compare each teacher's practice *as observed* to practice as reported by the teacher on the questionnaire. The purpose of this comparison was to validate the questionnaire. However, because most of the questionnaire items about teaching practices asked about frequency of their use, complete validation was not possible given the "one-shot" observation. Observers could, nevertheless, attempt to verify the presence of practices teachers reported engaging in "almost daily," and, conversely, verify the absence of practices teachers reported "never" using. The overall results of this analysis, across all the classroom observations, did not find the questionnaire to be invalid. (Two

[3] That each class was observed only once is a limitation of the study, as instruction in that one class may not have been representative of the teacher's instruction. That the visits were made toward the end of the year compounds this problem, as instruction close to the end of the year may differ from instruction earlier in the year.

questionnaire items were, however, found to be ambiguous and were thus not included in the analysis.)

Teacher interviews. The teachers' whose classes were observed were also interviewed. A brief interview was conducted prior to the observation and consisted mainly of questions about the lesson planned. A lengthier interview was conducted following the observation and included questions about the lesson observed, the teacher's "philosophy and practice" regarding mathematics instruction, perceived influences on mathematics instruction, and effectiveness in teaching mathematics. Again, the complete protocol is included in Appendix B.

Principal interviews. As mentioned, the principals at most of the observed schools also were interviewed. The principal interview protocol, also included in Appendix B, contained questions about the school's mathematics program, support from the district, school and teacher discretion, influences on mathematics instruction and achievement, professional development, and areas for improvement.

District-Level Interviews

In four of the eight districts where school visits occurred, a district curriculum administrator (e.g., district mathematics coordinator) was interviewed. The district-level interview included questions about the district's mathematics program; influences on mathematics instruction in the district; the use of content standards; professional development; student mathematics achievement; strengths and weaknesses of district mathematics instruction; and accountability. The district-level interview protocol is included in Appendix B.

Other Interviews

Interviews were conducted with a variety of other stakeholders as well, in order to gain a wide range of additional perspectives on mathematics instruction and implications for policy. Individuals who were interviewed included members of the Legislature/legislative staff, members of the State Board of Education and their staff, administrators from the California Mathematics Project and the California School Board Association, a mathematics professor, and a focus group of teachers formed by the California Federation of Teachers.

Questions in these interviews solicited opinions on the current level of mathematics achievement in California, on the appropriate role of state policy makers for the improvement of mathematics instruction, and on the appropriateness of the current state strategy for improving mathematics achievement. Interviewers next presented some of the study's major findings and asked for opinions on the appropriate policy responses to these findings. Because the interviews involved discussion of study findings, they took place toward the end of the study, in April and May of 2000.

Tenth-Grade Pilot Study

In addition to the more thorough investigation at grades 4 and 8, some exploratory research and development work was conducted at grade 10. This exploratory work utilized instruments and protocols employed at the fourth- and eighth-grade levels, but did not analyze any student achievement data. The intent of this work was to refine the instruments and procedures for use in a future high school study and to frame the major issues involved in undertaking such a study. The tenth-grade research consisted of the following elements:

- ♦ The eighth-grade teacher questionnaire was adapted for the tenth-grade level. (See Appendix B.) Four mathematics teachers from two high schools within a single district completed the instrument. These teachers then participated in a focus group to critique the questionnaire and its appropriateness for use with high school teachers.

- ♦ Researchers conducted observations in classrooms of the four teachers who had participated in the focus group. The classes that were observed—two Geometry classes, one Algebra 1 class, and one Advanced Algebra class—each had more than 50% tenth-grade student enrollment. The observation protocol was the same as that used for the fourth- and eighth-grade levels.

- ♦ Interviews were then conducted with the four teachers, the mathematics department chair and principal at each school, and the district mathematics resource specialist. The protocols for these interviews were similar to those used for the larger study.

The findings from this exploratory study are not included with those from the main study in the body of this report. Rather, the implications for a tenth-grade study are included in Appendix D.

(This page intentionally left blank.)

Chapter 3

Instructional Practices and Effectiveness

Highlights of Findings

- **There is no strong correlation between specific types of instructional practices and student achievement.**
  An analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found only weak relationships between instructional practices and student achievement. Classroom observations, similarly, found a wide range of practices among teachers both of higher-achieving classes and lower-achieving classes. While these findings do not necessarily prove that no strong relationship between practice and achievement exists, they do suggest that at the very least, the relationship is complex and not easily identified. There does not appear to be a particular instructional method that, even if widely implemented, would improve student mathematics achievement throughout the state.

- **Teachers themselves listed several different types of practices—and the use of a variety of practices *per se*—as contributing the most to their instructional effectiveness in mathematics.**
  In the opinion of teachers, several different types of practices—and perhaps even more importantly, a *combination* of different types of practices—contribute to instructional effectiveness. For example, many teachers attributed their effectiveness to a focus on both computational mastery and conceptual understanding, or to the use of a variety of different strategies, perhaps based on diagnostic assessment of students' needs.

- **Although teachers value a balanced approach, they do not always have the training or support necessary to effectively implement such an approach.**
  Many teachers, especially at the fourth-grade level, believe that an approach balancing computation and conceptual understanding is important. However, teachers do not always have a clear sense of how to implement such an approach, nor do they always feel supported by the school, district, or state in the implementation of a balanced approach.

Background

Nearly every academic area has faced some degree of national, state, and/or local controversy surrounding appropriate content and instructional practices. For example, for much of the early 1990s, the debate between "whole-language" and "phonics" approaches dominated discussions of the teaching of reading. At the heart of the mathematics discourse in recent years has been a debate between "reform" practices, emphasizing hands-on, higher-order conceptual thinking, and "traditional" practices, emphasizing memorization and practice of basic skills, such as arithmetic. At times, and in some places, the debates have escalated to the point where the media has dubbed them the "math wars" (e.g., Hartocollis, 2000; Mervis, 2000).

Contributing to the debates has been a dearth of research on effective practices—especially research clearly indicating what, if any, types of practices seem to be associated with higher achievement. The lack of conclusive research stems partly from the difficulties inherent in analyzing student achievement and attributing effects to instructional and/or other factors. Educating children is a complex enterprise, especially given the diversity of their needs and the rapidly changing nature of society. Determining what seems to help improve achievement—particularly when there may not be any one or two easily identified and measured factors—can seem nearly impossible.

Exacerbating the dilemma of investigating factors contributing to achievement is that the educational landscape is in a near-constant state of flux. In part, this is due to the political nature of educational governance. A given set of policy makers may do a great deal to implement their ideas for educational improvement, but frequently their efforts are short-lived; no sooner do they put their programs in place than a new administration, with different ideas and different programs, takes over. The result is that few attempts at real change ever even become implemented at the level of the classroom—much less become implemented *effectively* (O'Neil, 2000). Those few that *are* implemented seldom take hold long enough for their effects on student achievement to be evaluated with reliability and validity. Before the effects of certain policies or approaches can be determined, researchers must document that these policies and approaches were even implemented.

There has, of course, been some prior research into mathematics instruction. One of the most well-known studies was the 1995–96 Third International Mathematics and Science Study (TIMSS), which was designed to foster a better understanding of how mathematics and science learning in the United States compares with that in other nations. The study looked at student achievement, curriculum and expectations for student learning, classroom instruction, and the lives of teachers and students. However, although this was the largest international comparison study ever conducted, it did not attempt to analyze the relationships between student achievement and instructional practice in individual classrooms. In fact, the TIMSS reports caution that "no single factor in isolation from others should be regarded as the solution to improving the performance" of U.S. students, and that "no single factor or combination of factors emerges as overwhelmingly important" with regard to patterns of achievement (U.S. Department of Education, 1997, pp. 15, 18).

Nevertheless, some earlier research has reported small, positive associations between achievement and some types of instructional practices. For example, Stipek, Salmon, Givvin, Kazemi, Saxe, and MacGyvers (1998) found that emphases on problem-solving and process-oriented solutions were related to higher scores on a mathematics test of conceptual understanding. Other studies have found a positive relationship between the teaching of higher-order thinking and achievement (Martinez & Martinez, 1998; Ginsburg-Block & Fantuzzo, 1998). Research has also demonstrated the value of collaboration (Webb & Palincsar, 1996) and of embedding instruction in real-world contexts (Verschaffel & DeCorte, 1997). Cohen and Hill (1998), meanwhile, found that teachers' use of practices consistent with the 1992 California Mathematics Framework was positively related to student achievement.

This study, too, explores the relationships between student achievement and instructional practices. Results of this analysis are presented in this chapter. The matter of the effects of policies on instruction—and the levels of actual implementation—is taken up in subsequent chapters.

Quantitative Findings on Instructional Practices and Effectiveness

As explained in the Methodology chapter, one of the essential elements of this study was a statistical analysis linking teachers' survey responses with the mathematics achievement data of the responding teachers' students. The goal of this analysis, which was conducted by RAND, was to identify practices associated with higher achievement. Results are presented below, preceded by a discussion of what types of practices appear most prevalent, as reported by teachers on the questionnaire.

- ♦ **On the questionnaire, teachers reported relatively frequent use of teacher-centered, problem-solving, and computational practices; conversely, instructional use of computers appeared to be an infrequently used practice.**

The questionnaire items were grouped into 12 scales, 7 of which related to instructional practices and 5 of which related to the influence of standards, professional development, and teaching environment. The scales were as follows:

1. Teacher-Centered Practices
2. Problem Solving
3. Computational Practices
4. Applications
5. Group Work
6. Individual Work [1]
7. Computer Use
8. Familiarity and Influence of Mathematics Frameworks and Standards
9. Alignment with District Standards
10. Perceived Teacher Support
11. Perceived Teacher Collaboration
12. Professional Mathematics Development

The grouping was done using a combination of judgments about item content and empirical analysis. Specifically, questions that were intended to measure the same construct were grouped together. These judgments were then evaluated with an empirical analysis using intercorrelations. Items within each scale usually correlated more strongly with one another than they did with items on other scales. Appendix A1 (at the back of Appendix A) shows the questionnaire items in each scale. For instance, the "Teacher-Centered Practices" scale comprised the following questionnaire items:

- Go over homework with the class
- Demonstrate how to solve a particular type of problem
- Listen to teacher presentation of a new topic or procedure

Figure 3.1 shows the mean, standard deviation, and reliability (coefficient alpha) of each of the seven "practices" scales at each grade level. (Survey results about the influence of standards, professional development, and teaching environment will be discussed in subsequent chapters.) Each of these seven scales used a 5-point Likert scale, where a rating of "5" indicated "almost daily" use of the practices, and a rating of "1" indicated that the practices were "never" used. As the table shows, teachers reported very frequent use of teacher-centered practices, and fairly frequent use of problem-solving and computational practices. The use of computers, on the other hand, appears to have been a practice only infrequently used by most teachers.

[1] It is important to note that the individual work and group work scales were not opposites of one another, and that teachers could engage in both types of activities and thereby receive high scores on both scales; i.e., if their students frequently worked collaboratively as well as independently. Similarly, teachers could receive low scores on both scales if they frequently engaged in other activities that were not represented on either scale.

Figure 3.1
Mean, Standard Deviation, and Reliability Coefficient for
Each of the Seven "Practices" Questionnaire Scales at Grades 4 and 8

Scales	Fourth Grade				Eighth Grade		
	Mean	SD	Alpha		Mean	SD	Alpha
1) Teacher-Centered	4.45	.51	.49		4.69	.39	.35
2) Problem-Solving	3.88	.46	.80		3.68	.44	.71
3) Computational Practices	3.56	.54	.59		3.45	.49	.52
4) Applications	2.85	.47	.53		2.73	.43	.43
5) Group Work	2.81	.71	.69		2.37	.59	.65
6) Individual Work	2.42	.74	.58		1.93	.58	.62
7) Computer Use	1.82	.75	.86		1.48	.55	.86

- **The frequency of certain types of practices appeared to be related to some student and teacher characteristics.**

There was, of course, considerable variation in teachers' reported use of particular instructional practices. In some cases, differences in practices appeared linked to other factors, such as classroom and student characteristics. For example, at the fourth-grade level, teachers with a higher proportion of gifted students were less likely to use computers or have students work individually. Teachers who reported that their class was "fairly homogeneous and average in ability" were more likely to use group work. Teachers with a higher proportion of gifted, LEP, and special education students were less likely to focus on mathematics applications.

At the eighth-grade level, teachers who described their class as "fairly homogeneous and high in ability" were more likely to report the use of computers, while teachers with students "fairly homogeneous and low in ability" were less likely to engage in teacher-centered practices. Teachers of classes with a higher proportion of female students reported emphasizing computational practices less frequently, but those teaching a higher proportion of African American students focused on computational practices more often.

Some teacher characteristics also appeared to be related to use of certain types of instructional practices. At the fourth-grade level, female teachers (74.1% of respondents) tended to report a focus on computational skills. African American teachers (6.6% of respondents) reported using group work less frequently, and Hispanic teachers (11.8% of respondents) reported engaging in individual work less often. Hispanic teachers were also less likely to emphasize applications and to use computers in instruction. Moreover, fourth-grade teachers who reported that they collaborated with one another and that their practices were influenced by standards were more likely to emphasize group work, individual work, applications, and higher-order thinking skills. Greater collaboration was also positively related to computer use, as was more mathematics professional development. Additionally, teachers who had taken more mathematics courses tended to report more frequent use of group work.

Among the eighth-grade teachers, greater influence of standards and more mathematics professional development (both as reported by the teachers themselves) were positively related to the reported use of problem-solving practices. Teachers of integrated math courses were more likely than either Math 8 or algebra teachers to indicate the use of computers, and were less likely to report engaging in teacher-centered practices.

- **The statistical analysis linking instructional practices, as reported by teachers on the survey, and the SAT-9 scores of the students in the classes of the surveyed teachers found only weak relationships between instructional practices and student achievement.**

The regression analyses of the relationships between the teacher questionnaire scales and student achievement controlled for district, student ethnicity, student gender, participation in a gifted program, participation in a special education program, free or reduced lunch status, LEP status, prior year scores in mathematics and reading, and 1999 reading scores. In addition, at the fourth grade level, coverage of probability was also included as an independent variable[2]; at the eighth-grade level, type of mathematics course was included.[3]

A variety of other variables, such as teacher characteristics (ethnicity and gender), teacher background (certification type, degree, and mathematics coursework), class size, and instructional time devoted to mathematics, were not found in preliminary analyses to be significantly related to student outcomes, hence these variables were dropped. One exception was total number of years teaching, which was positively related to test scores: a one-unit standard deviation increase in years teaching was associated with a .074 standard deviation unit gain in scores at the fourth-grade level and a .043 standard deviation unit gain in achievement at the eighth-grade level. However, this variable was also related to instructional practices, meaning that if the analysis adjusted for total years teaching, the effects of instructional practices on achievement would be reduced. Because of this, the final analysis used two models, one with the total number of years included, and one without.[4]

[2] Preliminary analyses indicated that among all of the mathematics content topics listed on the questionnaire (in an item asking about teachers' coverage of each topic), only probability appeared to be related to achievement. Thus, the other topics were eliminated, while probability was retained.
[3] The course categories used in this analysis were Math 8 (included courses identified as Math 8, Math 7/8, pre-algebra, and problem solving), Algebra, and Integrated Math.
[4] More detail about how the analysis was conducted, as well as the results of the analysis, is included in Appendix A (the RAND report). The analysis was sufficiently multi-pronged and thorough to detect the presence of any strong correlations within the data itself, given the nature of the instrumentation.

The majority of teacher scales did not show a statistically significant relationship with student outcomes.[5] At the fourth-grade level, only one scale was significantly related to achievement when controlling for total years teaching: practices emphasizing applications. The relationship, however, was very weak (a one-unit standard deviation increase on this scale was associated with a .035 standard deviation unit gain in scores). In the model *excluding* total years teaching, the relationship between the applications scale and achievement lost its significance, but another scale—the use of practices emphasizing computational skills—was slightly positively associated with achievement. But again, this effect, significant only in one of the two models, was quite small—a one-unit standard deviation increase on the computational practices scale was associated with a .036 standard deviation unit gain in scores. In both models, some coverage of probability was positively associated with higher scores (a .088 standard deviation unit increase in scores with years of teaching excluded, and a .076 increase with years of teaching included).

The finding that coverage of probability and practices emphasizing application and computational skills were positively related to student achievement is logical given the content of the SAT-9, which includes many contextualized statistics items that require procedural and declarative knowledge. Because the test focuses on problems that are solvable via heuristics, it may not be the most appropriate measure to assess higher-order thinking skills. Thus, the failure to find a significant association between problem-solving practices and achievement might stem from limitations of the SAT-9 as opposed to a lack of relationship *per se.*

At the eighth-grade level, greater reported use of computers in instruction was negatively related to outcomes, but again, the effect was quite small: a one-unit standard-deviation increase on the computer-use scale was associated with a .041 standard deviation unit decrease in test scores. The negative relationship may be attributable to several sources. Students who receive computer instruction may spend more time "playing with" the computer than actually using it to solve mathematics problems. In a related manner, teachers who use computers may need to devote more instructional time to logistics (e.g., explaining how to use the computer), which might translate to less time focusing on mathematics concepts. Moreover, the SAT-9 may not be sensitive to detecting the effects of computer instruction. Some mathematics problems that can be presented via a computer may not translate well to a paper-and-pencil format. It might be the case that students who receive computer instruction are encountering different kinds of mathematics problems in their classrooms than those presented on the SAT-9.

Another finding at the eighth-grade level was that the teacher-centered scale was positively related to test scores for algebra courses, but such practices were unrelated to outcomes for

[5] Figures illustrating the regression coefficients for both models at both fourth- and eighth-grade levels are included in Appendix A.

Math 8 courses. This may be attributable to differences in the content of the two types of courses: whereas Math 8 courses typically entail ideas that have been introduced in prior mathematics classes, algebra tends to involve skills and concepts that are unfamiliar and qualitatively different from those previously learned. Hence, teacher-centered practices, such as going over homework or demonstrating how to solve a problem, may be more beneficial with algebra than with Math 8. This interaction illustrates the importance of considering course content when evaluating the relationship between achievement and instruction, as particular practices may be more effective with one course than another.

- **That the analysis found only weak relationships does not necessarily mean that stronger relationships do not exist.**

A few caveats must be kept in mind when interpreting the results presented above. First, as mentioned above, the nature of the SAT-9 may render it an inappropriate measure for assessing relationships between certain classroom practices and achievement. Moreover, there were concerns that the validity of the SAT-9 may have been compromised by efforts to "teach to the test." (The matter of "teaching to the test" will be discussed further in the chapter on Assessment.) If teachers are indeed narrowing their curriculum to the topics found on the SAT-9, serious questions arise regarding the inferences that can be drawn from the scores.

In addition, because the study did not employ an experimental design, we cannot be certain that the observed relationships are attributable solely to classroom practices. There may be other systematic student, teacher, and school variables that were not measured but that nevertheless affect what teachers do and what students learn.

Furthermore, the lack of significant relationships between many of the scales and the test scores should be interpreted cautiously because some of these scales were low in reliability. This makes it difficult to detect effects. The results for two of the scales—the teacher-centered practices scale and the problem-solving scale—should be viewed with particular caution as responses on these scales were highly skewed toward frequent reported use.

Even more importantly, all of the scales depended on the accuracy of teacher perception about their practices, which may not always have been 100%. Surveys are an imperfect measure of identifying instructional practices; like any such measure, the items are subject to inaccurate responses, particularly those that reflect social desirability.

Another possible explanation for the lack of effects stems from the study's focus on students' exposure to practices during a single academic year, which does not allow us to follow changes in teachers' practices or examine the effects of student exposure to these practices across several years. Some practices may have been implemented only a short time ago, in accordance with recently released standards. Teachers may need more time before they can effectively implement the practices, or students may need to be exposed to the practices for more than a single year before the effects of these practices on achievement become clearly evident.

Finally, the survey questions addressed only the frequency with which teachers used particular practices and did not address the way in which they were used or the overall quality of instruction. Although classroom observations and teacher interviews, which will be discussed in the following section, helped alleviate this problem, the small-scale basis of this qualitative data collection limits the extent to which its findings can be generalized.

Qualitative Findings on Instructional Practices and Effectiveness

♦ **As with the quantitative survey/test score analysis, classroom observations did not find that any particular type of instruction or set of instructional practices was necessarily correlated with higher student mathematics achievement. Observed teachers with higher-achieving classes displayed a wide range of practices.**

The classes of the 55 teachers who were visited by trained mathematics observers ranged across the spectrum of achievement. Some of the teachers had classes who, on average, performed at the high end of the spectrum (as compared to the other classes in the sample and controlling for students' prior year achievement and demographic characteristics), while others were toward the middle or at the low end. When all of the teachers in the entire survey sample (281 fourth-grade teachers and 118 eighth-grade teachers) are divided into quartiles based on their classes' SAT-9 achievement, each quartile includes at least some of the observed classes, as illustrated by Figure 3.2.

Figure 3.2
Achievement Quartiles of the Observed Classes

Quartile	Number of Fourth-Grade Observed Classes in the Quartile	Number of Eighth-Grade Observed Classes in the Quartile
1 (lowest)	5	2
2	6	7
3	7	7
4 (highest)	10	10
Total	**28**	**26**[6]

[6] One eighth-grade class that was observed lacked student test scores, and thus was not able to be included in the survey analysis. Hence the total number of classes in this table is 54, not 55.

As the figure shows, however, the observed classes are not evenly distributed over the four quartiles, but rather cluster toward the upper end, with the fewest number of classes in the first quartile and the highest number in the fourth quartile. The reasons for this are not entirely clear, but may be due to a self-selection factor. Although candidates for classroom visits were chosen randomly (provided certain criteria were met), teachers were not required to host visits, but rather were presented with the option of being visited or not. Some teachers did indeed decline to be visited, either when initially contacted with the request or in subsequent cancellations. It may be that teachers with lower-performing classes were less likely to agree to be visited, thereby tilting the sample of visited classes toward the upper end of the achievement spectrum.

As with the quantitative analysis discussed in the previous section, an analysis of observers' qualitative write-ups/descriptions of the observed classes did not reveal any strong, overt trends or correlations between types of instructional practice and student achievement. For example, when the observation data on all of the top-quartile visited classes were examined (10 fourth grade and 10 eighth grade), no clear commonalities could be traced, nor did they appear to be much different, as a group, than the observed classes in lower quartiles. Overall, it appeared, on the basis of classroom observations, that no particular type of instruction was linked with higher student achievement (as a class) on the SAT-9.[7] To the contrary, teachers whose classes performed well (relative to the rest of the survey sample) displayed a wide range of instructional practices. Selected classroom profiles included in Appendix C highlight the range of practices employed by the teachers of observed top-quartile classes.

As a case in point, at one school that was visited, the two observed fourth-grade teachers both had classes in the top quartile of student achievement but held differing philosophies of instruction and displayed markedly differing types of instructional practice. Contrasting snapshots of the different philosophies and practices of these two teachers—Marc and Vince (pseudonyms)—are presented here.

> *In response to interview questions about teaching philosophy, Marc said that he wants the inherent creativity of mathematics to be apparent to his students, and that he doesn't want his students to be intimidated by the subject (as he was as a student). He said that he uses many visual representations and as many manipulatives as possible.*
>
> *In the lesson of Marc's that was observed, the class was working on a supplementary unit involving polygons in which students were designing a futuristic city. During the whole-class review of polygons that started the lesson, the class discussed the derivation of words and the relationship of terms used in mathematics to other activities and contexts. Marc related the word*

[7] However, as only one observation per teacher was conducted, and most observations were made toward the very end of the school year, few generalizations can be made about the observed' teachers' instructional practices. Multiple visits spread throughout the school year might provide a more complete picture of any given teacher's type of instruction.

lateral *to a recent field trip to the aquarium and reminded students of how they looked at the parts of fish, especially the fins. When working with students to show why a triangle was a right triangle, Marc asked students to show how they are supposed to bend their elbows (at 90 degrees) when doing a particular folk dance. (This teacher choreographs dances for students, relating the mathematics he is using.)*

The main part of the lesson had the students working together in teams to solve a design problem. The teams actively discussed the process of mathematical thinking required, while the teacher monitored the groups' work and worked with those who did not understand the task. All students appeared to be engaged in the tasks at hand and worked well together. After about 30 minutes of group work, Marc asked the groups to report, either in writing or by drawing, the method by which they obtained their information. He then took a survey. Marc closed the lesson by making sure that the group leaders took notes on what to do next; they were to continue after lunch.

Vince, meanwhile, mentioned in the interview that he believes students need reinforcement of basic arithmetic skills and that speed is important. His general approach to mathematics teaching is focused on raising test scores and preparing students to take standardized tests. Although he knows that cooperative learning has become "popular," he thinks it is only useful if students already have all the required skills and can be in homogeneous classrooms.

During Vince's lesson, two students at a time were called to the board to do drill problems on basic operations while the rest of the class worked on the problems at their seats. Some story problems were given; these, too, focused on operations (mainly simple adding or subtracting). Although the accuracy of students at the board was noted, no feedback was provided to the other students about their work. (Each student went to the board at least once.) The teacher kept score for the pairs who went to the board, and a play-off round for speed was the culminating activity. Although an aide circulated among students, the teacher never left his seat during the entire lesson. At various times, low-level, closed questions were asked of the students at the board; no explanations were offered. There was no discussion, nor was there conversation among students. Most students did, however, look engaged.

♦ **In the opinion of teachers themselves, several different types of practices—and perhaps even more importantly, a *combination* of different types of practices—contribute to instructional effectiveness.**

There is one further data source on the factors contributing to teachers' instructional effectiveness: teachers' self-report. The fourth-grade questionnaire included an open-ended item that asked, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?" The eighth-grade questionnaire included a similar, but not quite identical, item: "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"[8] Admittedly, teachers' responses to these questions were not systematically analyzed in relationship to the achievement of the teachers' classes, and thus can only be taken for what they are—self-report, with no external validation. However, they do provide a snapshot of what teachers themselves tend to think of as important to instructional effectiveness.[9]

Most likely because of the slightly different way the question was phrased at each of the two grade levels, the eighth-grade responses were somewhat different from the fourth-grade responses. Eighth-grade teachers, who were asked about their effectiveness "as a mathematics teach*er,*" were more likely to give responses having to do with themselves or their personal characteristics. Such responses, given by more than 65% of responding eighth-grade teachers (60 of 88) but only by about 35% of fourth-grade teachers, included things like:

- affection for or rapport with students
- love for or understanding of mathematics
- organizational or classroom management skills
- ability to motivate or explain
- enthusiasm, patience, or flexibility
- experience or background (in teaching or in other professions).

In contrast, fourth-grade teachers, who were asked about the effectiveness of their "mathematics teach*ing*," were much more likely to talk about instructional approaches or strategies. Indeed, more than 50% of fourth-grade respondents (120 of 219) gave such answers, but fewer than 30% of eighth-grade respondents did.

Within the broad category of "instructional approaches or strategies," however, many different types of responses were given. The larger subcategories included the following:

Tailoring instruction to students' needs. About 15 fourth-grade teachers talked about the importance of basing instruction on student needs, for example as determined by diagnostic assessments or by student feedback. Responses along these lines included the following:

> *Using student feedback to determine and provide what is needed for understanding*

> *I try to build on their individual needs*

> *Continual assessment of my students. I use this information to guide the content of my lessons.*

---

[8] The questions were phrased differently from one another because of the different context for mathematics teaching at grades 4 and 8. Most eighth-grade mathematics teachers teach mathematics as their only or primary subject area, so these teachers are appropriately considered "mathematics teachers." Fourth-grade teachers, however, generally teach multiple subjects, so the question asked about their mathematics teach*ing.*
[9] See Figure E1 in Appendix E for a graph of responses to the survey item.

One of the classroom observers, who visited a total of 13 classes (including both fourth-grade and eighth-grade classes), hypothesized that ongoing attention to students' needs might be an important factor in instructional effectiveness. This observer reflected:

> *Although one particular teaching strategy did not significantly correlate to the teacher efficacy [in the 13 observed classes], teachers' paying attention and responding to the vicissitudes of kids' attention/engagement emerged as the strongest correlate to efficacy.*[10] *This recommends a specific strategy: teachers should consider changing approach on an as-needed basis to keep students engaged. Moreover, classroom observation data suggest that classroom problems are related to teachers not noticing what is going on with students as they teach and not making necessary changes to re-engage students so that they do not fall behind. In contrast, students benefited from teachers who reflected on the following queries: "Am I using students' time well?" "Are the activities productive?" "How much of a given class allows students to be idle?" The teachers who mentioned these concerns tended to establish and promote more productive use of student time.*

Making real-world connections. Roughly 20 fourth-grade teachers gave a response about connecting mathematics to the real world or to students' lives. "Getting students ready for 'real-life' mathematics," wrote one teacher. "Application to the real world and everyday usage of mathematics is stressed," wrote another. "Make situations relevant to students' experiences," commented a third. The other responses in this subcategory were similar.

The use of hands-on materials and/or an activity-based approach. This subcategory was the largest, including responses from more than 30 fourth-grade teachers. Many of the responses merely mentioned "manipulatives" or "hands-on learning" without much elaboration, but some discussed the use of manipulatives in introducing concepts or in developing students' conceptual understanding. For example, one teacher talked about how manipulatives and exploration help students "discover concepts and formulas." Another said that "using manipulatives to introduce new concepts" enables students to "advance further with confidence."

Focusing on basic skills, step-by-step sequential building, or practice and reinforcement. About 25 fourth-grade teachers attributed their effectiveness to an emphasis on basic skills, step-by-step building, or repeated practice. "I have a step-by-step approach that builds sequentially from one skill to the next," wrote one teacher; "I make sure the students understand and have learned the material before we move on to more complex concepts," he continued. "Getting children to understand the basic skills and why we need math," wrote another teacher. Other responses spoke of such things as constant review and practice, scaffolding techniques, and memorization of basic mathematics facts.

[10] Efficacy in the observed class based on the observer's judgment of whether instruction was likely to contribute to students' understanding of mathematics; not necessarily linked to higher test scores.

Responses to the Instructional Effectiveness Survey Question by the Teachers of the Higher-Achieving Classes

Teachers of the higher-achieving classes in the survey sample attributed their effectiveness to a wide range of factors. The table below displays the responses of the teachers of the top performing classes in the survey sample—ten at each grade level—to the instructional effectiveness survey question.

Figure 3.3
Responses to the Instructional Effectiveness Survey Question by the Teachers of the Top Ten Classes

Class Rank in Study (1=highest)	Fourth Grade Responses to "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?"	Eighth Grade Responses to "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"
1	*Emphasis on both basic skills and problem solving; on-going application of skills in content areas & real life situations. Consistent daily homework in math encompassing a variety of skills & mathematical strategies. Emphasis on critical thinking in all content areas.*	*organized & prepared lessons! clear student expectations!*
2	*right now consistency—I am desperately in need of more training which our school is scheduled to receive next year.*	*[no answer given]*
3	*Sharing ideas with other teachers.*	*[no answer given]*
4	*Availability of manipulatives/materials Teachers knowledge of subject matter/seminars*	*—Patience —Willingness to try new things —Intelligence*
5	*scaffolding techniques - review/review/review memorize basic facts/ mental math teach logical thinking skills.*	*My high school math teacher (3 years)*
6	*I picked my own teaching materials. I only used MathLand about 10% of my teaching.*	*math degree love of math for math's sake.*
7	*—Flexibility to roll with the reality; tailoring instruction to the class. —Hard work. —Not allowing stragglers to get away.*	*[no answer given]*
8	*—Following an old math text as a guide —Teaching to top students & review for others —Dedication to students!*	*Collaboration with other teachers at my school and in the district. Respect for my students and vice versa which leads to good rapport and classroom environment*
9	*Knowing the subject matter and how to teach it.*	*My love of mathematics and my understanding of math*
10	*Relating math to real life situations Combining concept understanding with computation mastery*	*Belief in mathematics to analyze and solve a wide variety of problems*

Using a variety of different approaches or having a "balanced" program. By no means are any of the aforementioned subcategories mutually exclusive.[11] It was not uncommon, for example, for a teacher to list a focus on *both* basic skills and hands-on activities. For instance, one teacher wrote, "I have a balance of computation and problem solving activities; students use manipulatives and we work on conceptual development as well as learning algorithms."

In fact, many teachers said that variation in approach, *per se,* was the factor that most contributed to the effectiveness of their mathematics instruction. Responses such as the following came from approximately 30 fourth-grade teachers:

> *I use a variety of teaching techniques.*
>
> *The way I incorporate a variety of teaching strategies and activities to really help the students understand the concepts and why and how they solve the problems.*
>
> *A variety of methods; from traditional, such as textbooks, to more progressive ones such as the use of manipulatives, etc.*

Although relatively few eighth-grade teachers discussed instructional approaches as the primary factor in their effectiveness, some of those who did also mentioned the use of different strategies and approaches.

Overall, the evidence clearly indicates that most teachers do not believe that any one instructional approach is necessarily the most effective—at least not for all teachers (or for all students) at all times. What works well for one teacher with one group of students may be less effective for another teacher or for a different group of students. And what appears to work best for many teachers (at least according to the teachers themselves) is a combination of approaches, or—as some put it—a "balanced program." In this way, the findings from the quantitative survey analysis, the classroom observations, and teachers' self-report all suggest that there are no "magic bullets" for improving student achievement.

- ♦ **Many teachers believe that an approach balancing computation and conceptual understanding is important. However, teachers do not always have a clear sense of how to implement such an approach, nor do they always feel philosophically supported in the implementation of a balanced approach.**

The perceived need for "balance"—such as between computation and conceptual understanding, or "traditional" vs. "reform" approaches—was reiterated in responses to

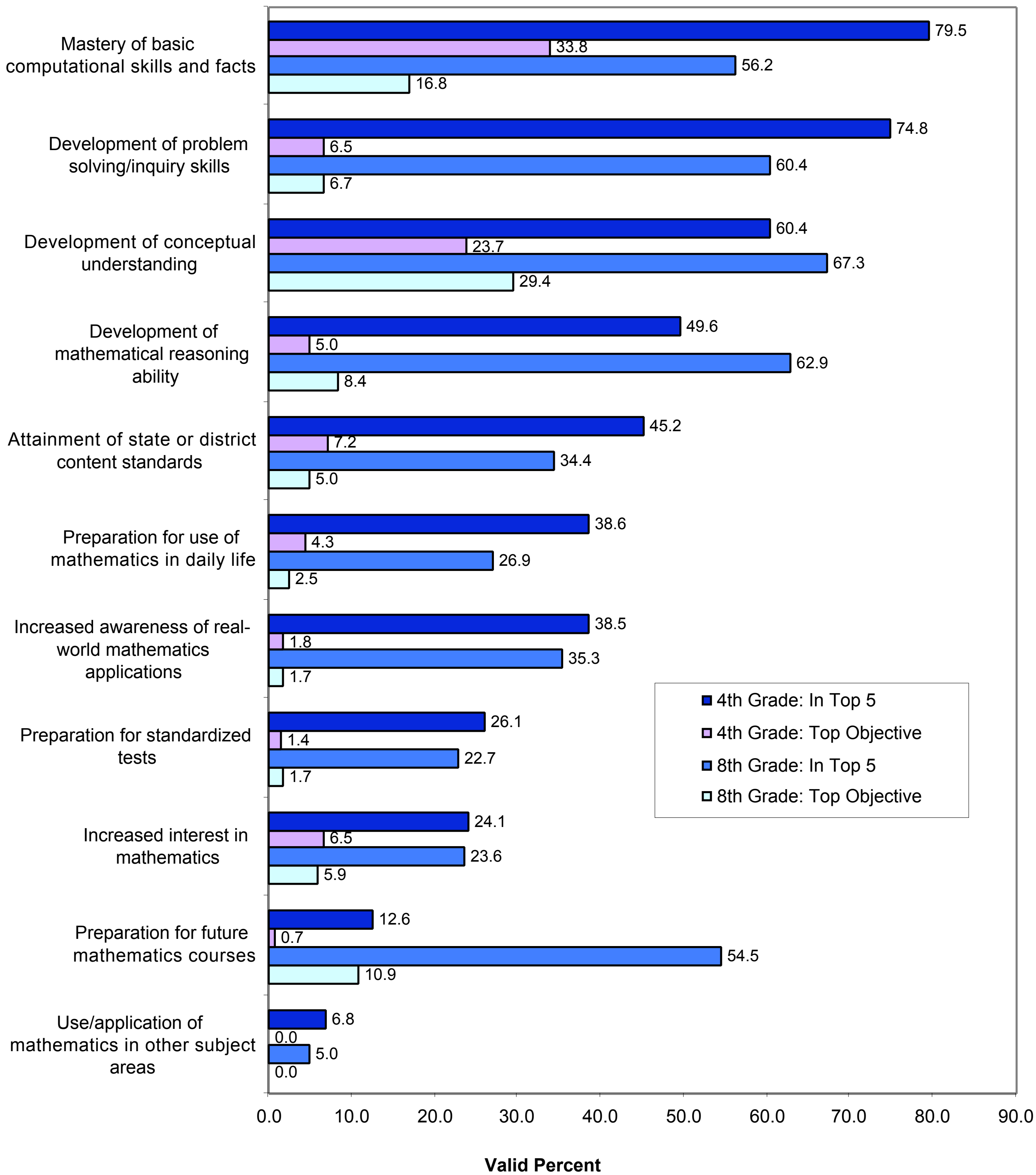
[11] There were also other large categories of responses to the effectiveness question, such as materials and professional development. (See Figure E1 in Appendix E.) These will be discussed in subsequent chapters. Instructional approach and teacher personal characteristics, were, however, the most commonly cited types of responses to the effectiveness question, as discussed here.

other survey questions and in interviews. For example, one survey item listed 11 possible objectives for mathematics instruction, and asked teachers to select the 5 objectives on which they placed the most emphasis for students in their class. Teachers were then asked to rank order the 5 objectives they had selected from 1 to 5 in terms of the emphasis they placed on each one. Figure 3.4 lists all 11 objectives, and shows what percentage of teachers included each objective among their top 5 and what percentage selected each objective as their top one. The chart includes separate figures for the fourth-grade teachers and the eighth-grade teachers.

As the figure shows, "mastery of computational skills and facts," "development of problem solving/inquiry skills," "development of conceptual understanding," and "development of mathematical reasoning ability," were the objectives most frequently selected—particularly as one of the top five—by teachers at both grade levels. Nearly 80% of fourth-grade teachers picked "mastery of basic computational skills and facts" as one of their top five objectives, but "development of problem solving/inquiry skills" followed close behind, selected by about 75% of fourth-grade teachers. Among eighth-grade teachers, "development of conceptual understanding" was the objective most commonly included in the top five, selected by 67.3% of teachers. Taken as a whole, the figure suggests that teachers highly value both basic skills mastery and problem solving/conceptual/reasoning ability.

[text continues on page 30]

Figure 3.4
Teachers' Top-Ranked Objectives for Mathematics Instruction
(fourth grade n=278; eighth grade n=119)



However, teachers' placing *value* on these various objectives does not necessarily mean that they are skilled at effectively teaching to each one. For example, some of the teachers who were interviewed talked about the importance of problem solving or of fostering conceptual understanding, but when these teachers' classes were observed, observers sometimes found little evidence of the stated objective in practice. One experienced observer, who visited four fourth-grade classrooms, commented:

> *Teacher understanding of "problem solving" is not consistent with currently used definitions espoused by NCTM and other reform groups. Two teachers told me they were concentrating on problem solving during my observations, yet in one class the students were doing routine, rote computations and in the other, students were being asked to recognize pairs of equivalent fractions. There is much concentration on procedural development, not conceptual development.*

Indeed, one elementary school principal who was interviewed commented on the need for teachers to receive additional professional development in how to create a balanced approach combining both computation and problem solving:

> *Last year was our PQR year, and we chose math as the area to examine and look at practices in. What came out of that process was that we, as a staff, realized that we needed more knowledge and more training in how to teach problem solving, while at the same time teaching computational skills. We know the current math push is for problem solving, and we agree with that, but I still think computation is important; if you can't add or multiply it's hard to solve problems. So, we dedicated staff development to this; we got additional training from district personnel—they came and did three sessions—to help teachers with strategies and ideas on how to specifically do that: obtain the level of computational skills but not to sacrifice problem solving. That's what our philosophy has been: to be able to do both effectively, and not one at the expense of the other.*

However, not all teachers even believed that there was *ideological* support for such a balanced philosophy. Several teachers objected to the tendency for curriculum policy to swing from one extreme to the other without stopping in the middle, or without remaining consistent for a suitably long period of time. "Too much of a swing from traditional math to inventive math and now back to traditional," wrote one fourth-grade teacher on the survey in response to the question, "What are the biggest obstacles to your mathematics teaching?" And, in response to the question "If there are specific state, district, or school policies that have hindered your mathematics teaching, please describe," an eighth-grade teacher wrote, "Constant change in direction: in today, out tomorrow." Another eighth-grade teacher said in an interview:

> *I feel very strongly that there needs to be a balance between skills and manipulatives. The theory behind figuring out how to do the problems, as well as memorizing algorithms, and I think that there needs to be a balance behind that…I'm aware that there's trends… We had gone on a trend towards interactive [mathematics], and we're now moving more towards the basics; I would like to see the pendulum kind of stop more in the middle, where we have a balance between the two.*

An eighth-grade teacher in a different district commented, "I've seen the modern math pendulum swing from one extreme to the other. Why can't it stay in the middle? I believe in activity-based teaching to a point, but basic skills still need to be taught…. I believe in five years we'll go back to basics."

Apparently, then, while many teachers agree that the pendulum is swinging from one side to another, they do not always agree on exactly which way it is swinging; some see a trend back to basics, while others think the move is in the opposite direction, towards hands-on "reform" approaches. This likely is due to different emphases within different districts and also different emphases at national, state, and district levels. Indeed, some teachers commented that they felt different forces—such as the state vs. their district, or content standards vs. standardized tests—were pulling them in different directions, and that they did not always know how best to deal with this. As one fourth-grade teacher wrote, "Often I'm torn between 'mixed messages.' The district stresses conceptual understanding, hands-on, relationship-oriented math, while the state is requiring a more 'traditional' mastery of concepts. It's often hard to know what and how to teach math."

The current *Mathematics Framework for California Public Schools,* which was adopted by the State Board of Education in 1998 (see Chapter 5), states the following:

> *Mathematics education must provide students with a balanced instructional program. In such a program students become proficient in basic computational and procedural skills, develop conceptual understanding, and become adept at problem solving. All three components are important; none is to be neglected or underemphasized. (p. 7)*

Thus, to the extent that the body of this *Framework* supports the notion of balance, it may help alleviate some of the concerns teachers expressed. However, in order to have this effect, teachers will need to become familiar with the *Framework* and must have the means (e.g., aligned curriculum materials and professional development) to implement its ideas in the classroom. Such topics will be discussed in subsequent portions of this report.

In the Next Chapter

As discussed above, many teachers believe in the importance of a balanced instructional approach, but feel thwarted in their implementation of such an approach by a lack of ideological support for it at the school, district, or state level. In addition, many teachers indicated that a lack of sufficiently balanced curriculum materials hindered their efforts to foster both computational mastery and conceptual understanding among students. This, along with other findings about teachers' use of and thoughts on curriculum materials, is discussed in the following chapter.

(This page intentionally left blank.)

Chapter 4

Curriculum Materials

Highlights of Findings

- **Although curriculum materials often play the major role in shaping instruction, many teachers reported grave concerns about the programs their districts have adopted and said that they use other programs instead.**
  At the fourth-grade level, the most commonly cited obstacles to mathematics teaching had to do with curriculum materials. The use of curriculum materials did not appear to be as problematic at the eighth-grade level as at the fourth-grade level, but materials were still an issue. A substantial proportion of survey respondents said that they use programs other than those adopted by their district as their primary curriculum resource, suggesting that caution should be exercised in attributing low student achievement to adopted materials, since these materials may not even be in widespread use. Programs from previous adoptions and supplementary materials are what many teachers use instead of or in addition to the programs from the current adoption. A lack of professional development in the use of the adopted materials may be partly responsible for teachers' preference for other materials.

- **Teachers' main concerns about curriculum programs had to do with usability, balance, and alignment.**
  One of the most commonly cited concerns about districts' adopted programs was that they are difficult to use—that they are "unfriendly," hard to read, disorganized, or require too much photocopying. Another frequently mentioned concern about the adopted materials was that they lack a sufficient balance between computational skills and conceptual thinking. A third commonly cited concern about curriculum materials was that they are not aligned with standards and/or assessments.

- **Teachers do, however, appreciate the adopted curriculum programs for some purposes and would value *supplementary* use of these programs.**
  Many teachers believe that their district's adopted curriculum program works well as a supplement but not as a base text. Some teachers already use the adopted programs in this way, but other teachers feel they lack the freedom to do so or have difficulty finding appropriate alternate materials in sufficient quantities.

Background

Like several other states, California adopts instructional materials for the major subject areas, including mathematics, on a statewide basis. (However, whereas other states use such a process for all grades K–12, California's constitution mandates statewide adoption only for grades 1–8.) In predetermined years on a multi-year cycle for each subject area, the State Board of Education adopts the instructional materials that are deemed suitable for use, based on prespecified evaluation criteria tied to the most recently adopted curriculum framework. In general, the State Board adopts only programs that are designed for use by students and teachers as a principal learning resource for a full-year course of study. The most recent major ("primary") adoptions for mathematics programs were in 1994 and in 1999.

Until recently, there has been one major pool of state money from which districts could draw for the purchase of K–8 instructional materials: the Instructional Materials Fund (IMF). Districts are required to use at least 70% of their IMF funds (allocated to districts based on average daily attendance) for the purchase of instructional materials that have been adopted by the state. However, districts may spend up to 30% of their IMF funds on materials other than those adopted by the state, provided that these materials meet certain legal compliance criteria. Moreover, districts may petition the State Board of Education for approval to use up to 100% of their IMF allocations on non-adopted materials.

State-level changes over the past three years have significantly affected the nature and process of instructional materials adoption and purchase. In particular, the adoption of new state content standards and standards-aligned frameworks (see next chapter) instigated some changes to materials adoption. For future materials adoptions, adopted materials will be required to "help teachers present the content set forth" in the new standards. In an effort to facilitate the use of standards-aligned materials, the state legislature enacted AB 2519. This bill provided for a series of standards-based materials adoptions, including a special adoption for mathematics and language arts in 1999 and for mathematics in 2001. Unlike the usual adoptions, the 1999 AB 2519 adoption allowed for the adoption of partial or supplementary programs as well as basic full-year programs.

In addition, in 1998 the legislature appropriated $250 million per year (for four years, beginning in 1998–1999) for the purchase of the newly adopted standards-aligned materials in the four core curriculum areas (reading/language arts, mathematics, history/social science, and science). Districts were permitted to use these funds (also allocated based on average daily attendance), known as the Schiff-Bustamante Funds, for purchase only of the specially adopted standards-aligned materials.

The data collection for this research study took place in 1998–1999, before most of the new changes affecting instructional materials went into effect. Thus the data do not reflect these changes—in particular, the move toward materials that are aligned with the state standards. Most of the materials that teachers in this study reported using were among those adopted by the State Board in 1994, when the curriculum framework and adoption criteria were substantially different from those currently in place.

Curriculum Programs in Use

♦ **For many teachers, the textbook plays the major role in shaping curriculum and instruction.**

One of the questions asked of teachers who were interviewed was, "How do you decide what mathematics to teach?" Although the range of responses given was fairly wide, one of the more common responses was along the lines of "I follow the textbook." Two of these responses were as follows:

> *[from an eighth-grade teacher] How do I know what to teach? I basically just follow along through the book. That's how I'm knowing what I should be teaching.*

> *[from a fourth-grade teacher] I follow the book. The district said we have to use it. I occasionally use other texts too.*

Clearly, instructional materials have a strong impact on what teachers teach. Of course, even when teachers "use the book" to guide their curriculum planning, they may be selective about the content they choose to emphasize and the exercises they decide to assign. Hence, two teachers "following" the same text may be teaching significantly differently curricula. This difference can be magnified when one or both of the teachers use supplemental materials of their own choosing, as indicated by the speaker of the second remark quoted above.

Moreover, teachers do not always think that the materials they are given to work with are the most effective or the easiest to use, and some of them primarily use materials other than those adopted by their districts. For example, one of the fourth-grade teachers who was interviewed stated, "The old textbook runs curriculum." Here is a clear case of curriculum driven by a book, but perhaps not the book intended by the current district administration. These issues will be further discussed in the following sections of this chapter.

♦ **At the fourth-grade level, the most commonly cited obstacles to mathematics teaching had to do with curriculum materials. The use of curriculum materials did not seem to be as problematic at the eighth-grade level, but materials were still an issue.**

When asked on the survey, "What are the biggest obstacles to your mathematics teaching?" nearly half of the fourth-grade respondents (105 out of 234, or 44.9%) mentioned something having to do with curriculum materials. Indeed, no other type of obstacle was cited by nearly as many teachers; the next most commonly discussed obstacle had to do with class size/ability range, cited by about one-quarter (26.5%) of the fourth-grade respondents.[1] (Class size will be discussed in the chapter on structural and student influences on instruction.)

Similarly, in response to the question, "If there are specific state, district, or school policies that have hindered your mathematics teaching, please describe," the greatest number of fourth-grade responses (57 of 156, or 36.5%) had to do with curriculum materials.[2] Moreover, several teachers included comments about their curriculum materials in the survey's final question, "Do you have any additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?" Thus it would seem that, at the fourth-grade level, teachers perceive curriculum materials—and the adoption policies surrounding them—as a strong but often problematic influence on their instruction.

The matter of curriculum materials appeared to be slightly less of an issue at the eighth-grade level than at the fourth-grade level. Whereas over 40% of the fourth-grade teachers mentioned something having to do with curriculum materials as being one of the biggest obstacles to their mathematics teaching, only about 20% of eighth-grade teachers did so. However, curriculum materials still formed the second-largest category of eighth-grade responses to the obstacles question. Moreover, in the hindering policies survey question, curriculum materials constituted the largest category of eighth-grade responses, at 21.7%—not quite as large as the fourth-grade teachers' 36.5%, but certainly still substantial.

♦ **Many teachers do not use the curriculum materials that have been adopted by their district as their primary curriculum resource.**

In terms of the specific objections raised, the majority of respondents raised concerns about the nature of the particular mathematics curriculum program/textbook that had been adopted by their district (or, in a few cases, by their school). To place these comments in context, it is important to know what these texts were.

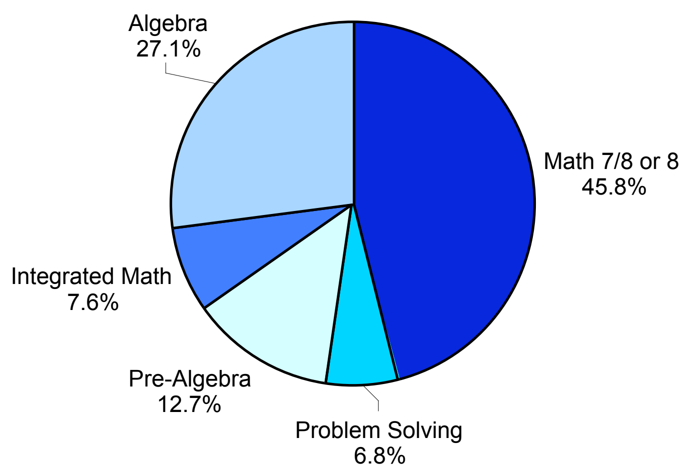
At the fourth-grade level, the most commonly adopted programs[3] were *MathLand* (Creative Publications), adopted by three of the eleven survey districts, and *Quest 2000* (Addison

[1] See Figure E2 in Appendix E for a graph of responses to this survey question.
[2] See Figure E4 in Appendix E for a graph of responses to this survey question.
[3] Here we are referring to the districts' *primary* adoptions. Several districts also adopted supplementary materials.

Wesley), also adopted by three districts. Dale Seymour *Investigations in Number, Data, and Space,* meanwhile, was the adopted text in two of the other districts. Of the remaining three districts, one district had adopted Houghton Mifflin *Mathematics* and another district had adopted *Mathematics Plus* (Harcourt Brace)[4]. In the final district, there was no one single program that was adopted for districtwide use.[5]

The matter of curriculum materials adoption at the eighth-grade level is somewhat more complex, as not all teachers are teaching the same type of mathematics course. Some may be teaching Math 8, while others are teaching algebra, still others are teaching integrated math, and so on. (Figure 4.1 shows the percentage of different types of eighth-grade mathematics courses represented in the survey sample.) Each different course type may have its own adopted text; thus, the range of curriculum materials used and adopted at the eighth-grade level is quite wide—much wider than at the fourth-grade level.

Figure 4.1
Eighth-Grade Courses in Survey Sample
(n=118)[6]



To simplify matters, the analysis of teachers' use of adopted curriculum materials at the eighth-grade level was limited to the eighth-grade teachers who filled out the questionnaire

[4] Interviews indicated that this district also allowed the use of *MathLand*.
[5] A curriculum administrator who was interviewed in this district indicated that the district had adopted three programs: *MathLand*, *Quest 2000*, and Dale Seymour *Investigations*. However, only a few schools in the survey sample from this district appeared to have adopted *MathLand*, and none seemed to have adopted either of the other two programs. According to the survey, the programs most commonly used by teachers in this district were Addison Wesley's *Mathematics*, Silver Burdett Ginn's *Mathematics: Exploring Your World*, and Holt, Rinehart and Winston's *Mathematics Unlimited.*
[6] The one teacher not included answered the questionnaire for a geometry class.

about Math 8 or Math 7/8 (henceforth referred to as "Math 8").[7] As Figure 4.1 shows, such teachers constituted nearly one-half of the survey sample.

There were six survey districts in which five or more Math 8 teachers filled out the questionnaire. In all but one of these six districts, Glencoe's *Interactive Mathematics* was the adopted curriculum program for Math 8. The Glencoe *Interactive* text was also the program most likely to be mentioned by name in the eighth-grade teachers' written survey comments and in interview remarks. As a result, the analysis of eighth-grade teachers' use of and concerns about their curriculum materials focused on this program.

Identifying districts' adopted programs, however, is only part of the story in identifying what programs teachers use—a district's adoption of a program does not guarantee its actual use by teachers in the classroom. As detailed in the text and Figure 4.2 below, many teachers indicated on the questionnaire that the text adopted by their district was not the primary text they themselves used.

Survey question #20b asked, "What mathematics textbook, published instructional program, or curriculum resource do you use the most in your class?" Although space was provided for only one program (teachers were asked to fill out the title, publisher, and copyright date if known), many teachers listed two, slightly complicating the analysis of the responses. If a teacher listed two programs, then use of each program was considered to be "in combination." If a teacher listed only one program, then use of that program was considered "pure." In reality, however, even teachers who listed only one program may have been using other programs as well, but they might have felt obligated by the phrasing of the question to list only one. This is a limitation of the data on what programs teachers were using.

As Figure 4.2 shows, in the one district where *Mathematics Plus* (Harcourt Brace) was the major adopted program, it appears to have been implemented to a relatively high degree, in terms of the number of teachers reporting its use as their primary program. Of 23 teachers in this district responding to #20b, 17 of them (73.9%) reported that this was their primary program. Three others indicated the use of *MathLand*, also allowed by this district. The fact that the district gave schools a choice about their program may help explain why such a high percentage of teachers in the district were indeed using the adopted programs.

The other districts—and programs—did not fare as well. In the district where Houghton Mifflin *Mathematics* was the adopted text, only 11 out of 19 teachers (57.9%) reported its use as the primary program, and only 9 of them reported using it "pure."

[7] Unlike the previous chapter, this discussion does *not* consider courses identified as pre-algebra or problem-solving to be Math 8.

Figure 4.2
Use of the Adopted Program in Selected Survey Districts, as Reported in Survey Question 20b

Program	Number of Survey Districts That Adopted the Program	Number of Teachers in Those Districts Responding to #20b	Number (and Valid Percent) of Teachers Reporting "Pure" Use of the Program in #20b	Number (and Valid Percent) of Teachers Reporting Combination Use of the Program in #20b	Total Number (and Valid Percent) of Teachers Reporting Use of the Program in #20b
Fourth Grade					
MathLand	3	79 (of 85)	45 (57.0%)	6 (7.6%)	51 (64.6%)
Quest 2000	3	77 (of 83)	36 (46.8%)	10 (13.0%)	46 (59.7%)
Dale Seymour *Investigations*	2	33 (of 38)	7 (21.2%)	3 (9.1%)	10 (30.3%)
Mathematics Plus	1	23 (of 24)	17 (73.9%)	0 (0.0%)	17 (73.9%)
Houghton Mifflin *Mathematics*	1	19 (of 21)	9 (47.4%)	2 (10.5%)	11 (57.9%)
Eighth Grade (Math 8)					
Glencoe *Interactive Mathematics*	5 (for Math 8)	30 (of 35 Math 8)	10 (33.3%)	0 (0.0%)	10 (33.3%)

The numbers are similar for the districts that adopted *MathLand* and *Quest 2000*. In the three districts where *MathLand* was the sole adopted text, a total of 79 teachers answered #20b. 45 of these teachers (57.0%) reported the "pure" use of *MathLand*, and another 6 teachers (7.6%) reported using it in combination. Thus, only about two-thirds of respondents (64.6%) in these three districts reported using *MathLand* as at least one of their primary programs.

In the three *Quest 2000* districts, a total of 77 teachers answered #20b; 36 of them (46.8%) reported *Quest 2000* alone, and another 10 (13.0%) reported using it in combination with another program, for a total of 59.7% using *Quest 2000* as one of their primary programs.

Dale Seymour *Investigations* was used by an even smaller proportion of teachers. In the two districts where this was the adopted program, 33 teachers answered #20b. Of these 33 teachers, only 7 reported "pure" use of Dale Seymour, with 3 others reporting use of the program in combination. Thus, only 10 of 33 teachers (30.3%) in these two districts indicated that the district-adopted program was at least one of their primary programs. In one of the two districts, only 3 of 20 respondents listed the program in their answer to #20b.

A similar picture exists for the one eighth-grade program included in the analysis, Glencoe's *Interactive Mathematics.* Only 10 of the 30 Math 8 teachers (in the five *Interactive Mathematics* districts) who responded to the question about their most used program listed this text. In 2 of the 5 districts, *no* teachers listed it.

That many teachers are not primarily using their districts' adopted program comes as no surprise to most district curriculum and instruction administrators. For instance, in one of the *MathLand* districts, the district mathematics coordinator estimated in an interview that about 80 to 90% of district teachers were using *MathLand* to some extent, but that only about 15% had "fully implemented it," and that most had implemented it "about 50% or less." She suggested that since state frameworks and textbook adoptions are on seven-year cycles, teachers who don't like a particular approach or program have learned to "wait it out."

These data suggest that caution should be exercised in attributing low student achievement to currently adopted materials. In fact, these materials may not even be in widespread use.

♦ **Older programs, from previous adoptions, are what many teachers use instead of or in addition to the programs from the current adoption. Some teachers, meanwhile, make supplementary materials the core of their instruction.**

Since so many teachers did not report using the adopted text as at least one of their primary programs, the question arises as to what they were using instead (or, in the case of teachers who were using the adopted text as part of a combination, what else they were using). The answer, based on survey responses and interviews with teachers and principals, mainly appears to be textbooks from older adoptions. One relatively new teacher who was interviewed explained:

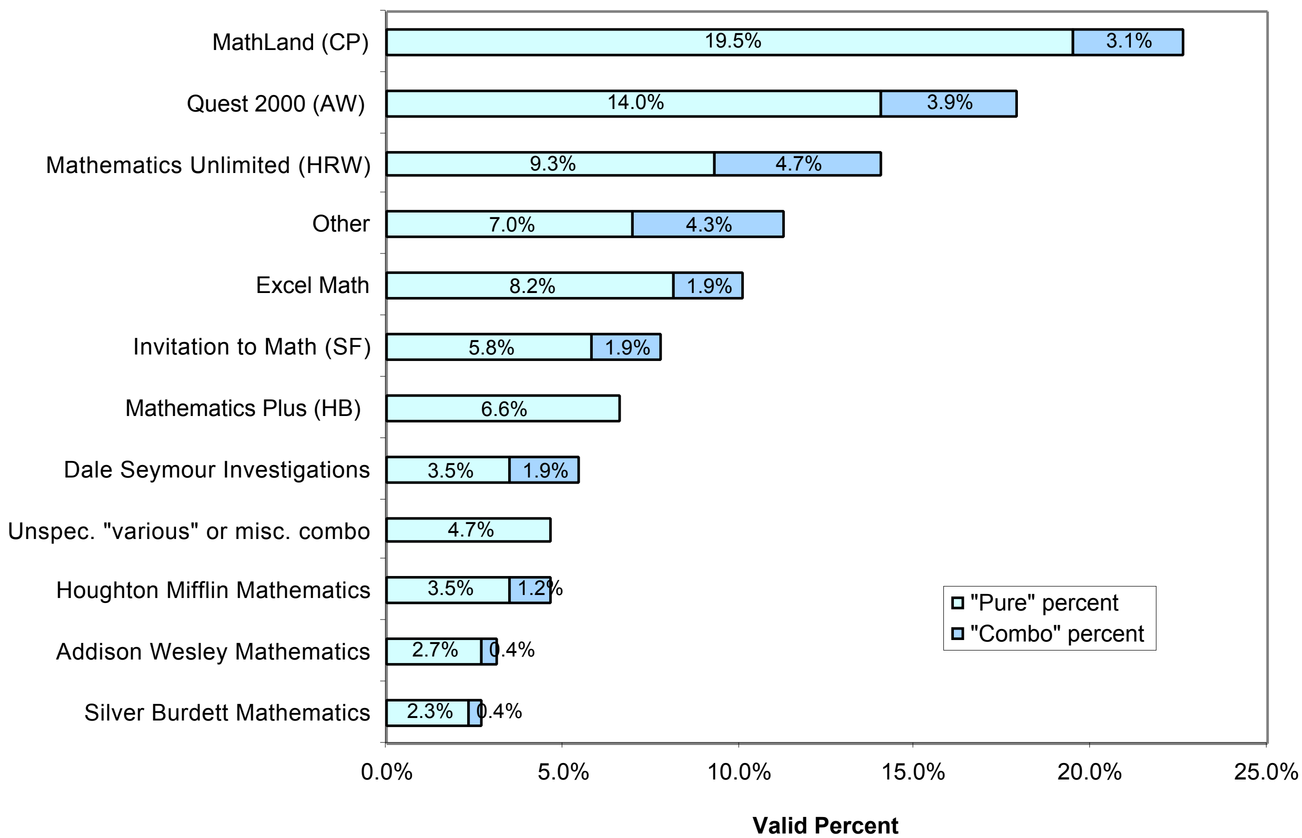
> *We're supposed to use* MathLand *as our text but my kids have a hard time using abstract examples and concepts. We end up using* Math Unlimited; *it's outdated but more concrete…. I found [it] in the closets."*

The text mentioned by this teacher—Holt, Rinehart and Winston's *Mathematics Unlimited* (1988)—was one of the most commonly mentioned older texts in use at the fourth-grade level, across all of the districts. In fact, as shown by Figure 4.3, this text was the third most commonly cited textbook used (behind *MathLand* and *Quest 2000*) *among all 257 fourth-grade teachers* who answered #20b, with 14% of teachers listing it as at least one of their primary texts (including 9.3% listing it as their only primary text).

The other older text that was cited by many fourth-grade teachers was Scott Foresman's *Invitation to Mathematics* (1988). It was the fifth most commonly cited text overall (not including the catchall "other" category), with 8.2% of teachers listing it as at least one of their primary texts, including 5.8% listing it as their only text.

Excel Math (Ansmar Publishers)—a curriculum that consists mainly of sets of "lesson sheets"—was the fourth most commonly cited text program in use among fourth-grade teachers, and represents an additional answer to the question of what teachers use instead of their district's main adopted program. In one of the *Quest 2000* districts, 9 out of the 24 teachers in the district listed *Excel* in their answer to #20b, and 7 of them listed it “pure.” The use of *Excel* was even more pronounced in the district where only 3 out of 20 teachers indicated using the adopted program, Dale Seymour *Investigations*. In this district, 17 out of 20 teachers listed *Excel* as their primary resource, 14 of them “pure.” While not the primary program in this district, *Excel* is made available by the district as a supplementary resource. It would appear, then, that many teachers are using materials intended as “supplementary” as the core of their program.

Figure 4.3
Percentage of Fourth-Grade Teachers Reporting Various Programs as Their Most Used Curriculum Resource (Survey Question 20b)[8]
n=257



Note: For the “other” category, the “pure” percentage represents the use of a single curriculum program other than any named here. The “combo” percentage part of “other” indicates the use of one curriculum program named here and another one not named here. The “unspecified various or miscellaneous combo” category includes two different types of responses to question 20b: 1) responses that did not name any particular program but merely stated “various” or “several”; and 2) responses that named two (or more) programs, neither of which were named here.

[8] At the eighth-grade level, too many different programs were named (largely as a result of the range of courses being taught) to construct a similar graph.

At the eighth-grade level, there was considerable variation to what teachers said they were using instead of *Interactive Mathematics,* but the general themes that emerge are similar to those found at the fourth-grade level. Among the 20 teachers in *Interactive Mathematics* districts who did not report using the adopted text, four of them listed Holt, Rinehart and Winston's *Mathematics Unlimited*, and two listed Scott Foresman's *Invitation to Mathematics*—both of which were programs from a previous adoption. Another five listed a different Glencoe program—*Applications and Connections,* and two more were using Glencoe *Pre-Algebra.*

♦ **Teachers may use programs other than the adopted ones for any number of reasons. For instance, they may have not received sufficient professional development on how to use the adopted programs.**

The fact that so many teachers do not predominantly use their districts' adopted programs could be attributable to a variety of reasons. One is that there may be a natural resistance to change that requires extra work, as changing from one program to another likely would, especially given that so many teachers rely on the text to guide their instruction. This natural resistance to change would be exacerbated if the purpose or the need for the change were not evident.

A second reason why teachers may avoid using adopted materials, particularly if the adopted materials are very different from the materials used previously, is that teachers may feel unsure of how to use them. For instance, "not understanding how to use the text [*Quest 2000*]," was one teacher's response to the "obstacles" survey question; another teacher, in response to the "hindrances" survey question, wrote "I wasn't told exactly what the *MathLand* curriculum was or how to properly teach it." An administrator in this same district said in an interview that teachers who go to training sessions on *MathLand* (the district's adopted program) and see how it works try it and like it, but that others resist using it. An interviewed eighth-grade teacher in another district said that she likes *Mathematics Unlimited* because it is "more like what I used when I went through school."

Indeed, for teachers to use materials unlike those they have taught from before—and unlike those they learned from themselves as students—may require significant professional development. Yet 64% of fourth-grade survey respondents and 53% of eighth-grade respondents reported that since January 1998, they had had less than four hours of professional development on the "use of particular mathematics curricula or curriculum materials (e.g., a particular textbook.)" Admittedly, more professional development may have been available in years prior to 1998 when the materials were first adopted, but at the very least, it appears that materials-related professional development is not an ongoing activity for the majority of teachers. Moreover, new teachers would have missed out on earlier-provided opportunities.

A chi-square analysis did find a significant relationship (p<.05) between use of the adopted program and amount of materials-related professional development among fourth-grade teachers in the ten districts with clearly identified adopted programs. Teachers in these districts who had had more than 1 day of materials-related professional development since 1998 were more likely to report "pure" use of their district's adopted program than were teachers who had had less than 1 day of such professional development.

A third possible reason that so many teachers do not primarily use the adopted materials is that they find the adopted materials inadequate in one way or another. This was supported by comments teachers made about the programs in response to the survey's open-ended questions and in interviews.

While some of the comments about various programs were made by teachers who indicated that they did, in fact, use these programs, many of the comments came from teachers who said they used other programs (as their primary curriculum resource) instead. A brief numerical analysis of how many of the negative remarks came from users and how many came from non-users follows. Because *MathLand* and *Quest 2000* were the most commonly adopted and used fourth-grade programs, the numerical analysis focused on these two programs.

In the survey's section of open-ended questions, 28 of 85 teachers in the three *MathLand* districts (32.9%) wrote negative remarks about the program. 14 of these teachers reported in #20b that they used the program "pure," while 11 of the 28 teachers did not report *any* use of *MathLand* in #20b (presumably because of their objections to the program). Of the remaining 3 teachers, 2 reported using *MathLand* in combination, and 1 left #20b blank.

Meanwhile, in the three *Quest 2000* districts, 41 of 83 teachers—i.e., nearly 50%—remarked negatively on the program in open-ended comments. Of these 41 teachers, 18 were "pure" users, 5 were combination users, and 14 were non-users, according to #20b. (The remaining 4 left #20b blank.)

Despite the evidence that the adopted programs are problematic for teachers, it bears noting that many teachers do use their district-adopted programs without apparent complaint. Of the 45 reported "pure" users of *MathLand* in its three districts, 24 who also answered the open-ended questions did *not* comment negatively on the program.[9] For *Quest*, meanwhile, 14 of 36 "pure" users did not comment negatively.[10] Thus, not all users of these programs strongly objected to them, at least not in comparison with other items they felt were more important to comment on in their responses to the open-ended questions. A few teachers even wrote exclusively positive comments about the adopted programs.

[9] The other 7 "pure" *MathLand* users from these three districts did not choose to answer any of the open-ended questions, so their opinions on the program cannot be inferred.
[10] The other 4 "pure" *Quest 2000* users from these three districts did not answer any of the open-ended questions.

Nevertheless, because negative comments far outweighed positive comments and dominated the responses to the open-ended "obstacles" and "hindrances" survey questions, a closer look at these negative comments is warranted. The following section discusses the nature of teachers' concerns about their curriculum programs based on these comments.

The Nature of Teachers' Concerns with Adopted Curriculum Programs

♦ **One of the most commonly cited concerns about districts' adopted programs was that they are difficult to use—that they are "unfriendly," hard to read, or disorganized.**

Having established that many district-adopted programs are fairly unpopular, naturally the next question is, why? What is it that makes these programs unpopular? The scope of this study did not allow for a review of the programs themselves. Thus, we can only present teachers' perceptions, from their self-report on the survey and in interviews, of the problems with the various programs. *No independent confirmation or verification of teachers' remarks was attempted, and the authors of this report do not necessarily share the opinions presented herein.*

Many teachers' survey comments did not articulate specific objections to the adopted materials. For instance, "poor textbook selection by the district," "no good district math program," or "ineffective text" were among the obstacles and hindrances cited.

However, many other teachers did discuss the nature of their concerns about curriculum materials. One concern raised by many teachers is that the adopted programs are "unfriendly" or difficult to use. For instance, one teacher wrote, "The *Quest* series is extremely poorly organized. The T.E. [Teacher's Edition] does not show me what students will see. The student text is almost useless." Another teacher wrote, "Text [*Mathematics Plus*] is confusing and unclear at times."

Similarly, one of the main concerns expressed about the eighth-grade Glencoe *Interactive* text had to do with its readability. Several teachers, both in survey comments and in interviews, indicated that the reading level of the text is too difficult for many of the students. As one teacher wrote in response to the hindrances survey question, the "Glencoe text that has been mandated by district" is "very difficult to read by students!"

Several elementary school principals who were interviewed commented that teachers find it difficult to use *MathLand* and Dale Seymour because these programs lack sufficient "structure." In part, this may mean that they do not come with what many teachers consider to be a textbook— a traditional hard-bound pupil's edition—but rather consist of booklets, blackline masters, kits of manipulatives, and the like.[11] Some teachers in schools where these were the adopted programs bemoaned the lack of a textbook. "A textbook is tangible and is easier to give homework from," wrote one teacher, "It is also good as a reference."

- ♦ **Some teachers said that the adopted materials require too much photocopying, either because of the way the programs were designed or because of the way they were purchased.**

The lack of a textbook *per se* lies at the heart of another usability concern mentioned by some teachers—the amount of photocopying necessary. For instance, teachers may receive a full classroom set of student workbooks, but because these workbooks will need to be reused in subsequent years, students cannot actually write in the workbooks. The following were cited as obstacles/hindrances on the survey from fourth-grade teachers in two different districts:

> *Having to photocopy so many materials because student copies are not available or can't be written in by children.*

> *We can't use student workbook because we probably won't get more, so we have to copy them.*

Similarly, one principal who was interviewed commented that the adopted program, *MathLand*, requires much duplication of materials for student use. He reported that over one million copies were made to service 480 students.

The need to make copies was also an issue for some of the eighth-grade teachers. Even if students each have their own copy of the text itself, they usually do not have their own copies of the ancillary materials that accompany the text. Many teachers like to assign homework from these materials, necessitating photocopying. For example, one interviewed teacher said that although each student has his/her own copy of the base text (Glencoe *Interactive*), the program's skills workbooks exist only as a single classroom set, so students cannot take them home for homework. "I spend an exorbitant amount of my budget, and of my time, making copies. Because I don't have a book to go out of here [for homework]," she explained. Hence, some teachers' concerns about the adopted materials are not about the mathematical content of the materials, but about the way the materials must be used because of how they were purchased.

[11] As of 2000, *MathLand* does have a student book, but this had not yet been published at the time of data collection.

- ♦ **Another frequently mentioned concern about the adopted materials was that they lack a sufficient balance between computational skills and conceptual thinking.**

Another top concern about nearly all of the adopted materials, reported by both fourth- and eighth-grade teachers, was that they do not adequately address basic skills,[12] as demonstrated by the following representative survey comments, *each about a different curriculum program:*

> *The required curriculum materials: there is not an appropriate textbook which emphasizes basic computational skills.*
>
> *Adherence to district curricula that doesn't respond to the needs of the child—requires higher order skills, but doesn't teach them.*
>
> *I do not like the new math series [adopted by the district]—Too way out there! The book is assuming too much. Kids need more basic skills to use this book.*
>
> *[Adopted] text…does not stress basics enough!*

Teachers' desire for more coverage of basic skills does not, however, necessarily mean that they want their curriculum materials to be *exclusively* basic-skills oriented. Indeed, many teachers do appreciate the investigative, hands-on, activity-based approach taken by programs such as *MathLand*, *Quest 2000*, Dale-Seymour, and Glencoe *Interactive*, but have difficulty in implementing the approach for practical reasons (relating to the "usability" concerns discussed above):

> *I am not impressed with* MathLand *as a complete program. It's great to have the kids explore and discover but there is not enough time for them to discover everything.*
>
> *[About* Quest 2000*] The manipulatives are good, and there are many good activities, but it is poorly written and hard to "read."*
>
> *The current math program [Dale Seymour] is great if I'm willing to give every waking moment to prepare for it, and use my own money to buy the extra supplies that are needed, but then I also need to do that for science and language arts.*

Several teachers spoke of seeking a *balance* between basic skills and higher-order conceptual thinking and of wanting materials with such a balance:

[12] Again, this perception was not independently verified through an examination of the programs themselves.

> *[cited obstacle] Creating a balance in the curriculum and finding materials that support this kind of mathematics education.*

> *[cited obstacle] The lack of an adequate text which combines real life applications with adequate computation.*

> *The old Holt series was more sequential and provided lots of practice. Not open-ended, though.* Quest *too far out—did not cover a lot of material in a year. Excellent for constructing meaning, but took way too long. We seem to go from one extreme adoption to another.*

As such, many teachers do not want to completely *eliminate* the adopted materials, but merely wish to *supplement* them (or to use them as a supplement) to provide the desired balance. This was particularly the case with *MathLand*, as represented by the following two comments:

> MathLand *adopted program cannot be used as a core with students who have not mastered the basics. As a supplement, fine—it works.*

> *Our district has implemented* MathLand *as our only math resource. Teachers have found it ridiculous that one program can meet the wide range of classroom math needs. I wish we would adopt 2-3 programs to use and provide needed materials for an entire class (not just 20 ea. class).*

Teachers' desire for balance and their interest in using the adopted program as a supplement apply equally at the eighth-grade level, with Glencoe *Interactive.* As with the fourth-grade programs, one of the main reasons teachers dislike or avoid using the *Interactive* text is that they perceive it as too activity-oriented or theoretical, lacking a sufficient balance between computational practice and conceptual understanding. Teachers do see value in the program, but more as a supplement than as the base text. The district mathematics coordinator in one of the Glencoe *Interactive* districts spoke of how the district "ran into difficulties" when they adopted new materials in an attempt to implement the 1992 Framework and the NCTM standards:

> *The change was tremendously dramatic for most teachers. The grades that shocked me the most were the middle school grades, where we had been using replacement units for a number of years…. I would say almost all our middle school math teachers were using [the replacement units] to a certain extent. Well, the Glencoe* Interactive *was almost taking those replacement units and putting them in book form. So, to me, that should have been the easiest one [of all of the newly adopted texts at various levels within the district] to implement. Well, that's probably where we had some of the greatest resistance…. What teachers had had was predominantly computational kinds of materials, so they had been using these replacement units [as a rich supplement to make] mathematics almost come to life. Well, the whole thing just reversed. Now, those replacement units—the* Interactive *units—became the core. And teachers, they didn't see a cohesive mathematics program. They had used the replacements for enrichment, and relied on the*

> *computational as their core, and when it reversed, it didn't quite work…. The foundation needs to be there, and then you build on the foundation…. Teachers are looking for something they can really get their hands on, and what they see is, the computation stuff is the stuff they can really hang on to, and you can build on that. You try to go the other way, and it's much more difficult.*

In one of the other Glencoe *Interactive* districts, a teacher who was interviewed also spoke at length about the program and about her concerns that it lacked balance:

> *I do use the district-adopted curriculum [Glencoe* Interactive*], but I use it as supplementary material. I don't use it as the foundation of my program. And only because, all by itself, it's all theory. And there's really not a lot of practice involved. And I like the idea of interweaving the theory and the practice. So, if you have a book that's all skills and drills, it's not going to cut it. If you have a book that's all theory, it's not going to cut it. There needs to be a combination, a balance between the two…. The adopted text doesn't have the practice problems that I assign for homework…. My kids really like it because it's all fun and games, and they do get something out of it, but it's not as much as I would like. You really have to have the basic skills down in order to do this* Interactive *book, and I find a lot of these kids do not have their basic, basic skills, like long division—they do not have that down at the beginning of the year. So I can't even start this book until we've covered the basics…. There's a lot of parental concern with this* Interactive *book;* I *have a lot of concerns with it. I can't teach out of just the* Interactive *book.*

When asked, "What, if anything, would help you improve your math instruction?" this teacher simply replied, "A textbook. One that has a balance between skills and theory."

Another teacher who was interviewed said that the Glencoe text had influenced his teaching "in a positive way," and he indicated that he had received considerable professional development and support on its use that he had found effective and helpful. Even so, on the survey this teacher listed the Holt, Rinehart and Winston *Mathematics Unlimited* as being his primary text.

- **A third commonly cited concern about curriculum materials was that they are not aligned with standards and/or assessments.**

For many teachers, the concern about the curriculum materials was not necessarily about the materials *per se*, but rather about the materials' relationship to—and specifically, their lack of alignment with—state and/or district standards. This was particularly an issue at the fourth-grade level. On the survey, over one-third of fourth grade teachers (35.9%) said they disagreed with the statement, "Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching." The level of disagreement on this item was much higher than for any of the other 12 opinion items relating to standards. (The item with the next highest level of disagreement was, "The

NCTM standards have influenced my teaching for the better," with which 20.8% of responding fourth-grade teachers disagreed.)

Fourth-grade teachers' open-ended remarks also reflected the concern about lack of alignment between materials and standards. The concern was widespread, found in nearly every district included in the study. Each of the following survey comments was made by a teacher in a different district:

> *…Our district is stuck with a $1 million program that is ineffective and which doesn't address the state standards or our new district standards.*

> *Lack of adequate materials to implement all of the Math Content Standards (1998)*

> *Perhaps if we felt that the current program we are using corresponds with the state frameworks and state standardized tests…. Many teachers have felt that the two things [the program and frameworks/STAR test] don't support each other.*

As with this last comment, several teachers also expressed concern that the curriculum materials were insufficient for preparing students to take the required assessments. Representative survey comments about this included:

> *District not aligning curriculum to state assessment instruments*

> *Ineffective materials and adoptions with a very poor weighting of topics which doesn't relate to standardized tests in any way.*

One teacher who was interviewed indicated that the lack of alignment between the approach of the adopted program (Dale Seymour) and the SAT-9 was the major reason why teachers at his school were using an older text:

> *We have a new math adoption; supposedly we were to throw away the old one. The new math is 100% manipulatives, but as we're working with this, a lot of the teachers are finding that, when the students go to take the SAT-9, it doesn't help them at all. So, a lot of [my use of materials] is taking things that we used from the old adoption, and trying to fit them in with the new adoption. But in all honesty, I end up using the old adoption probably more.*

The issue of alignment will be discussed further in the subsequent chapters on standards and assessment.

- **Some teachers would like to have more freedom in their use of curriculum materials. Others indicated that they already have such freedom, supplementing liberally or choosing programs other than the adopted ones.**

As some of the remarks in the preceding discussion suggest, several teachers indicated a desire to have more freedom in selecting the programs they use, and many objected to being, as they put it, "forced" or "required" to use a particular program. In response to the "hindering policies" survey question, one fourth-grade teacher wrote:

> *School selected (school-wide adoption) instructional materials/publishers programs. Choices that aren't individual but [made by the school or the district]. I feel limited and constrained by materials selected by someone else…. To improve my instructional effectiveness I would like to select the choice of materials/text for my classroom program in mathematics as well as some other academic areas.*

Not every teacher, however, feels quite so constrained in the use of curriculum materials. While some districts or schools may strongly discourage use of materials other than the adopted programs, others appear to offer a bit more flexibility. Several teachers who were interviewed spoke of using many different programs or of supplementing heavily, and the following survey comments were made in response to the question, "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe":

> *Allow me to use the materials I choose, rather than requiring texts.*

> *A shift from "one size fits all" attitude to "use what resources we have" to implement and meet math standards.*

For some teachers, though, tracking down supplementary materials is a challenge—one that they would rather not have to face. The following remarks were among those made in response to the survey question about obstacles to mathematics teaching:

> *Cost of materials to enrich the program*

> *The textbook our district purchased. Having to supplement on my own materials that will clarify and enhance the different math concepts.*

> *Lousy curriculum—I mean lousy. As a new teacher who has had little instruction in math I am constantly forced to "pull" together curriculum and quite frankly feel like a failure most of the time (only in math).*

As this last comment suggests, the level of teachers' willingness to supplement may be a function of their experience level. Teachers who have been teaching for a while may have more of a "stock" of materials to use in supplementing (or, perhaps, in replacing) the adopted programs, while newer teachers may not. Indeed, one district coordinator who was interviewed even pointed out that new teachers seem to use whatever materials they are given, while more experienced teachers pick and choose from a wide array of resources. However, an analysis of data on fourth-grade teachers' experience level and use of adopted materials did not reveal that "pure" users of the adopted materials had significantly fewer years of teaching experience, on average, than teachers who did not use the adopted materials or who used them in combination.[13]

- **Some fourth-grade teachers cited a shortage of materials as being an obstacle to their mathematics teaching. In many cases, however, the shortage is linked to the program in use.**

Approximately 30 fourth-grade teachers indicated on the survey that an insufficient quantity of materials was one of the biggest obstacles to their mathematics teaching. About half of these teachers did not specify what *types* of materials were in short supply, mentioning only "lack of materials" or "inadequate supplies" in their answer to the open-ended question. Others specified books, manipulatives, or other supplementary materials. A few mentioned technology resources (such as computers or computer support).[14] Some of the teachers who were interviewed also spoke of insufficient quantities of materials.

In some cases, the shortage of materials appears to be a function of large class size. "Proper materials—not enough for a class over 25," wrote one teacher in response to the obstacles question on the survey. (Class size is further discussed in Chapter 8.) For some, the problem was manipulatives[15]; for others, it was books. Shortage of books becomes a particular problem when teachers want to assign homework out of the books, because there are not enough books for each student to take one home, or there are not enough "consumables," as discussed earlier in the chapter.

Large class size notwithstanding, the problem of materials shortage cannot be completely separated from concerns regarding the curriculum programs themselves. In particular, the reason that some teachers experience a shortage may be that they are using materials other than those adopted by the district, and these other materials may be in shorter supply than the adopted ones. One teacher wrote:

> *The biggest obstacle in my classroom is not enough math books for each student. Normally I have 2 to 3 students to math book.*

---

[13] Across all ten districts with clearly identifiable adopted programs, there was virtually no difference in the mean years of total teaching experience (as reported on questionnaire #32a) of "pure" users of the adopted text as compared to combination users/non-users (as reported on #20b). In the three *MathLand* districts, "pure" *MathLand* users did have fewer years of experience, on average, than other teachers; the same was true with the three *Quest 2000* districts. However, the difference between the means in each set of three districts was not statistically significant even at a .10 level.
[14] On a different set of survey items including questions about instructional use of computers, approximately 20% of fourth grade respondents and 33% of eighth-grade respondents indicated that they had "no access" to computers.
[15] On the other hand, several teachers cited an *abundance* of manipulatives as something that had *helped* their mathematics teaching.

This teacher, however, indicated that her primary text was the Holt, Rinehart and Winston *Mathematics Unlimited*, even though her district's currently adopted text was *MathLand*. Thus, it is likely that the book she had a shortage of was not the newly adopted program, but rather the older one, for which she would have been unable to get new or replacement copies. Other teachers who noted a lack or a shortage of materials may also have been referring to supplementary materials rather than to the primary adoption.

In the Next Chapter

As discussed in this chapter, one of the concerns held by many teachers was that adopted materials are not aligned with standards. Especially given how many teachers use their textbook to guide instruction, it is crucial that curriculum materials be aligned with standards. Standards, however, may have their own set of problems. These are discussed in the following chapter.

Chapter 5

Content Standards

Highlights of Findings

- **Teachers' reactions to content standards are mixed.**
  Some teachers appreciate the adoption of standards and the guidance they bring. Many teachers, however, believe that the new state standards are too ambitious—that some of them are developmentally inappropriate or that they focus on breadth at the expense of depth and cover more material than can be fit into a year. Eighth-grade teachers were particularly concerned about the requirement that all eighth-grade students take algebra.

- **Teachers' familiarity with content standards is highly variable.**
  Even within schools, some teachers were highly familiar with the standards, and others seemed barely to know about them at all. There was considerable confusion, and some frustration, about the existence of different sets of standards (e.g., district, state, national).

- **As of spring 1999, content standards had yet to make a consistent, significant impact at the classroom level.**
  Although teachers reported that local standards had influenced their teaching, interviews and observations suggested that the standards *per se* were not having a high level of meaningful impact on classroom mathematics instruction. The apparent lack of alignment between curriculum and standards may contribute to this problem. Alignment of content standards with curriculum and instruction is an ongoing process.

Background

Content standards—what students should know and be able to do—have been one of the hottest topics in education across the nation for the past several years. Of all of the subject areas, mathematics was one of the first in which standards were developed, and California was a leader in that effort, with the 1985 publication of the *Mathematics Framework for California Public Schools, Kindergarten Through Grade 12*. This document, which focused on the importance of discerning mathematical relationships, logical reasoning, and effective use of mathematics techniques, stressed the importance of mathematical power and understanding for *all* students. It identified seven strands of mathematical content: number, measurement, geometry, patterns and functions, statistics and probability, logic, and algebra. The document was groundbreaking, laying the foundation for much of the national mathematics reform efforts of the 1980s and 1990s.

Nationally, the mathematics standards movement hit full stride in 1989, with the publication of the *Curriculum and Evaluation Standards for School Mathematics* by the National Council of Teachers of Mathematics (NCTM). Developed by consensus among NCTM members, the document set out standards for each of three grade-level spans (K–4, 5–8, and 9–12), including emphases on problem solving, mathematical communication, mathematical reasoning, and mathematical connections. Content areas were similar to the California *Framework's* strands. For example, the standards for grades K–4 included number sense and numeration, measurement, geometry and spatial sense, patterns and relationships, and statistics and probability. The content areas for the other grade-level spans were similar.[1]

As the NCTM document took hold and began to spark national interest, California was working on an updated edition of its *Mathematics Framework*. The revised document, which came out in 1992, built on the concepts and recommendations contained in the 1985 version, in an effort to extend them into a more comprehensive vision for mathematics education and to reinforce the goal of mathematical power for all students. It kept the same basic strands of the 1985 edition (adding one more, discrete mathematics, and making changes to some of the others) and added "unifying ideas" for each grade span (K–5, 6–8, and 9–12). In general, the 1992 *Framework* was consistent with and aligned to the NCTM standards.

Neither the *Framework* nor the NCTM document, however, defined standards for individual grade levels. The 1994 reauthorization of the federal Elementary and Secondary Education Act (ESEA), Title I, called for states to articulate grade-level academic standards, and California began encouraging districts to develop local grade-level standards in mathematics (as well as in language arts) in 1996–97. Also in 1996, a "Mathematics Program Advisory" was distributed to superintendents and principals by the California Department of Education, the California Commission on Teacher Credentialing, and the California State Board of Education. This program advisory, a policy statement written in response to recommendations by a statewide Mathematics Task Force, emphasized the importance of a balanced mathematics program—one including basic skills in addition to conceptual understanding and problem solving.

The following year, in 1997, the California State Board of Education (SBE) adopted statewide grade-by-grade standards in mathematics, published as the *Mathematics Content Standards*

[1] In 2000, the NCTM published a revised standards document, entitled *Principles and Standards for School Mathematics.* Although this document had not yet been published at the time of the study's data collection activities, a discussion draft was circulated in 1998.

for California Public Schools: Kindergarten Through Grade Twelve. These new State-Board–adopted standards represented a departure from the *Framework* and NCTM documents. Although the standards within each grade level were organized around five strands similar to those from the earlier documents,[2] they emphasized fluency in basic computational skills to a much greater extent than the earlier documents had. Moreover, particular standards items were much more highly detailed, and placed significantly more emphasis on specific mathematical content, than those from the earlier documents.

The new state standards, *per se,* did not automatically replace the local standards that districts had been developing. Districts were, however, advised to align their local standards with the new state standards in order to ensure that the local standards were "at least as rigorous as" the state standards. The state's definition of rigor included breadth, depth, pace of learning, and levels of performance (CDE, 1998).

Finally, in 1998, the State Board adopted yet another updated *Mathematics Framework for California Public Schools, Kindergarten Through Grade Twelve*. This new *Framework* was strongly aligned with 1997 *Mathematics Content Standards,* and thus differed substantially from the 1985 and 1992 *Frameworks.* A strong grade-by-grade focus and attention to particular content replaced the more conceptual and thematic approach of the earlier *Frameworks.* The publication of the new *Framework* was somewhat controversial, as some members of California's professional mathematics education community felt that the document had not been developed in a sufficiently public and broad-based consensual process (Anderson, J., 1998; Becker & Jacob, 2000).

This chapter presents study findings about teachers' reactions to mathematics standards—the concept of standards in general and in some cases particular standards documents. The chapter also examines the impact that mathematics standards have had on classroom instruction.

Reactions to Standards

♦ **Teachers' reactions to standards are mixed. Some appreciate the adoption of standards and the guidance they bring, but many teachers also believe that the new standards are too ambitious.**

In response to the survey question, "If there are any specific state, district, or school policies that have *helped* your mathematics teaching, please describe," many teachers cited standards.[3] In fact, at the fourth grade level, standards formed the most frequently cited

[2] Number sense; algebra and functions; measurement and geometry; statistics, data analysis, and probability; and mathematical reasoning.
[3] See Figure E3 in Appendix E for a graph of responses to this survey question.

category of responses, mentioned by 28.2% of teachers. At the eighth-grade level, standards were mentioned by 28.8% of teachers, second only to professional development/teacher preparation, which was cited by 33.9% of the eighth-grade teachers.

Teachers said that the standards have helped guide their instruction and bring about much-needed uniformity. Sample remarks from the survey, each from a different district, include:

> *[from a fourth-grade teacher] Having knowledge of the district standards has helped me in terms of planning.*
>
> *[from a fourth-grade teacher] Standards have really made my teaching more focused—I now know exactly what my students need to know instead of relying on a textbook.*
>
> *[from an eighth-grade teacher] High district standards support high standards in classroom*
>
> *[from an eighth-grade teacher] Standards—easier for transferring students, promotes some sort of unity*

Some of the teachers who were interviewed also acknowledged the value and importance of standards, either in general or for them personally:

> *I've read the district and state standards. Our district ones are grade level expectancies. I want my kids to be where they need to be.*
>
> *I think standards are good because it's hard to help kids learn without basics.*
>
> *I am aware of the* California Framework, *the NCTM Standards, and the* California Content Standards. *I have seen the draft of the new NCTM Standards 2000. All of these have influenced my teaching for the better.*
>
> *The district level standards are aligned with the state standards, so the district ones are what I pay attention to. I am aware of national tests and national comparisons are made. It is really important to me to know that what goes on in my classroom should be going on in all classrooms.*
>
> *I believe standards are important. You have to know where you're going before you take off or you're going to just be everywhere. They've influenced me more since I've come to California. To me, "standard" is just a word that gets everybody to the same. If these are what are going to get all to the same page so we can be assessed in the same way, then good. It's important. They're not just a measure of what kids do, they're a measure of what we [teachers] do. I think standards have also helped us talk about what we do….The state standards have had the most impact on me. They give me direction. Also, the professional standards have helped me a lot. They keep me learning and relearning.*

These types of remarks notwithstanding, a large number of teachers made less favorable comments about standards. In response to the survey question, "If there are specific state, district, or school policies that have *hindered* your mathematics instruction, please describe," 12.2% of responding fourth-grade teachers and 18.8% of the eighth-grade teachers mentioned standards.

Teachers' concerns about the standards were mainly that the standards, especially the state standards, are too ambitious—that some of them are developmentally inappropriate or that they focus on breadth at the expense of depth and cover more material than can be fit into a year. Representative survey comments along these lines included the following:

> *Each year the state is requiring more and more of the students and their foundation in math is becoming thinly spread. Let's get the foundation stronger.*
>
> *I believe the new content standards expect too much from 9–10 year olds. It's difficult enough for them to understand current concepts within the parameter of our school year.*
>
> *District policy that all students be exposed to grade level material, even though they may not have mastered previous skills.*
>
> *There are too many topics that students are expected to learn. Need to eliminate some topics and allow for more conceptual development in a few key concepts.*

Interviews revealed that eighth-grade teachers were particularly concerned about the requirement that all eighth-grade students take algebra.[4] "I don't understand the push," said one teacher who was interviewed. "Cognitively, they [students] are not ready. They just don't understand it." A teacher in a different district stated, "The state standards say that algebra should be taught to all eighth graders, I'm against it. I think it's a maturity issue. Not all kids are ready. It's too abstract for some." Another interviewed teacher mentioned being "skeptical" about eighth-grade algebra, and a principal remarked that many middle school teachers have never taught algebra before and "are nervous."

Despite these concerns, however, the large number of comments made about eighth-grade algebra—both by principals and by teachers—made it clear that several districts were, in fact, preparing to implement it. As one principal put it, "I don't believe all eighth graders, and definitely not all seventh graders, are developmentally ready for algebra. However, the district has required the change. We will offer support for students during the year in the form of math lab and study club." As shown by Figure 4.1 in the chapter on curriculum

[4] The State-Board–adopted content standards are grade-specific from kindergarten through grade seven, and then are organized by discipline headings, beginning with Algebra I. Although the standards document says that "the standards for grades eight through twelve do not mandate that a particular discipline be initiated and completed in a single grade," the lack of other grade-eight-specific standards implies that at least some algebra must be taught in eighth grade. Many districts believe that the most appropriate way to address the standards is to require eighth-grade algebra.

materials, only 27.1% of the eighth-grade classes represented by the survey were algebra classes, so undoubtedly the transition to eighth-grade algebra for all students has been a major one.

Overall, these findings suggest that while most teachers like the *idea* of standards, they do not always think that the particular standards that have been adopted are the most appropriate ones. In other words, teachers support the theory behind standards, but may find themselves hindered by both the details and the realities of implementation.

Familiarity with Standards

- **Teachers' familiarity with content standards is highly variable. There is considerable confusion, and some frustration, about different sets of standards.**

While the teachers who mentioned standards on the survey and in interviews (as represented by comments in the preceding section) seemed to be fairly familiar with standards, not all teachers necessarily shared this familiarity. Observations and interviews in the eight visited districts revealed that teachers' familiarity with standards was highly variable. This variability was across districts, across schools within a given district, and even across teachers within a given school.

For example, a teacher in one district claimed that her district's standards "are on the wall in every classroom" and said that "our jobs as teachers are linked to these standards." However, the other teacher interviewed *in the same school* said, "As for the district standards, I'm a new teacher and not aware of what they are exactly." A third teacher in this district (but at a different school) mentioned that teachers were required to provide evidence that they met standards. Yet another teacher in the district said that they hadn't even *received* the standards.

In another district, there seemed to be some confusion about whether the district even had adopted standards. One principal reported that the district had created mathematics standards, but that "they remain unadopted." But a principal at a different school in the same district said, "Of course, we adhere to what the district standards are and what they want us to teach." At the school of this second principal, one teacher stated that "The district is just beginning to develop standards," while a second teacher stated that district standards are "the most important" document/policy having an impact on his mathematics teaching.

Not every district yielded quite this level of contradictory information, but by and large, there was not a great deal of consistency in interviewees' remarks regarding standards. An additional complication was that different people used the term "standards" to refer to different documents. For example, in discussing the "state standards," some people were talking about the 1997 State-Board–adopted standards, whereas others were talking about, say, the 1992 Framework. Similarly, some people used "standards" to refer to the NCTM standards; others meant the state standards, and still others meant their district standards.

Indeed, several principals and teachers reported confusion and frustration about having different sets of standards (e.g., national, state, district) or about having standards constantly changing:

> *[From a teacher] At all three levels [national, state, district] we have been bombarded. When we, as the math department, were given the standards, the NCTM, state, and local standards all conflicted with each other. We adopted the NCTM standards, which used to be closely aligned with the state standards. The state standards are what we are tested on. The new state standards are very different…It seems like a moving target. Every couple of years the state comes out with a different strategy and we all change and then things change again.*

> *[From a principal] I don't think teachers are very tuned to standards. There's confusion. Our people are lost. Our standards aren't exactly the same as the state's and there's confusion about why they would have different standards.*

> *[From a teacher] I am very involved with NCTM math reform. I also liked the 1992* Framework. *I am not up to date and am frustrated.*

> *[From a principal] Teachers are confused by the standards and they ask for more specifics. They [teachers] have not seen the new standards. Also, parents have been very upset about the changes in standards.*

> *[From a teacher] We have all these standards (state, district, school), but it doesn't meet student needs.*

There also tended to be some confusion about the extent to which district standards are aligned with state standards. In one district, the teachers who were interviewed appeared to have widely disparate impressions of the relationship between their district standards and the state standards, as demonstrated by the following comments from two different teachers:

> *[The state has] given us the standards and guidelines and tells us what to teach….Same kind of effect from the district; they are more stringent and require more.*

> *[from a fourth-grade teacher] The district standards are not as difficult as the state standards because the district standards do not have algebra, geometry, or integers.*

One teacher in this district stated that "I am accountable to my district standards…there's not really any state standard influence." In contrast, another teacher—who had recently finished working on performance assessments in the district office and said that he was "very involved" in standards and frameworks—remarked that the district standards were based on the state standards. A second teacher at the same school said that she was "aware that the district is trying to align its standards to state standards."

Impact of Standards on Instruction

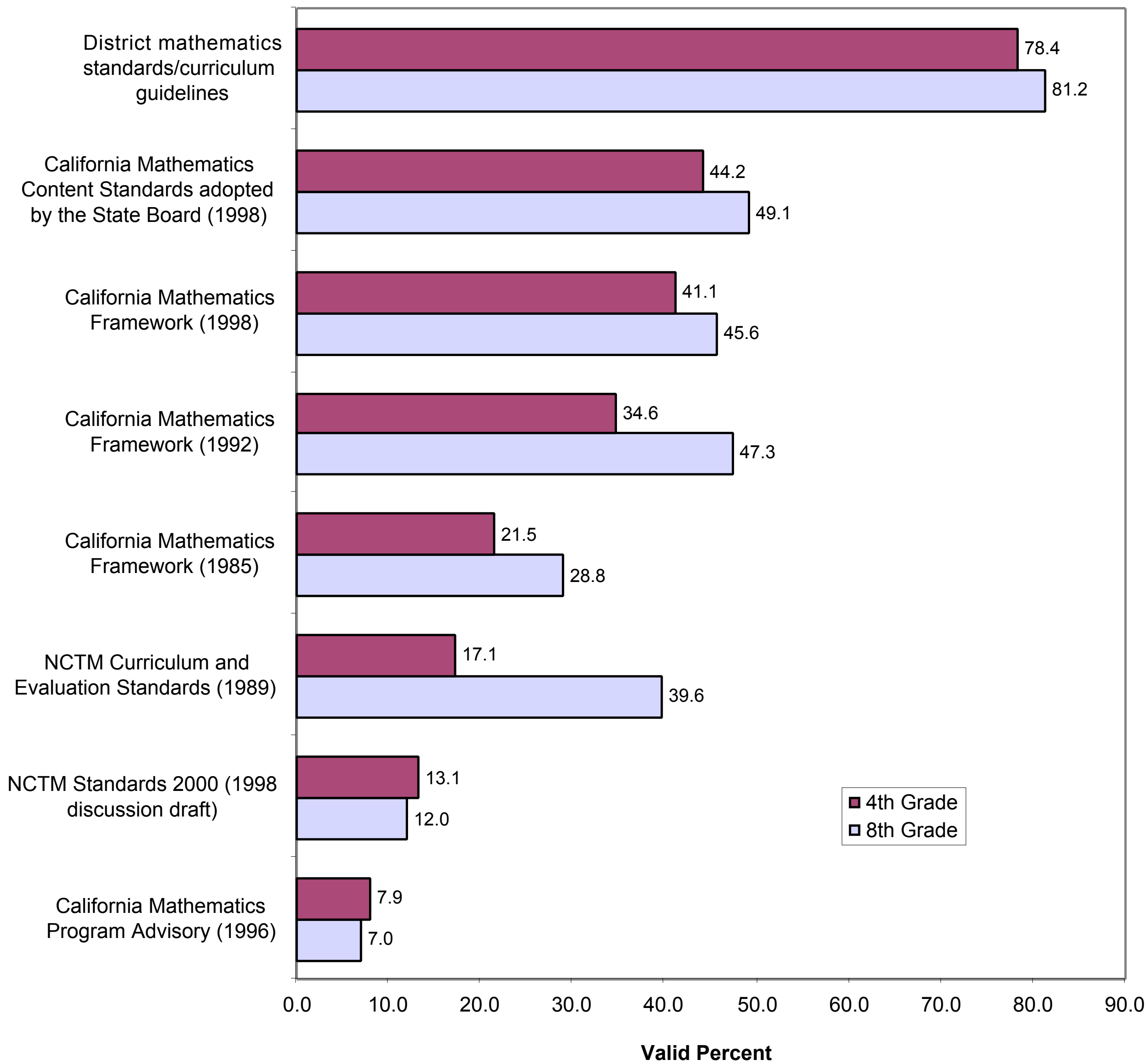
♦ **Although teachers report that standards—especially local standards—have influenced their teaching, other data suggested that the standards *per se* were not having a high level of meaningful impact on classroom mathematics instruction.**

Despite teachers' concerns about the nature of the standards and the high level of confusion surrounding them, a large percentage of teachers reported on the survey that standards, particularly their district standards, have influenced their teaching. One of the items on the questionnaire listed the titles of several standards/frameworks documents and asked teachers to rate how familiar they were with each document, from "have not heard of this" to "has influenced my teaching." Figure 5.1 shows the percentage of teachers who marked "has influenced my teaching" for each of the documents.

As the figure illustrates, roughly 80% of teachers at both fourth-grade and eighth-grade levels said that their local district mathematics content standards/curriculum guidelines had influenced their teaching. On the other hand, very few teachers reported that their teaching had been influenced by the national (NCTM) standards, although more eighth-grade teachers (39.6%) reported being influenced by these standards than fourth-grade teachers (17.1%). About 45% of fourth-grade teachers and 25% of eighth-grade teachers said that they did not know whether their district mathematics standards were aligned with the NCTM standards. The RAND analysis found that these teachers were less likely to report instructional focuses on individual work, group work, and problem solving.

[text continues on page 62]

Figure 5.1
Percentage of Teachers Who Reported That Particular Documents Have Influenced Their Teaching



Note: The total number of respondents (n) varied by item. For fourth grade, the range for n was 253 (for California Mathematics Program Advisory) to 278 (for district mathematics standards/curriculum guidelines). For eighth grade, the range for n was 108 (for NCTM Standards 2000) to 117 (for district mathematics standards/curriculum guidelines).

As for the state-level documents, only 21.5% of fourth-grade teachers and 28.8% of eighth-grade teachers reported that their teaching had been influenced by the 1985 California Mathematics Framework. However, this is not surprising, given that a majority of teachers at both grade levels reported having had 10 or fewer years of teaching experience. The 1992 and 1998 Frameworks appear to have exercised somewhat more influence on survey respondents, as shown by the figure. At the eighth-grade level, the percentage of teachers who said that 1992 Framework had influenced their teaching was slightly higher than the percentage reporting influence by the 1998 Framework. Since the 1998 Framework had only just been adopted when the survey was administered, this is perhaps to be expected, although more fourth-grade teachers reported influence of the 1998 document than of the 1992 document.

RAND's analysis found that teachers who said their teaching was influenced by the 1992 or 1998 California Mathematics Frameworks or the NCTM standards were more likely to report engaging in practices focusing on group work, applications, and problem solving. However, as discussed in Chapter 3, several other factors, such as student demographics, also were related to use of particular types of practices.

Very few teachers said that the 1996 California "Mathematics Program Advisory" had influenced their teaching. In fact, a majority of teachers (53.8% fourth grade; 66.7% eighth grade[5]) indicated that they had not even heard of this document. As this Program Advisory was addressed to superintendents and principals, rather than to teachers themselves, and was more a statement of policy and philosophy than a curriculum document, these figures are not surprising. Nearly all of the data collected by this study suggests that to maximize the influence of documents on instruction, the documents must be distributed to individual teachers. Moreover, this dissemination must be an ongoing process, as new teachers are constantly entering the profession.

Approximately 45% of fourth-grade teachers and 50% of eighth-grade teachers reported that their teaching had been influenced by the *California Mathematics Content Standards* recently adopted by the State Board. Of all of the documents listed on the survey, these standards were second only to district standards in terms of reported influence on teaching, at both grade levels. Given that these standards had been adopted only a little over a year prior to the survey administration, these figures, while still not even representing a majority of teachers, are higher than might be expected.

Other data, however, suggest a somewhat lower influence of the new state content standards on instruction. For example, one of the new state standards for fourth grade is, "Use concepts of negative numbers (e.g., on a number line, in counting, in temperature, in 'owing')." Yet of all of the fourth-grade teachers who reported that the new state standards

[5] These figures are slightly different than the ones given in the RAND report in Appendix A. The figures presented here are the percentages of teachers who actually responded to the survey question, whereas RAND imputed values for the missing responses and included those in the percentages.

had influenced their teaching, fully half of them (59 of 118) indicated on the survey that they did *not* teach negative numbers in their class. Similarly, nearly one-third of these teachers (38 of 118) reported that they did not teach use of variables, even though another fourth-grade standard calls for students to "demonstrate an understanding and the use of the concept of a variable."

Interviews and observations, too, suggested that the influence of standards (in general) might not be at the high level suggested by the responses to some of the standards-related survey items. Overall, direct impact of the standards on curriculum and instruction appeared to be relatively low, or at best, somewhat superficial in most of the districts visited. (See the "District Spotlight" for one exception.)

Although several of the teachers who were interviewed did say that they follow—or try to follow—standards in their teaching, many other teachers did not mention standards at all, or mentioned them only minimally.[6] A few interviewed teachers suggested that the standards (district or state) "did not apply" to them or to their students, for one reason or another. As one teacher stated,

> *We have district standards for eighth-grade math which are algebra. But we're not teaching algebra. Everyone is supposed to put the standard they are addressing on the board. So I just make them up with what I'm going to be teaching. But they're not real standards, they're goals. The district standards don't even apply to my class.*

Other teachers mentioned that they were aware that standards existed, but that they had not read them, or did not use them systematically:

> *I studied a little bit of the nationwide math standards in college last year. I wish I knew more. Being from out of state it's a learn-as-I-go with regard to the state standards.*

> *The state's standards seem to be covered in almost anything that we do anyway. I don't spend too much time matching individual standards with what I'm teaching.*

> *I know we have new state standards and also district standards that are aligned with the state….I have the state standards but I don't really refer to them.*

> *I perused the state standards prior to the SAT-9 and was disappointed that we had only covered half of them.*

---

[6] Several teachers who did not mention district "standards" *per se* did mention other district curriculum guidelines such as scope-and-sequence documents, timelines, benchmarks, or checklists. (Such comments were particularly frequent in two of the eight districts.) To some extent, the documents mentioned may resemble or serve some of the same purposes as content standards; one teacher said that the district scope and sequence gave "expectations for each grade level." Another teacher remarked that a district timeline essentially tells him "what to teach at what time to make it through the year, or what they expect to be covered by such-and-such a time throughout the year."

> *I use standards. But after I get to know my kids I pick the ones that I think I'll get the most out of and do those. The ones I miss, I just miss, because I'd rather the kids know something that they can build on rather than a hodgepodge of everything.*

The eighth-grade teacher who made this last remark later commented on the difficulty he has in helping students meet standards when the students lack sufficient preparation:

> *I use the standards. However, many of these kids come in here with limited reading skills and little or no computation skills. So I assess them. I spend one to nine weeks finding out what they know and compare it to what they should know when entering eighth grade. Then I must decide whether to give them what they should know or advance them. I base it on what the majority needs.*

When asked "How do you decide what mathematics to teach?" the majority of teachers who were interviewed did not mention standards prominently in their responses. Several teachers spoke instead of following the curriculum established by their school or district. To the extent that the curriculum is aligned with standards, then, instruction may also be aligned with the standards. Alignment of standards with curriculum is discussed further in the following section.

District Spotlight: Mathematics Content Standards That Matter

In one of the eight districts visited, the district's content standards have clearly exercised a powerful effect on schools and teachers. Every teacher interviewed in this district (6 total) talked about the content standards and the impact of the standards on curriculum and instruction. For example, when asked, "How do you decide what mathematics to teach?" standards figured prominently in the answers of five of the six teachers, and the sixth teacher implied the same in the answers to other interview questions. Following are some of the remarks of teachers in this district about the influence of the district's content standards:

> *We have 8 district standards. What I like about them is that they simplify our curriculum and tell us exactly what we can focus on….The standards guide my teaching.*

> *For planning purposes, I went through the district standards, month by month…. We are completely standards-based in our approach.*

> *My approach is to combine various strategies and to cover the standards….I teach the standards.*

The principals at the schools in this district also had a very high level of awareness of the standards. At one school, the principal said she thought that mathematics instruction was "clearly being driven by [district] standards" and mentioned that her school is piloting the new district report card, which focuses heavily on reading and mathematics standards. Another principal stated that curriculum is "absolutely dictated" by the district-developed standards, although teachers "have freedom" in how to teach them. She also mentioned that she thought the standards had helped with student achievement by allowing teachers to clearly communicate to parents where their children were and where they needed to go.

A principal at a third school in the district also commented that she thought the standards had had a major positive impact and made a direct difference in the classroom. She indicated that standards help her "talk to teachers," since she can better see what teachers are covering and what they should be covering, and she thinks that standards set up a positive atmosphere of peer pressure to produce good outcomes. She reported that all students have copies of the standards in their binders, and teachers link back to them during lessons. The classroom observer did not directly confirm this, although in a different school in the same district, the observer made the following note about a particular teacher's class:

> *It was interesting how explicit the emphasis was on standards and teaching to them. These are at the forefront of the teacher's plans; he referred to them when describing what he does and why he does what he does. Additionally, the teacher had all the standards printed and laminated. He has them hanging on the wall, covering at least an eighth of the wall space.*

Alignment of Standards with Curriculum

♦ Alignment of content standards with curriculum and instruction is an ongoing process.

Several principals and teachers who were interviewed discussed present efforts to align curriculum and/or instruction with standards. The following comments were made by interviewees in three different districts:

> *[From a principal] We've looked at district standards and SAT-9 to determine curriculum. Now we're going to break it down by quarter.*

> *[From a teacher] Curriculum decisions come from the state and are brought to our attention at a faculty meeting. Then it's up to the teachers to write a pacing plan. Each grade level sets goals for each semester.*

> *[From a teacher] I have modified some of my teaching style to fit what the standards are saying….There's definitely standards that are being put in place and things of that nature that have influenced by teaching….They come straight from the district. Like, the principal goes to a district meeting. And she comes back, and she says, "Okay, here's what's going on."…. Like for example, at the beginning of the school year, I'm a math teacher, and so I didn't do a whole lot of writing in my class. Well, now I do tons of writing in my class, because that's part of the standard now: "Students will be able to learn to read and write across the curriculum."*

The teacher of this last remark, however, was also one of the teachers who said that he decided what to teach by "following the book." As mentioned in the previous chapter, many teachers reported that curriculum materials—namely, the textbook—play the primary role in determining the content of instruction. Thus, *to the extent that curriculum materials are aligned with the standards* and instruction follows the curriculum materials, then instruction is aligned with the standards. And some interviewees did indicate such alignment:

> *[From a principal] The state framework determines the curriculum. As for the text, the principal and teachers look at the state approved books to try and meet the standards which state that by a particular age, a student must have mastery of specific skills….The school has full discretion over pacing, but we need to meet the standards.*

> *[From a teacher] The district standards are pretty much aligned with the book we use. They went through that whole process when they chose the book, back, like, two years ago. From what I understand—I wasn't here…. The curriculum is pretty well laid out. They tell you what concepts need to be done; you don't have to do it exactly the way it is in the book, but that's basically what you've gotta teach.*

The principal at this teacher's school, however, did not take it as a given that following the district-adopted text ensured coverage of the standards. She stated:

> *The district is attempting to align the math standards with curriculum….Our major job next year is to align curriculum, see if we're achieving the standards, and understand what the assessments show about changes that need to be made….Our priorities are to align curriculum to standards and to do a quarterly assessment here so that the goals are set for each grade level in math.*

Moreover, as demonstrated by some of the comments in the chapter on curriculum materials, it cannot always be assumed that curriculum materials are aligned with the standards. The ever-changing nature of standards, and the different sets of standards, only exacerbate this problem. An interviewed teacher in one district stated:

> *This year we made the transition to an algebra curriculum for eighth grade that is different than traditional algebra. This was supposed to be the transition year. Now, these books…have not been adopted by the district. They follow the old state standards and the NCTM standards, but they don't address the new state standards.*

Another teacher who was interviewed lamented similarly, "Math standards keep changing and how can we get a curriculum to match when it's always changing?" Yet another teacher commented, "I think we need to align our curriculum with the state standards because they are aligned with the SAT-9." This remark hints at the power of the SAT-9 in driving curriculum, to be discussed further in the following chapter. The extent to which the SAT-9 truly is aligned with the state standards also will be discussed.

District Spotlight: Aligning Mathematics Standards with Curriculum

School-level comments about alignment of mathematics curriculum with standards were particularly prominent in one of the eight districts visited (not, interestingly, the same district discussed above in which standards figured so prominently in interview responses). Principals and teachers at three out of the four schools visited in this district mentioned alignment efforts.

At the first school, the principal said that at the beginning of the year, the faculty had discussed the district mathematics standards and grade-level teams met to decide the goals and objectives for the year based upon the appropriate standards. They created a yearlong plan to address all of the standards, and teachers continue to work in grade level teams to plan how to meet the standards. A teacher at this school confirmed independently that the fourth-grade teachers had, indeed, met as a group to align their curriculum to the district standards.

At the second school in this district, the principal spoke of how “Standards are the basis now in the school and in the district” and stated that “the present school effort is to align curriculum to standards.” (She said that the school follows the direction of the district inasmuch as the district selects the text and adopts the standards, but the school itself develops the “course of study.”) A teacher at this school, meanwhile, discussed how the teachers had been “mapping” district standards to curriculum, resources, and practices. She implied that this had been a district-wide activity.

The principal at the third school discussed alignment between professional development efforts and the standards, explaining that the school has an outside consultant who comes in on a monthly basis to demonstrate how to use materials and “how the materials correspond to the district standards.” The relationship between the consultant and the content standards was not mentioned by the teachers at this school, but one of the teachers did discuss how, using the district and state standards as a guide, the mathematics teachers had met and “made a list of priorities” for teaching mathematics. She said that this had been a “useful discussion” and that they had “shared methods.”

In the Next Chapter

If content standards are not being taught, their impact on students is likely to be minimal. One way to promote classroom implementation of content standards is to align high-stakes assessments with the content standards. When such assessments exist, schools and teachers may have more motivation to help students master the standards. Assessment is the subject of the next chapter.

(This page intentionally left blank.)

Chapter 6

Assessment

Highlights of Findings

- **The SAT-9 has made a significant impact on schools and teachers.**
  Teachers are highly aware of the SAT-9 and its importance. At many schools, the influence of the SAT-9 goes beyond test preparation and extends into the realm of shaping the curriculum itself.

- **As much as it may drive instruction, the SAT-9 has been the cause of much anxiety at the school level.**
  Principals and teachers expressed grave concerns about overreliance on the SAT-9. A lack of alignment between the SAT-9 and the curriculum is one major area of concern; a lack of alignment between the SAT-9 and content standards is another.

- **Many teachers feel that they are being compelled to "teach to the test" and that this may harm students.**
  Some teachers believe that ultimately, teaching to the SAT-9 will negatively affect students' understanding of and appreciation for mathematics, as the test focuses on breadth rather than depth and does not sufficiently measure different types of mathematical achievement, such as conceptual thinking.

- **The augmented section of the STAR program caused particular anguish among teachers and students in spring 1999.**
  Although the augmented portion of the STAR program may have been more aligned with the state standards than the base SAT-9, many teachers felt that the augmented items were grade-level inappropriate and unfair to students, given the preparation they had had. Some teachers, however, indicated that they planned to adjust their curriculum coverage so as to better prepare students for the augmented items.

- **The quantity and timing of assessments can be problematic.**
  Several teachers and principals commented that too many assessments were taking time away from instruction. Also, the time at which any given assessment is administered plays an important role in how much of the content students have covered. Some teachers remarked that the SAT-9 included items that were not taught until mid- or late spring, after the test was administered.

Background

As with content standards, assessment in California over the past decade has had a rocky history. In the early 1990s, California implemented its first performance-based assessment system, the California Learning Assessment System (CLAS), specifically designed to measure students' mastery of curriculum laid out in the state *Frameworks*. However, in 1994, after just one year, funding for the test was vetoed by the governor for a combination of political, technical, and ideological reasons. In 1995, the state enacted the California Assessment of Academic Achievement Act (AB 265), which provided districts with funding to administer tests selected from a state-approved list.

Then in 1997, the Standardized Testing and Reporting (STAR) program was enacted. STAR, which was motivated by a perceived need for a statewide, comparable measure of academic performance for districts and schools that could report individual scores for all students, required all districts to administer the same nationally normed, "off-the-shelf," basic-skills, standardized test. The test selected as the centerpiece of the STAR program was the SAT-9 (Stanford Achievement Test, Ninth Edition, Form T), published by Harcourt Brace Educational Measurement. The STAR program, still in force today, required virtually all students in grades 2–11, including English language learners, to take the SAT-9 each spring.

Meanwhile, as part of the statewide Standards-Based Accountability System, most districts were required in 1997–1998 to implement multiple measures of assessment for at least one grade level in each of three specified grade spans. The SAT-9 had to be one of the measures (as specified by the STAR program), but districts were relatively free to choose the other measures, provided that certain criteria were met and that the different measures were combined (to determine student proficiency) in accordance with state guidelines. For mathematics, many districts elected to develop or purchase criterion-referenced or performance-based assessments to meet the multiple measures requirement (Guth et al., 1999).

In 1999, however, the Public Schools Accountability Act (PSAA)—the enactment of SBX1—replaced the Standards-Based Accountability System and its multiple measures requirement. Under the provisions of the PSAA, the SAT-9 is currently the sole indicator being used in a statewide index designed to rank schools' performance and determine their eligibility for a rewards and intervention program. Until other indicators of academic performance are deemed valid and reliable, the SAT-9 will remain the sole measure of student achievement.[1] As such, it has become a truly "high stakes" test.

[1] In spring 1999, the test was "augmented" with extra items designed to assess student mastery of the content standards adopted by the State Board of Education in 1997. Student achievement on these items is measured separately from the base test. A study conducted by William H. Schmidt of the Third International Mathematics and Science Study (TIMMS) Center found that the base (mathematics) SAT-9 is not aligned with the California mathematics standards (Boser, 1999).

The Impact of the Stanford-9

- **The SAT-9 has made a significant impact on schools and teachers and in some places appears to drive curriculum and instruction.**

Although, in theory, content standards (discussed in the previous chapter) should play the most important role in shaping curriculum and instruction, data suggest that assessment—and the SAT-9 in particular—actually carries more force. On the survey, 71% of fourth-grade teachers agreed strongly with the statement, "There is a school-wide effort to improve student mathematics achievement on the SAT-9." In contrast, only 51% of fourth-grade teachers agreed strongly with the statement, "There is a school-wide effort to implement our district mathematics standards." At the eighth-grade level, the figures for the two items were a bit closer together, but the SAT-9 still "won" over standards, with 80% agreeing strongly about the SAT-9 but only 70% agreeing strongly about the district standards.

Interviews with school-level personnel confirmed the importance of the SAT-9. Numerous principals and teachers spoke about "living and dying by the test scores," focusing professional development efforts on improving test scores, pacing instruction so that teachers can "strategically prepare" the students for standardized tests, and "anxiously awaiting" the SAT-9 results. (Interviews were conducted before the scores were released.) One principal explained that "the SAT-9 has been the catalyst" for changes occurring in her school; "Other state policies," she continued, "have had nowhere near the same level of influence."

Indeed, in answer to the question, "Did you do anything special to help your students prepare for this year's SAT-9?," the vast majority of teachers interviewed answered in the affirmative. A few of the teachers focused on basic skills or on particular content areas as part of this preparation. One eighth-grade teacher, for example, explained that her school had identified fractions and decimals as an area needing improvement on the test, "so we did a lot of review on that concept." Two fourth-grade teachers (both at the same school as one another) mentioned involving parents by speaking with them and telling them "we needed to help students prepare" or by sending letters home telling parents what skills were being tested.

More common responses, however, included work on "test-taking skills" (for example, in taking multiple-choice tests) and the administration of practice tests. As one teacher put it, "My main focus was teaching them how to take *a* test, as opposed to how to take this *particular* test." Another teacher, similarly, explained, "My focus was not on math as much as on how to read the questions." Several teachers mentioned the use of test-preparation booklets/materials, although in more than one instance, these materials had not arrived in time to be used for the current school year.

The amount of time spent specifically on SAT-9 preparation was variable. Roughly one-third of the teachers who were interviewed said they'd spent two to three weeks; about another third said one to two months or one day per week all year long. A few teachers reported that they had worked on SAT-9 preparation all year.

At many of the schools visited, the SAT-9 had an impact well beyond preparing students to take the test, extending into the realm of shaping the curriculum itself. Without prompting, many teachers mentioned the SAT-9 in their answers to questions about their "general approach" to teaching mathematics or about documents and policies that they felt had had an impact on their teaching. "The thing that jumps to mind is the STAR-9 testing," replied one teacher; "the greatest impact comes from the Stanford-9 and [another assessment used in the district]," stated another. Responses such as these, along with "preparing students to take standardized tests," were fairly typical.

Moreover, several principals stated unequivocally that the SAT-9 will "drive the way we teach" or had already done so. (Some interviewees acknowledged that assessment in general, rather than the SAT-9 alone, is the driving force.) The following comments were made by principals in three different districts:

> *We did a curriculum map last year related to the SAT-9. As a result our program has been skills based.*

> *SAT-9 played a large part [in influencing mathematics instruction at the school]—fortunately and unfortunately. You want to teach the students what they will be tested on.*

> *We use the make-up of the SAT-9 to determine what parts of the curriculum we should stress. For example, if there are more estimation problems on it we will cover that more next year.*

Some teachers, as well, made comments about the influence of the SAT-9 over their curriculum or their instructional practices. "The test influences what I teach," explained one teacher; "I try to cover all the areas that will be on the test," she continued. In a different district, a teacher remarked that after the students had taken this year's SAT-9, she asked them what they did not know on the test; they indicated geometry, so next year she intends to bring that in earlier. More generally, this same teacher stated, "If the SAT-9 is a test of skills, not theory, then we might as well continue to teach that way."

Perceived Problems with the SAT-9

- **As much as it may drive instruction, the SAT-9 has been a source of much anxiety at the school level. Principals and teachers expressed grave concerns about overreliance on the SAT-9.**

In response to the open-ended survey question about policies that have hindered mathematics teaching, 14.1% of fourth-grade teachers and 11.6% of eighth-grade teachers discussed assessment. Responses relating to assessment formed the second-largest category of responses to the question at the fourth-grade level, and the third-largest category at the eighth-grade level.

Many teachers commented simply that they felt there was too much emphasis on the SAT-9, on standardized testing, or on test results. Some teachers did indicate a belief that assessment as a measure of accountability is important— they just think that the SAT-9 may not be the most appropriate measure, particularly if it is the *only* measure. In response to the survey question about helpful policies, one eighth-grade teacher wrote, "Our district and school has focused on student learning and assessment has become a key issue. We look at assessment from many perspectives, not just testing." And an eighth-grade teacher who was interviewed commented:

> *I would hope we're being held accountable. The problem I see is that I don't think it's [the STAR test] the one way you test for that. I think it should be just one of a variety of things. But I definitely think we should be held accountable for student performance. If not, we're not doing our jobs….I just don't think it [accountability] should be measured with one set of tests, and that's it. The kids I have…are good kids; they came in with good scores, they'll go out with decent scores; they probably could have done that no matter whether I did a good job or not. On the other hand, you can get kids that are ill-prepared, and you know, how much you can help them improve — I don't know that anybody knows, is that 5 percentage points? Is that 25 percentage points? I guess we're all wondering, what's going to be the measure of achievement? So, that's all a little iffy when the test is the thing.*

The primary concerns that teachers expressed about the SAT-9 and its effects on instruction—and on students—are discussed in the following sections.

- **A lack of alignment between the SAT-9 and the curriculum is a major area of concern.**

One frequently cited concern about the SAT-9, as discussed in the chapter on curriculum materials, was that curriculum materials are not aligned with the test. "I'm seeing that my students struggle with standardized testing because the curriculum adopted program does not completely coincide. They have difficulty with transferring information learned while taking state test," wrote one fourth-grade teacher on the survey.

Many teachers who were interviewed expressed a similar sentiment. "The Stanford-9 test material is not in our curriculum!" bemoaned one eighth-grade teacher. Another spoke of how the SAT-9 was a "more traditional" approach that does not mesh with the curriculum. A fourth-grade teacher had even more to say about this:

> *The new adoption for the district — there's an obvious philosophy behind it that it should be hands-on…My biggest complaint with the hands-on is that [students are] not tested that way. It's like they [the district] want us to use hands-on materials, but then they test us in a much more traditional way, and the students, at least in this school, have a very hard time making that connection, you know, applying the hands-on stuff to the test. [And the test] is what the district's looking at…Regarding the district and the state, teachers are getting mixed messages about hands-on versus seatwork. I don't get a consistent message. No one fully explains to you how you're supposed to prepare kids for tests.*

One principal who was interviewed said that there had been much anxiety in her school over the STAR program; she said that the teachers were worried that the kids were being tested on topics not taught. A principal in a different district made a similar comment, about teachers seeing "a discrepancy" between things on the test and things that are taught. Several interviewed teachers confirmed this. "The test doesn't assess what's going on here," stated one teacher; "The SAT-9 is not a good judge," said another.

- ♦ **Many teachers feel that they are being compelled to "teach to the test," a particular problem if the test lacks balance and is not aligned with the standards.**

As suggested by the remarks from those who say that the test is driving curriculum, it appears that many schools and teachers are adapting instruction to fit the test. But many teachers strongly object to the idea of "teaching to the test," and believe that the overall effect on students will be negative. "Teaching for 'the test' drives the curriculum, in some areas to the detriment of what the students need," wrote one teacher on the survey.

Again, teachers who were interviewed echoed this sentiment. As one eighth-grade teacher stated emphatically, "The SAT-9 is going to have a negative impact. It really controls teaching and what is taught." Another interviewed teacher said that although he does not "believe in teaching to a standardized test," he feels "tugged in that direction, because everybody thinks it's important," and thus has to "honor it."

Some principals also expressed concerns about curriculum driven by assessment. One principal commented that looking at test scores might help improve the scores, but that this did not necessarily mean improving the curriculum. Another principal said that she worries that as teachers teach more and more narrowly to the tests, important things are getting left out of children's education. Previously, this principal remarked, she would have felt accountable to parents to give children a well-rounded education, but she now feels accountable to the district (who, in turn, is accountable to the state) to provide high scores. She thought that this sometimes gets in the way of giving students the best possible education.

Teachers helped provide an answer to the question of what, exactly, might be getting left out of children's education as a result of the emphasis on the SAT-9. As with instructional practices and curriculum materials, some teachers expressed the concern that the test lacks balance between computational mastery and conceptual understanding and between depth and breadth, and thus that "teaching to the test" inhibits a well-rounded mathematics instructional approach. Survey comments along these lines—each from a teacher in a different district—included:

> *[from a fourth-grade teacher, cited as obstacle] Trying to teach conceptually when we are responsible for the students doing well on a standardized test that is traditional.*
>
> *[from an eighth-grade teacher] The concern should be depth and understanding. Assessment tools need to address other intelligences. CLAS had the right idea. We need a TRUE multiple measure, not another multiple choice test.*
>
> *[from a fourth-grade teacher, cited as obstacle] Pressure to "teach to the test" and not have students explore and enjoy mathematics as much as I would like them to.*
>
> *[from a fourth-grade teacher] The time spent skimming over topics to prepare students for standardized tests could have been better spent by focusing on interesting concepts more thoroughly.*
>
> *[from an eighth-grade teacher, cited as hindering policy] The emphasis on the SAT-9! I am encouraged to spend time on too many topics so students don't get enough depth to remember topics so what they know this week they forget.*

Another major concern that many people voiced about the SAT-9 is that it is not aligned with content standards. For example, one principal said that "we have no measure" for determining if a student meets the district standards, implying that the SAT-9 does not serve this purpose. Another principal mentioned that there had been "some resistance to the SAT-9 because it is not aligned with the standards." She expounded further:

> *Do [the district math] standards align with the standardized tests that [students] have to take? No. They don't. And that's very frustrating for math teachers. What we're teaching and when we're teaching it, and when they take the standardized tests and they see that something is on*

there that they haven't taught yet — it's very frustrating. … Aligning our state testing with our standards is really important, so we don't have that frustration.

Indeed, some teachers particularly objected to the idea of "teaching to a test" that is not aligned with the standards. Two interviewed eighth-grade teachers commented:

I get the impression from the state government that we need to teach to the test. I mean, who cares about content anymore in the math class? We teach to the test. Because now they [the state government] are offering extra money tied to teachers whose test scores are high. And, so that speaks very loudly that…it doesn't matter about the content, let's teach to the test….I'm not going to, but that's what I'm hearing, and I'll bet you that, in time, the department will force me to do that….I think the standardized test that we have to take gets in the way. Because it forces me to teach to the test, instead of teaching to what the standards are.

There's a lot of pressure to make sure students perform well on [the SAT-9]. And personally, I think if the curriculum is strong and you teach the curriculum, then you don't have to worry about the individual test. But, I'm kind of shouting out in a field by myself on that. Or, at least, there are a lot of teachers shouting out there, and other people aren't listening. And I just fear that we're moving too much toward teaching to a test. It's not ever been stated that way, but I think it's moving in that direction. I avoid it [teaching to the test], thinking that the strength of the curriculum will do the job. And, I don't know what I'll have to do if the results aren't good, and I have to revise what I do. Because, I think, then the task is, change the curriculum…I think the problem we have right now is that the test and the curriculum are based on different standards, and they haven't brought them in line. And I'd like to see the test follow the curriculum — or, decide what the curriculum should be, establish the statewide standards, or national standards, or whatever the heck we're going to use, and then make sure the test follows that. And not the other way around. I don't want a curriculum chasing the test. I want the test to match the standards. And I don't think we're anywhere near there yet….

Of course, there is the further issue of which standards the test should be aligned to, given that (as discussed in the chapter on standards) different sets of standards—district, state, national—may not be aligned with each other. One fourth-grade survey respondent remarked, "There is a discrepancy between the need to cover all possible test topics to improve test scores, and the NCTM standards that emphasize thoroughness and deeper understanding of concepts and number sense."

- **Although the augmented portion of the STAR program may be more aligned with the state standards than the base SAT-9, the use of the augmented test in spring 1999 caused considerable anguish among teachers and students.**

At least in theory, the use of the new "augmented," standards-based sections of the STAR program may alleviate some of the concerns that people have about lack of alignment between the test and the standards. However, it appears that considerable progress remains to be made with the use of these new sections. According to sources within the California Department of Education, some of the augmented items (as administered in spring 1999) failed to meet technical standards of validity and reliability.

Moreover, several people objected to the augmented sections of the 1999 test on the grounds that they were unfairly difficult, especially given the level of preparation most students had had prior to the test. On the survey, one fourth-grade teacher wrote that augmented test was "despicable." "After hours of dreary testing," she continued, "students are made to feel ignorant of things they have never laid eyes on. I am disgusted." Another fourth-grade teacher reported that teachers had not been informed about "the new augmented portion of the math test that was added" until shortly before the test was administered and that there had been "no helpful information to aid or guide us."

Other survey comments suggested the test's content was grade-level inappropriate. Many of these comments did not mention the augmented sections *per se*, but, given other remarks that were made, it seems likely that the augmented sections were the basis for the comments. The following remarks were made by fourth-grade teachers in three different districts:

> *[cited as hindering policy] Rewriting requirements to meet STAR (which are not reasonable to begin with), which essentially want me to push 4th graders into 6th grade math without experiencing 5th.*

> *[cited as hindering policy] State tests should test concepts taught at this grade level.*

> *The "Star" testing is inappropriate for the "average child"—Great info for the students that excel in given areas/topics. I question the validity of results.*

Similar findings came from interviews. One principal remarked, "the augmentation portion was a bust"; she said that the test "set the students and teachers up because the expectations were not matched by what students found on test." And the following remarks were made by interviewed teachers in two different districts, the first one an elementary-school teacher and the second one a middle-school teacher:

> *I was really upset by the augmentation test. The students were asked to work with negative integers. I didn't teach them that.*

> *The SAT-9 tests a lot of stuff that they haven't even learned…The problem is that we're supposed to be aligned with the state test. And so, that means basically we need to advance all our students before they're ready….The seventh graders had to take this test, the STAR test…While they were taking it, I could just see the frustration on their faces, and I was like, what's going on? … [I*

realized], oh my gosh, they're so frustrated because this is the stuff I'm teaching my eighth graders right now, but my seventh graders haven't even seen this material yet.

This teacher said that as a result of this experience, next year he plans to move content down from the eighth grade to the seventh grade to the "best of his ability." Similarly, an interviewed fourth-grade teacher said, "I don't believe in teaching to the test but it's not fair for a child not to have exposure to what's on the test." She indicated that next year, she will add new topics to her curriculum—those on the augmentation test—so that students have exposure to them.

In this way, then, the use of the augmented portions of the STAR program may indeed be having the effect desired by the state: they seem to be spurring at least some teachers to teach particular content at levels they otherwise would not have. To the extent that this content is indeed aligned with the standards, then the test is encouraging standards-based instruction. As one principal put it, "[The augmented test] has really been an issue with our math teachers, because they feel that it's out of reach of most students. But maybe that's the purpose of it: make it within reach." However, this same principal also stated that there had been "a lot of resistance" among teachers to changing their curriculum to match what was on the state augmented test.

Quantity and Timing of Assessments

♦ Testing takes time away from instruction.

Another area of concern with regard to assessment is the amount of class time needed to administer and prepare for tests. Many teachers felt that this time could be spent in more instructionally valuable ways. On this matter, the SAT-9 was viewed as only one of the culprits; other assessments, such as those required at the district-level, also were partly responsible. Survey comments along these lines included:

[from a fourth-grade teacher] There have been a large number of tests required this year that took away from teaching time and covered areas not presented in our current text. There should be a more relevant, valuable, and enjoyable way to assess and educate students.

[from an eighth-grade teacher] Too many standardized tests given in fourth quarter cause loss of teaching time and promote apathy in the students.

[from an eighth-grade teacher] If you look at the amount of time taken by state and district assessments you lose about 5–10 days of instruction.

A principal who was interviewed also expressed the concern that too much time was being devoted to testing, and that it was cutting into instruction time. And an interviewed teacher in a different district said he thought that the district assessment, given three times over the course of the year, "was a little much":

> *We lost three instructional days, plus whatever preparation we were doing for it. And then also, it took some time to grade the papers, all that kind of stuff, which took away from my preparation time as well….So I thought it was a little much…to do three of them; I felt it would be better if it was just one.*

Some interviewed teachers said that they had stopped what they were doing in order to prepare students for assessments (including the SAT-9), and a few of them resented having to do this. As one teacher put it, "It [test preparation] slowed me down with respect to my regular instruction."

- **The time at which an assessment is administered also plays an important role in how much of the content students have covered.**

Some teachers voiced concerns not only about the amount of time required to prepare for and to give assessments, but the particular scheduling of these assessments, as indicated by the following interview comments from two teachers at one school:

> *I mean, it's really hard, because, like, we'll get a test coming up, a [district] performance-based assessment test, coming up, and I'll look at it, and I'll go, "Oh, gee, we haven't even covered this yet." So I'll have to stop what I'm doing, cover this material, so that they can do well on the performance-based assessment test. And then go back to my regular material.*

> *The district has had…performance-based assessments that we had three times this year…And I have no trouble doing performance-based assessments, but when it comes from the district, it doesn't necessarily fit with what you're doing at the time. I'd rather have an assessment that goes along with what they [students] are doing….It was like, just take this chunk out of time, and do this thing that's not associated with what you're teaching.*

Another scheduling concern is that some assessments—the SAT-9 in particular—are administered before students have been exposed to all the content in the assessments. One interviewed eighth-grade teacher stated that although the SAT-9 was given in the early spring, it focused on the last third of the year's curriculum, and the class simply "hadn't gotten to a lot of those topics yet." Another eighth-grade teacher, interviewed toward the end of the school year, said that her class had covered several more standards since the test was given, as a result of the way the book was set up. She hypothesized that if her students could "take the test today, they could get at least ten more right." As it was, however, she stated, “The SAT-9 was extremely frustrating — it was a whole week of upset and tears” for her students, whom she said are among the best at her school. She teaches five gifted classes.

In the Next Chapter

As shown in this chapter, the SAT-9 has made a significant impact on instruction, as teachers are eager to help their students do well on this high-stakes test. However, teachers’ good intentions alone may not be sufficient to raise student achievement. Even if student achievement on the SAT-9 does improve, achievement on measures of assessment that measure different types of mathematical skills and abilities might not. The implementation of meaningful instructional change that truly raises students’ understanding of mathematics might require changes in teacher preparation and professional development. These will be discussed in the following chapter.

Chapter 7

Professional Development

Highlights of Findings

- **Fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers in the period between January 1998 and spring 1999.**
  While about two-thirds of eighth-grade teachers reported having had more than 20 hours of mathematics professional development from January 1998 through spring 1999, over 50% of fourth-grade teachers said that they had had 10 or fewer hours of mathematics professional development during this same time period. However, this is unsurprising, as fourth-grade teachers are teaching other subjects in addition to mathematics.

- **Some teachers, especially at the fourth-grade level, identified a lack of comfort with mathematics content as being an obstacle to their teaching.**
  Very few fourth-grade teachers who were surveyed reported having a strong background in mathematics. Most of the eighth-grade teachers who responded to the survey appeared to have a relatively strong background in mathematics, including a mathematics-related teaching credential, but it is unclear how representative these data are of the larger pool of middle-school mathematics teachers.

- **Many teachers identified professional development as something that had helped their mathematics teaching, and they would like more.**
  Areas in which teachers seek additional professional development include standards and instructional techniques. Teachers would also like more opportunities to collaborate with one another.

- **Providing effective professional development for all who need it is a major challenge.**
  Some teachers and principals discussed the importance of professional development being accessible and worthwhile. Site-based professional development and moving to a specialist model at the elementary school level were among the solutions proposed by district administrators.

Background

Previous chapters have discussed instructional strategies, curriculum materials, standards, and assessment. While any or all of these may exert a strong influence on instruction, they are unlikely to exert a strong positive influence on student achievement unless teachers know how to use them for that effect. For many teachers, the acquisition of such skills and knowledge comes primarily through professional development.

Learning to teach is a life-long process, of which pre-service preparation is just one phase. Ideally, teachers emerge from this phase as strong novices, equipped with the skills and dispositions to facilitate continuation of the learning process. Thus, pre-service programs are only the beginning of a teacher professional development continuum. Subsequent educational programs help teachers to become *competent* through emphasizing increased knowledge of subject matter, pedagogy, learning theory, and classroom management techniques. These professional development experiences can be formal or informal, as well as long-term or "one-shot."

To increase their subject matter competency, many teachers enroll in formal university courses in mathematics content or mathematics education. Over the past sixteen years, thousands of California teachers have also participated in the CDE-sponsored California Mathematics Projects, housed at colleges and universities, focused on improving teachers' understanding of subject matter as well as instructional practice. Hundreds of elementary teachers have acquired new curriculum materials as well as strategies for teaching through participation in the Math Matters project, also sponsored by CDE. California teachers have also received professional development in mathematics through their involvement in long-term, National Science Foundation funded, district-based programs such as the Statewide Systemic Initiative sponsored *Math Renaissance* for middle schools, Local Systemic Change Projects, or Urban Systemic Initiatives (USIs).

County Offices of Education and school districts offer teachers a variety of professional development opportunities (often called "in-services") that vary from one-shot sessions to those involving a long-term series. Almost every school district invests considerable resources in sessions devoted to helping teachers become familiar with newly adopted instructional materials and since 1984, funds from the Eisenhower Professional Development Program have enabled local districts to increase and enhance professional growth opportunities for teachers of mathematics.

The California Mathematics Council (CMC), a professional organization, sponsors three major multi-day conferences for teachers of mathematics grades K-14. Approximately 9,000 teachers attend CMC conferences held at conference sites at Asilomar, Palm Springs, or Fresno each year. Local affiliates of the CMC also sponsor smaller conferences where teachers learn about new resources and strategies.

Informal professional development occurs in a variety of ways. Many teachers increase their knowledge through reading professional journals published by CMC or the National Council of Teachers of Mathematics. Teachers also share their expertise with one another at their own school sites through grade-level or departmental meetings focused on mathematics topics or through informal conversations in the lunchroom.

Over the past 15 years significant federal, state, and foundation funds have been devoted to mathematics professional development. Most of the data on teacher professional development in this study reflect only a snapshot in time—January 1998 through Spring 1999—and not the multitude of professional development opportunities available to teachers nor the intensity of professional development involvement of individual teachers. Rich descriptions of mathematics professional development experiences and their impact on classrooms were, however, provided during teacher and administrator interviews. Many of these experiences were prior to January 1998, indicating the limitation of the survey data.

Amount of Professional Development

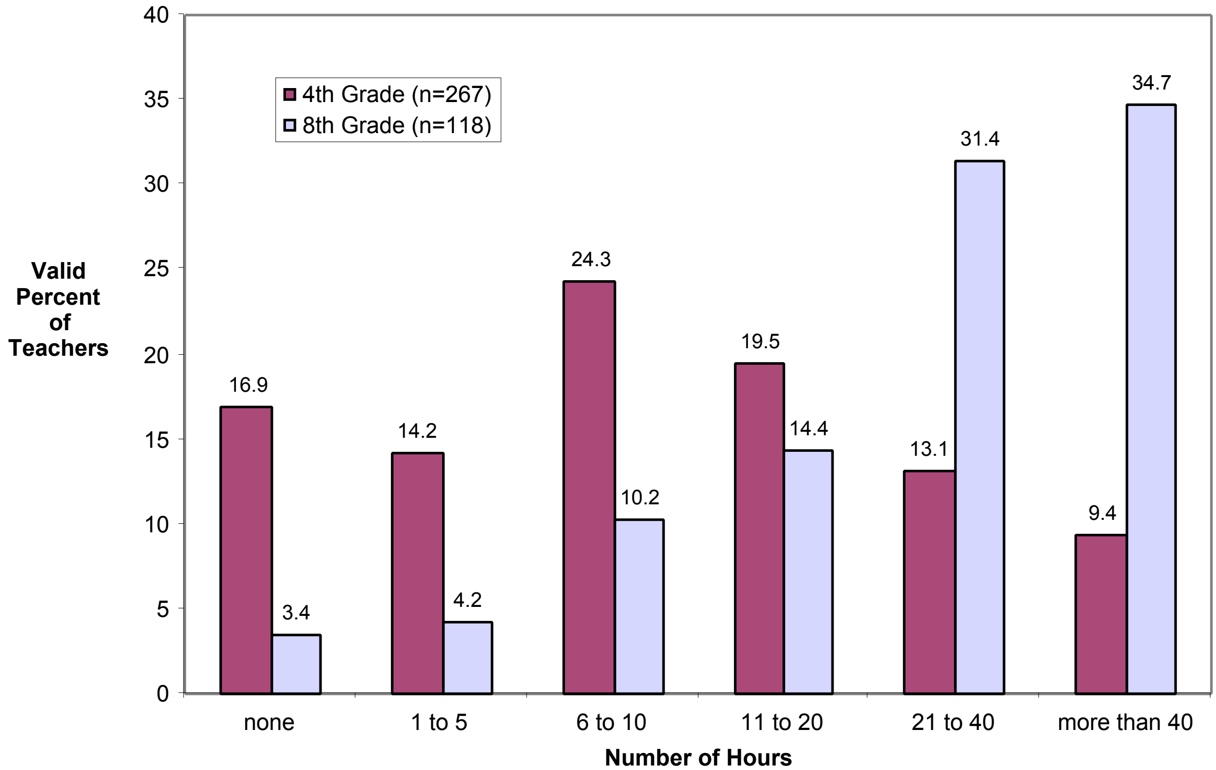
- **Unsurprisingly, fourth-grade teachers reported having had much less mathematics-related professional development than eighth-grade teachers.**

One of the questions on the survey asked, "Since January 1998, approximately how many hours have you spent in mathematics professional development?" Respondents were prompted to include "attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences." As teachers completed the survey in the spring of 1999, the period of reference covered a little over a year.

As Figure 7.1 shows, fourth-grade teachers reported having had fewer hours of mathematics professional development than eighth-grade teachers in the year-plus time period covered by the question. About 30% of fourth-grade teachers said that they had had 5 or fewer hours, and another 24% said they had had 6 to 10 hours. For the eighth-grade teachers, on the other hand, approximately one-third of the teachers reported having had more than 40 hours, and about another third indicated 21 to 40 hours.

That fourth-grade teachers have had fewer hours of mathematics professional development than eighth-grade teachers is not surprising. Fourth-grade teachers, of course, are teaching multiple subjects, of which mathematics is just one, while most of the eighth-grade teachers who were surveyed were teaching primarily mathematics. Thus, the eighth-grade teachers are probably more likely than the fourth-grade teachers to have engaged in professional development that focused specifically on mathematics.

Figure 7.1
Reported Number of Hours Spent in *All Types* of Mathematics Professional Development, January 1998–Spring 1999



More in-depth findings on professional development and preparation in mathematics are presented in the following sections.

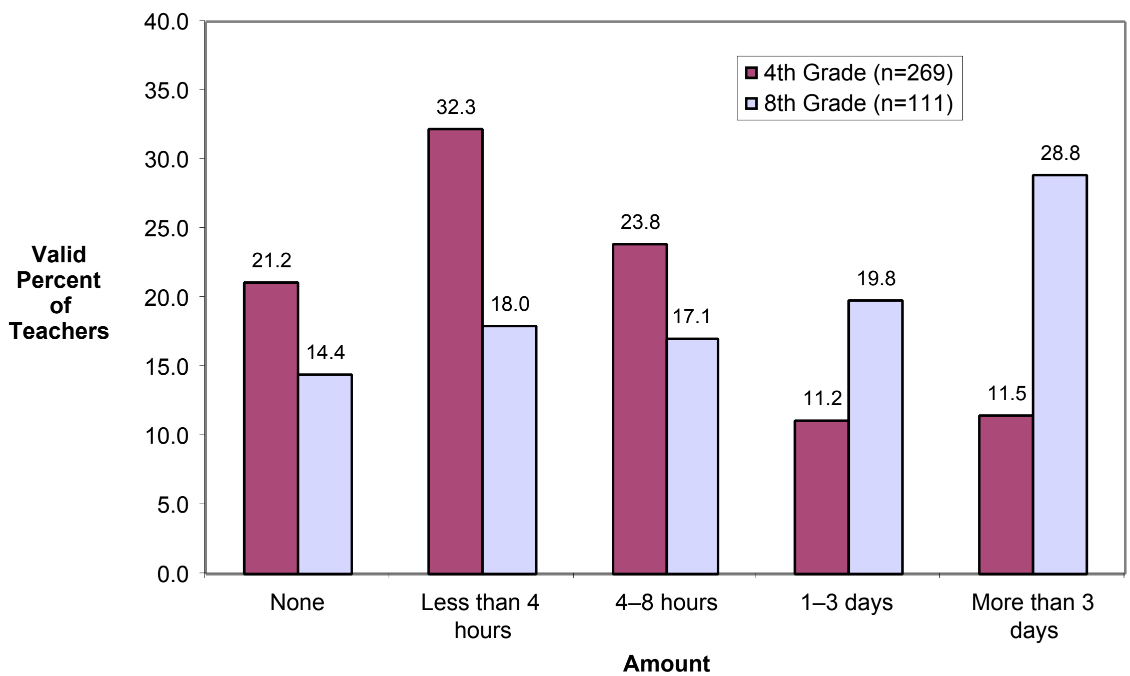
The Lack of Professional Development as an Obstacle

Several of the teachers who were interviewed mentioned increased professional development as something that would help them improve their mathematics teaching. On the survey, about 11% of fourth-grade teachers and 4% of eighth-grade teachers cited things such as "lack of training" and "insufficient professional development" as being among the biggest obstacles to their mathematics teaching. Many did not specify what, in particular, they felt was lacking in terms of professional development and training, but some did.

♦ **Some teachers, especially at the fourth-grade level, identified a lack of comfort with mathematics as being an obstacle to their teaching. Very few fourth-grade teachers who were surveyed reported having strong background in mathematics.**

A few teachers, especially at the fourth-grade level, indicated that the main problem was lack of comfort with or conceptual understanding of the subject matter. "My limited exposure to math concepts," wrote one fourth-grade teacher in response to the obstacles question on the survey; "I lack depth of understanding in concepts" wrote another. On a different survey question that asked how much time teachers had spent in specific types of mathematics professional development since January 1998, about 20% of fourth grade respondents said that they had had *no* professional development in mathematics content, and 32% said they had had less than four hours. In contrast, eighth-grade teachers reported having had considerably more content-related mathematics professional development. (See Figure 7.2.) Again, this is to be expected, as eighth-grade teachers have had more overall mathematics professional development.

Figure 7.2
Reported Amount of Professional Development in Mathematics *Content*
January 1998–Spring 1999



One factor that may influence comfort with mathematics, obviously, is mathematics background and preparation. The survey included several questions aimed at identifying mathematics background and preparation such as mathematics courses taken in high school and college, subject area of degree, and type of credential.

The mathematics background of most fourth-grade teachers appears relatively limited. In terms of high school mathematics courses, only about a third of fourth-grade respondents indicated that they had taken more than three such courses. At the college level, nearly one-third of fourth-grade respondents did not indicate that they had taken *any* college mathematics courses, and another third indicated that they had taken only one. Similarly, only four fourth-grade teachers reported having a bachelor's degree in mathematics. Almost no fourth-grade teachers had a mathematics-specific teaching credential, although 11 of 260 (4.2%) said they had a supplementary authorization in mathematics.

♦ **Most of the eighth-grade teachers who responded to the survey appeared to have a relatively strong background in mathematics, including a mathematics-related teaching credential.**

Unlike the fourth-grade teachers, responding eighth-grade teachers appeared to have substantial mathematics background. 75% of the responding eighth-grade teachers reported having taken four or more high school mathematics courses, and about 65% said they had taken at least three college mathematics courses. 37% reported having a bachelor's degree in mathematics. Moreover, only 13.4% of responding eighth grade teachers said that they did not have any mathematics-related teaching credential. Nearly half (47.9%) said they had a full mathematics credential ("single subject credential in mathematics" or "standard secondary credential in mathematics"). About another third (30.3%) had no full mathematics credential but did say they had a supplementary authorization in mathematics. (See Figure 7.3.)

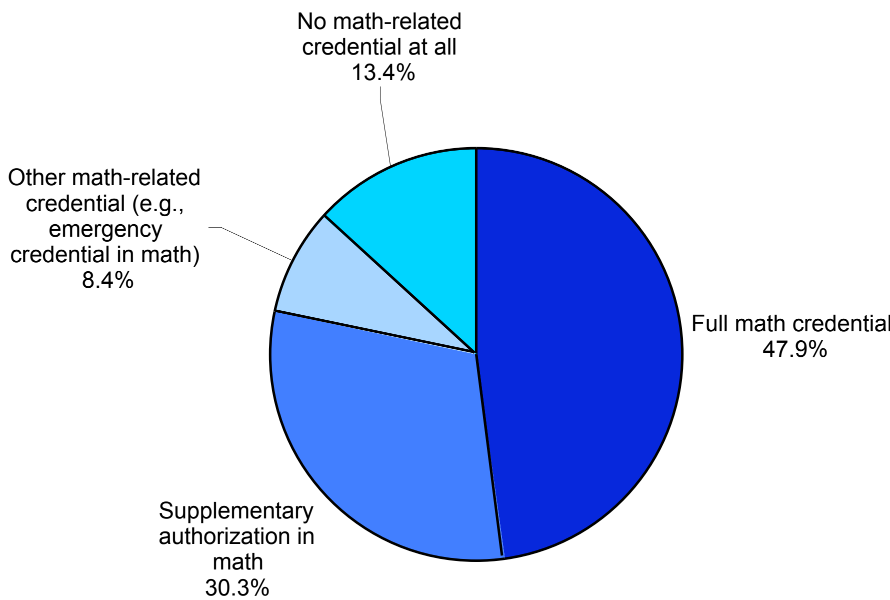
It is not entirely clear, however, how representative these figures are of the larger pool of eighth-grade mathematics teachers. Teachers with more mathematics background may have been more likely to respond to the survey than teachers with less mathematics background.

Middle school teachers' mathematics background may also vary to some extent by district. The district mathematics coordinator in one large district that was visited stated that until a few years ago, all middle school mathematics teachers in the district had a major, minor, or a supplementary credential in mathematics, and even now (at the time of the interview), only 22 middle school mathematics teachers did not.[1] In a different district, however, the

[1] This administrator did, however, acknowledge that fewer and fewer math majors, and more and more teachers with elementary credentials only, were becoming middle school mathematics teachers. He also pointed out that having a major, minor, or supplementary authorization does not necessarily guarantee having conceptual understanding of mathematics.

district mathematics coordinator who was interviewed indicated that only 17% of middle school mathematics teachers have a background in mathematics. In a third district, the district administrator who was interviewed expressed the opinion that middle school teachers "simply do not get adequate subject matter preparation in math" to be able to teach it effectively, particularly with the increased expectations called for in the new standards.

Figure 7.3
Eighth-Grade Mathematics Teachers' Credentials
n=119



One of the interviewed district administrators discussed the relationships among professional development, teacher preparation, familiarity with mathematics content, curriculum materials, and standards. The context for these remarks was the description of a district-sponsored program that aimed to provide 60 hours of mathematics professional development to every teacher teaching mathematics in grades K–8:

> *The first two or three days were really getting [teachers] used to the materials, getting [them] to know what the materials were…and then at the same time trying to talk about some of the mathematics….And what we kept finding was, you have to start spending a lot more time on good content, because the preparation for so many people was really weak. It became very clear when you started talking about some of the lessons and some of the units. So, we began to do more what I would call* content. *Not so much on pedagogy… Particularly I think in the upper grades, some*

of the people began to realize, these materials, they were moving into areas they hadn't ever spent any time on. Well, now, you move to today, where the standards come in—the standards ratcheted it up another couple levels. And you talk now to fifth grade teachers, and they'll tell you, "Wait a minute, half that stuff we still don't teach"…Integers, negative numbers, fractions. Many times they may have done awareness, or introductory kinds of things, but to have mastery? I mean, it's almost like they say, "Wait…this is too hard for my kids," but I think what they're really saying is, "I don't understand this myself." They haven't taught this material. But now, the expectation [is that they will]. As we've moved to the middle school concept, you have folks with elementary credentials moving up, and the math content is moving down…Well, [soon] you're gonna have a teacher with an elementary credential trying to teach algebra… I firmly believe they can. But they just aren't gonna have a strong background.

- **Other areas in which teachers seek more professional development include standards and instructional techniques. Teachers would also like more opportunities to collaborate with one another.**

Indeed, another area in which some teachers expressed a desire for more professional development was with standards. "We need district inservices and materials to support the new standards," remarked one fourth-grade survey respondent. As Figure 7.4 shows, two-thirds of responding fourth-grade teachers indicated that they had had less than four hours of standards-related mathematics professional development since January 1998, and more than half of the eighth-grade teachers reported that they had had eight hours or less of such professional development.

The picture is similar for professional development relating to mathematics instructional techniques, as illustrated by Figure 7.5. "Lack of training in excellent teaching methods," wrote one eighth-grade teacher in response to the "obstacles" survey question; "lack of specific teaching techniques," wrote a fourth-grade teacher. And a different fourth-grade teacher who was interviewed, when asked what would help him improve his mathematics instruction, gave the following response:

I'd like more strategies on how to motivate kids and teach them how math is relevant to their lives. More fun activities, math games, that kind of thing. I follow the book too closely. I need more background and training in using 100s charts—that's one thing that comes to mind. I'm just getting familiar with the curriculum itself… Also, I haven't been able to collaborate with other teachers. That would be beneficial to teachers in general, especially ones just starting out like I am.

The apparent low level of professional development in standards and strategies between January 1998 and spring 1999 may, however, be a function of the cyclical nature of professional development offerings (e.g., those based on the adoption of curriculum materials).

Figure 7.4
Reported Amount of Professional Development in Mathematics Standards (State and/or District) or Framework
January 1998–Spring 1999

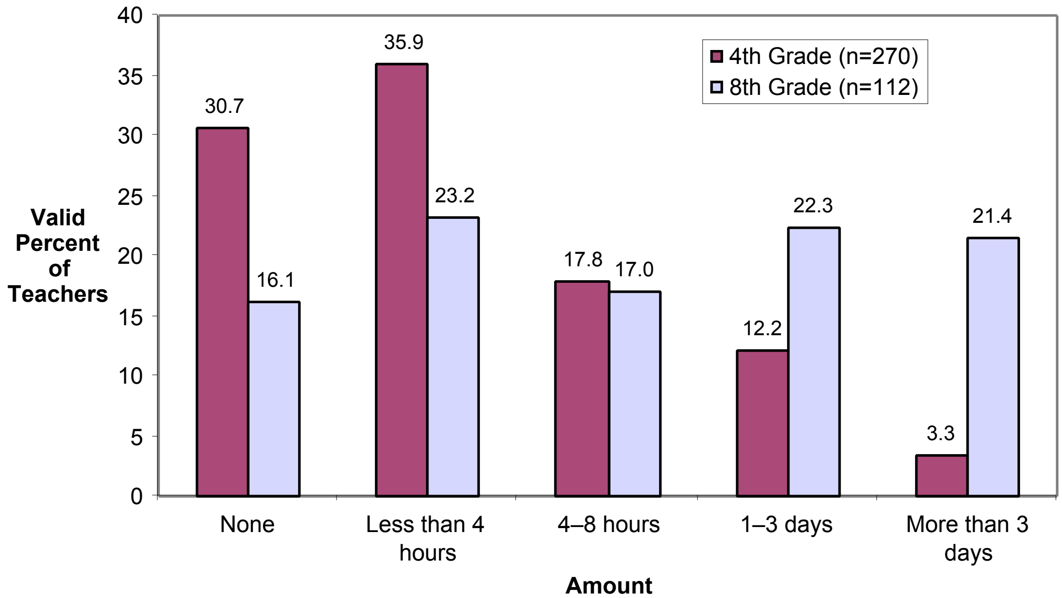
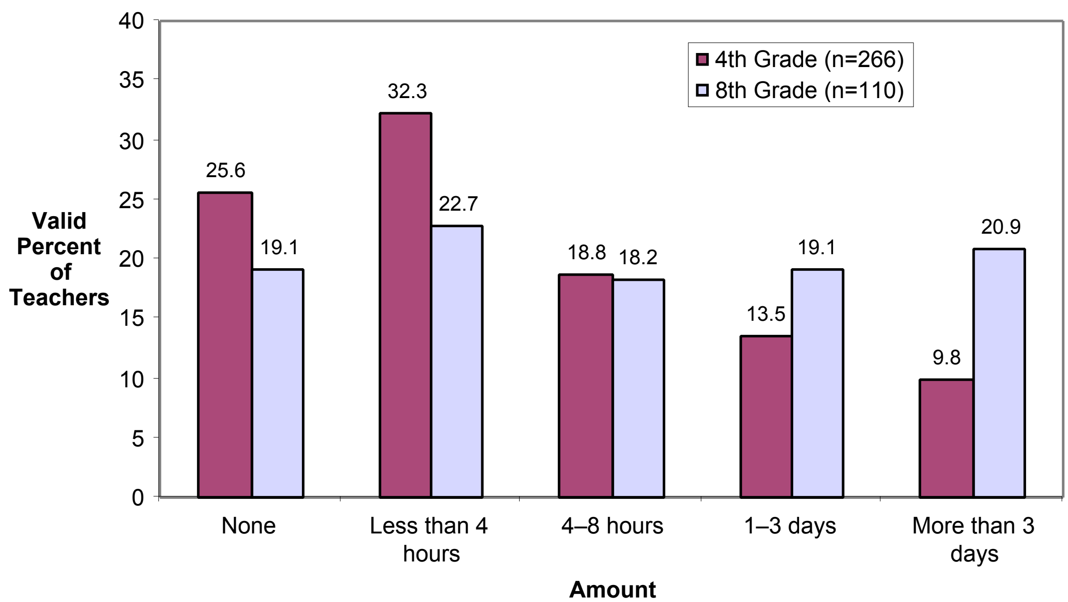
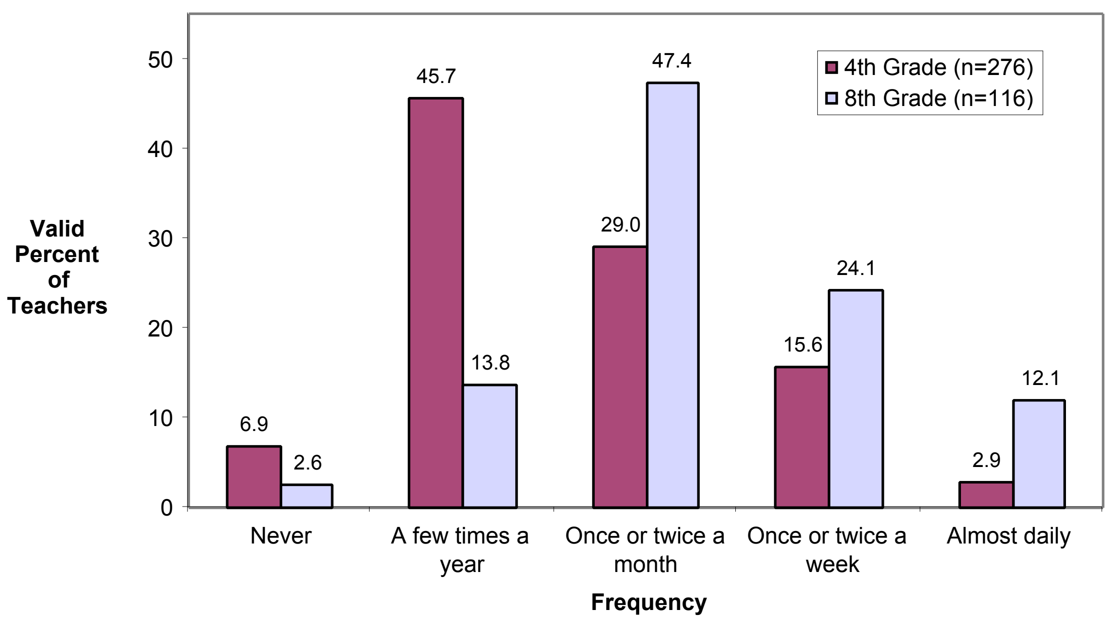


Figure 7.5
Reported Amount of Professional Development in Mathematics Instructional Techniques or Strategies
January 1998–Spring 1999



As exemplified by the speaker of the preceding quote, lack of opportunities to collaborate with other teachers was yet another professional-development-related obstacle cited by some teachers both in interviews and on the survey. Figures 7.6, 7.7, and 7.8 show the frequency in which teachers reported engaging in three different types of collaboration at their schools: sharing ideas about mathematics instruction, working together to develop mathematics curriculum, and observing one another teaching mathematics.[2] As with the other types of professional development already discussed, it is apparent that in these areas, as well, the opportunities of the fourth-grade teachers have been more limited than those of the eighth-grade teachers.

Figure 7.6
Reported Frequency of Teachers Sharing Ideas About Mathematics Instruction



[2] The scale used for these types of activities was different than that used for the other types of professional development. Whereas the others asked respondents about amount of time spent (in hours or days) since January 1998, these asked about frequency (from "never" to "almost daily"), and thus were not limited to any particular period of time.

Figure 7.7
Reported Frequency of Teachers Working Together to Develop Mathematics Curriculum

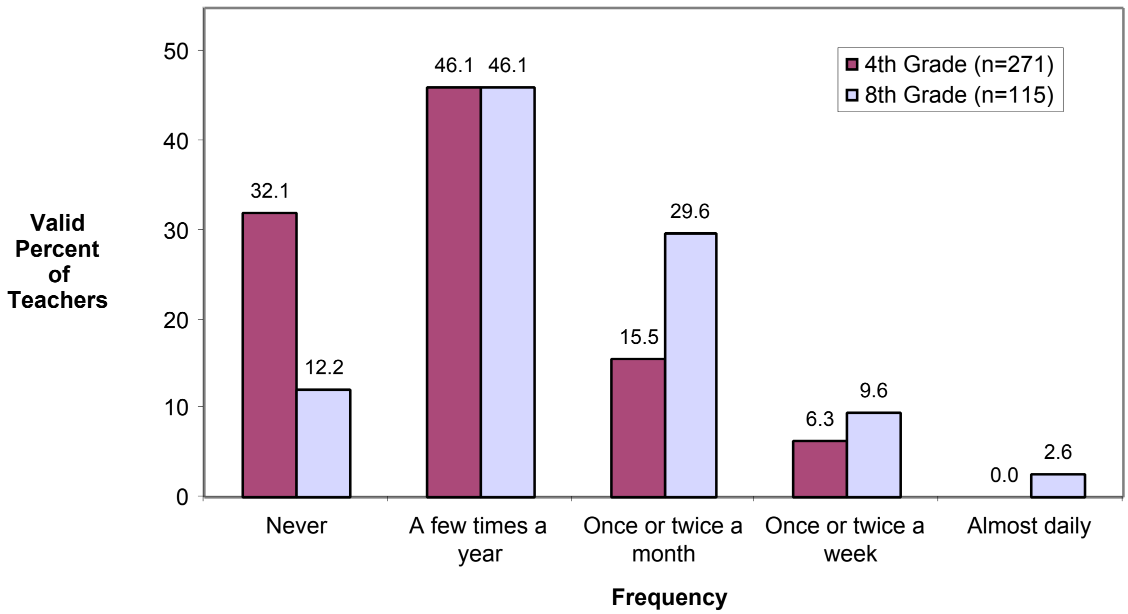
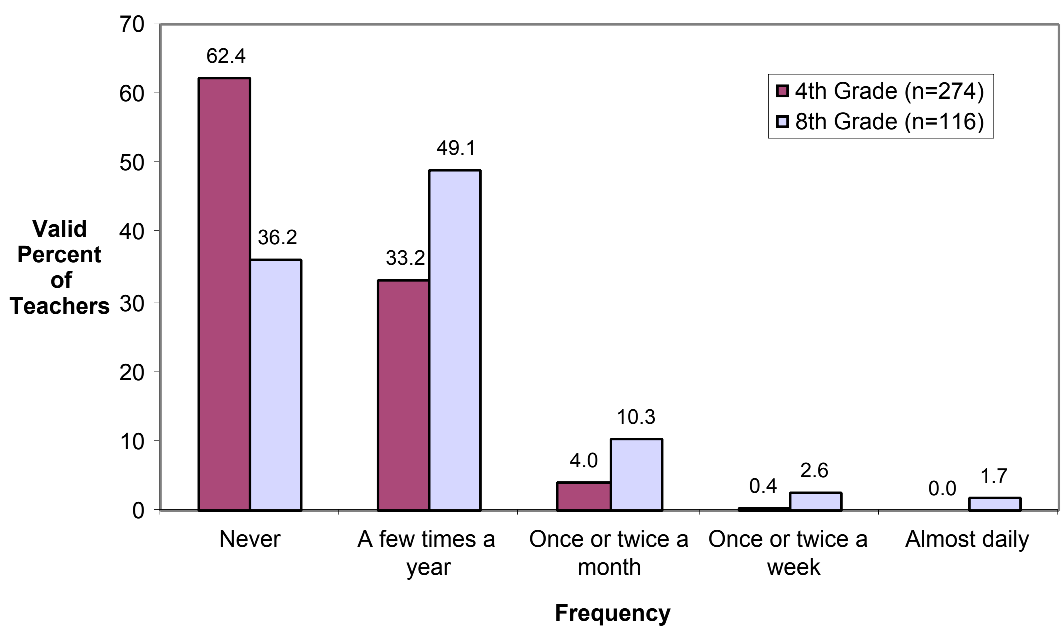


Figure 7.8
Reported Frequency of Teachers Observing One Another Teaching Mathematics



The Presence of Professional Development as a Help

Although several teachers did cite a lack of professional development as an obstacle to their teaching, there were more teachers who indicated that they *had* had professional development, and that it had helped them. Indeed, in response to the open-ended survey question, "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe," many teachers cited professional development/ teacher preparation. At the eighth-grade level, there were more responses in this category than in any other (33.9%); at the fourth-grade level, it was a close second—26.1% compared to 28.2% in the largest category (standards). About 15% of both fourth- and eighth-grade teachers also listed various types of professional development in their response to the question, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching/your effectiveness as a mathematics teacher?"

♦ **Many teachers identified professional development as something that had helped their mathematics teaching. The specific types of professional development mentioned varied.**

The specific types of professional development cited as being helpful ranged considerably, but each of the following was cited by 5 to 25 teachers (including both fourth-grade and eighth-grade respondents) on the survey:

- collaborations with other teachers (within the grade, school, or district) (See Figures 7.6, 7.7, and 7.8, above.)
- inservices/workshops on the use of particular curriculum materials
- other workshops/inservices
- attendance at professional conferences
- inservices on standards or assessment
- pursuit of advanced degree/college mathematics courses and other types of involvement with institutions of higher education
- a variety of specific mathematics professional development programs. (See the "District Spotlight" on the STEPSS program).

For instance, items cited on the survey as being helpful included:

Grade-level/department collaboration at site

District has provided monthly workshops directed at teaching our text adoptions. These are vital to my teaching!

Workshops to help me understand concepts and how to teach them

NCTM Math conferences, publications

Inservices on how to adapt the new standards to the curriculum

USI monies have been helpful with district inservices on math background learning from college professors

In a former district, I participated in Math Matters and it has helped me immensely in the way I teach math.

The same types of things were mentioned by many of the teachers who were interviewed, in response to the question, "Do you have professional development opportunities related to math instruction?" For example:

[from an eighth-grade teacher] The district just sponsored a workshop on teaching algebra. I have attended a few other district workshops this year. They give me things to think about…. A recent one on writing rubrics made me think about how I measure kids.

I attended the NCTM conference in San Francisco. It was a great conference.

We have common planning time at school when we try to problem solve and discuss what's going well.

Some workshops were set up with the new math adoption…. The PD activities have helped me with getting ideas on how to expand the variety of ideas.

The district does in-services and minimum day workshops. I usually get some good ideas.

District Spotlight: A Professional Development Program That Is Making a Difference

In 1998, one of the study districts, in partnership with two local universities, started a comprehensive mathematics professional development program for elementary schools. The program, called Strategies for Teacher Excellence Promoting Student Success (STEPSS), is aimed at strengthening and enhancing the mathematics content knowledge and instructional expertise of teachers and administrators in selected district schools. The program is also designed to develop leadership and coaching capacity for the improvement of mathematics curriculum and instruction, and, ultimately, to improve student mathematics achievement throughout the district.

The five-year, $3.8 million program is supported by the National Science Foundation's Local Systemic Change program and has several components. These include a one-week intensive institute for all faculty from participating schools; an additional week-long "teacher leader institute" for administrators and for teachers seeking a greater leadership role at their school; inservices, demonstrations, and guided practices on peer coaching; and monthly on-site coaching visits from district coaches.

In addition, the teachers from participating schools have ongoing opportunities to visit the "demonstration classrooms" of teacher leaders, to engage in a variety of mini-institutes on a wide range of topics, and to attend conferences. Finally, each participating teacher is required either (1) to participate in at least 30 hours of mathematics content courses offered by the partnership universities or (2) to matriculate in a master's degree program with an emphasis in elementary mathematics education. Their tuition and fees are supported in part by grant monies.

Nine district elementary schools have participated in the STEPSS program in its first two years (five schools started in the first year, and four more were added in the second year). Of these nine schools, seven were participants in the Mathematics Implementation Study. Based on survey comments made by many of the teachers at these schools, it is clear that the STEPSS program is having an impact.

Five teachers from five different schools each mentioned the program by name in responses to the survey's open-ended questions. Four of them mentioned it in the response to the question about policies that have *helped* their mathematics teaching. Two of the four simply wrote the name of the program, while the other two made the following remarks:

> *The STEPSS grant our district received from the federal government has provided great inservice, coaching, and support for professional growth in math education. Teachers' math content knowledge is being increased dramatically.*

> *What I value most are workshops in math and sharing with other teachers. Our district is just starting a new math approach with training, whereby teachers work together with a colleague. It is called the STEPSS. I am retiring; I wish this had started sooner.*

The fifth teacher who mentioned the program by name was at one of the second-year-cohort STEPSS school and merely wrote, "My school staff will start a STEPSS program" in response to the survey's final catch-all open-ended question.

Although the other 10 teachers in participating STEPSS schools who returned the questionnaire did not mention the program by name, several of them did make comments that were very likely about the program. For example, three of them wrote the following in response to the survey question about helpful policies:

> *Ongoing training and peer meetings/coaching on math curriculum.*

> *Paying for college math courses.*

> *District recommendation to become math experts by pursing Masters in Math.*

Another three teachers made the following remarks in response to the question, "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?":

> *Workshops with new and interesting tools with which to motivate students.*

[from one of the second-year-cohort STEPSS schools] I am desperately in need of more training which our school is scheduled to receive next year.

I am currently completing my masters in Curriculum and Instruction in Math. I feel the courses they are providing are helping me to be a more effective teacher.

Two teachers from one of the participating schools did comment that they were uncomfortable with the idea of peer coaching and that they felt the training was "excessive," taking them "out of the classroom too much." A third teacher at the same school indicated that pursing the master's degree while continuing to work full-time was hindering his mathematics teaching. However, two of these three teachers were among those who expressed their appreciation for the continuing education opportunities. Thus, based on the survey comments, it would seem that most of the participants are finding the STEPSS program to be valuable to their teaching in one way or another.

The Challenges of Providing Effective Professional Development

♦ Some teachers and principals discussed the importance of professional development being accessible and worthwhile.

Despite their general positive attitude about professional development, some teachers also talked about its limitations. Some discussed practical problems, such as the amount of time needed for professional development (particularly when it needs to be on the teachers' "own" time), or the cost of professional development (particularly when the money needs to come out of teachers' own pockets). The following comments were made by teachers who were interviewed:

Next year [the district] may not allow teachers to leave the classroom for conferences…so the professional development will have to be on their own time. I'm not sure how it will be under that system.

[At this site] professional development is on your own—at a University, and I'd have to pay for it myself.

In terms of PD I have access to a Math Matters session one time a month, and an actual support person to help me, and also we have three peer coaches who come out at least one time a month. I find it all very helpful but the hours interfere with teaching.

I would like to attend more conferences outside this area but there is no money.

Other teachers who were interviewed expressed concerns about the nature of the professional development itself, saying that although they had engaged in some professional development activities, they did not always find them very useful:

> *We educators do a pitiful job finding people to train us as educators. Professional development training tends to be boring.*

> *[District provided professional development days] are not all that helpful! We go over the same things time and time again.*

> *I've taken some [workshops] that were excellent, and some that were a total waste of time. And I guess that's why I'm reluctant to take them—because you never know ahead of time whether it's going to be good or not.*

> *[from a middle school teacher] The math [professional development] that is available for us is mainly…targeted toward elementary or high school, and there are very few workshops that are targeted towards the middle school student. And in that sense, I kind of feel that we're basically on our own as middle school math teachers, where we're caught in the middle.*

> *We had one day [of professional development] with follow-up. It introduced us to certain fun activities. But it was in English; at the time [early in the year] I was teaching in Spanish. I needed more of a demonstration.*

Several principals who were interviewed also talked about the importance of professional development being useful to teachers. One of the interview questions that was posed to principals was, "What do you think are the most effective kinds of professional development for your teachers in mathematics?" There were almost as many different types of answers given as there were principals interviewed, but the following were some of the responses:

> *The days that the people from the district came out, and did the training, the teachers loved those days. They got a lot of good strategies, a lot of good ideas. But without the follow-up, without the coaching element [where coaches from the district came out and went into the classrooms and observed and worked with the teachers], and the modeling in the classroom, we know it is not as effective….The follow-up, with the coaching, is critical.*

> *Teachers need continuous support so that the professional development does not just last for one day.*

> *The teachers have to have a hand in shaping the professional development; it has to meet their needs, otherwise they'll tune you out. They can't feel like it's a waste of their time. I don't mind being controversial, but I don't want the teachers to waste their time.*

- ♦ **District administrators acknowledged that providing effective professional development for all who need it is a major challenge.**

Several of the district-level mathematics administrators who were interviewed also discussed the difficulties involved in providing widespread, effective professional development. They all described the attempts their districts had made—some of which were moderately successful—but the obstacles they had came up against. Generally these were logistical in nature, having to do with the size of the districts, all of which were quite large, and the correspondingly large number of teachers that needed to be reached.

Reaching all of the elementary teachers was cited as a particular problem, since (as discussed above) mathematics is only one of the subjects taught by elementary teachers. One of the administrators talked about "trying to inservice" 5000 to 6000 elementary school teachers and concluded, "You can't do it. You can't do it, for math, and science, and language—I mean, you can't take the same 6000 teachers and try to provide the staff development that's needed for all the subject areas."

Moreover, some of the district administrators pointed out that much of the professional development is voluntary, especially for the K-6 teachers. One of these administrators said that many of the teachers who are most in need of professional development tend not to ask for it. Even when it is supposedly mandatory, teachers still may not participate; in one district where professional development is mandated for teachers in grades 7-8, there is a 30% no-show rate, according to the administrator who was interviewed there.

- ♦ **Site-based professional development and moving to a specialist model at the elementary school level were among the solutions proposed by district administrators.**

The district administrators did propose some possible solutions to the professional development problem. One solution that was mentioned is to have more site-based professional development, since even a strong centralized program cannot reach all of the teachers in a large district. In such a site-based program, sites would need to be supported so that they could define their own needs and work at improving their own capacity to meet those needs. Some of the principals who were interviewed did indicate that some on-site professional development opportunities had been useful to teachers. However, on-site activities may not work for all types of professional development, such as those aimed at strengthening teachers' mathematics content knowledge.

Another idea that was mentioned by administrators in two different districts is to move to a team-teaching, specialist, or departmentalized model for mathematics at the elementary school. In such a model, resembling what is done at higher grade levels, elementary teachers specialize in certain subjects, such as mathematics and science, and mainly teach only those subjects, instead of teaching all subjects. As one administrator suggested, moving to such a model might cut down on the amount of preparation that elementary teachers would need to do, and, in terms of professional development, would allow them to focus on their particular subjects.

In the Next Chapter

Moving to a specialist model for mathematics at the elementary level would be a major structural change to instruction. Other structural influences on instruction, such as policies relating to use of time and to class size, are discussed in the following chapter. Also discussed in the next chapter is how students themselves affect instruction, for example as a result of their preparation and skill level or of their behavior and motivation.

Chapter 8

Structural and Student-Related Influences on Instruction

Highlights of Findings

- **Several teachers identified structural factors, such as those relating to time and class size, as obstacles to their instruction.**
  Time-related factors, including disruptions, lack of planning time, schedule configurations, the need to teach other subjects, and the breadth of the curriculum, are perceived by some teachers as obstacles to effective mathematics instruction. Class size was another structural factor that was discussed by many teachers. However, teachers' concerns about class size appear to be as much about variation in student ability as about large classes *per se.*

- **Students' skill levels, attitudes, home lives, and language abilities may also influence instruction.**
  Students' lack of preparation—particularly in basic mathematics skills—presents a major obstacle for many teachers. Poor student behavior and low student motivation are also perceived as instructional obstacles by a large number of teachers, especially at the eighth-grade level. Some teachers identified factors having to do with parents and student home life as being a challenge, and a few also mentioned students' language differences. However, the proportion of teachers who indicated that language differences presented a major obstacle to their mathematics teaching was relatively small.

Background

In addition to materials, standards, assessment, and professional development, several other important influences on teachers and on their instruction became apparent in the analysis of qualitative data (open-ended survey comments and interviews). These included some that were structural, such as time and class size. Others were related to student characteristics such as preparation and skill level, behavior and motivation, parents and home factors, and language differences.

Numerous state, district, and school policies have bearing on these types of structural and student-related influences on instruction. For example, recent state policies and legislation touching on such matters have included:

The Class Size Reduction Program. California's Class Size Reduction (CSR) Program was established in 1996 to improve student achievement, particularly in reading and mathematics, in the primary grades. The CSR Program is a voluntary incentive program in which the state provides districts with additional per pupil funding for each child in grades K-3 who receives instruction in a class of 20 or fewer students. In 1998-1999, the third year of the program, 99% of California school districts participated.

Pupil Promotion and Retention Legislation. Three pieces of related legislation, all signed by the Governor in 1998, relate to the promotion—or lack thereof—of students from one grade level to the next. AB 1626 required each school district to "approve a policy regarding the promotion and retention of pupils" between certain grade levels based on "pupils' level of proficiency" in reading, English language arts, and mathematics. AB 1626 also required the Superintendent of Public Instruction to recommend, and the State Board of Education to adopt, minimum levels of performance on the assessments in the STAR program for the determination of student proficiency.[1] AB 1639, meanwhile, requires districts to offer supplemental instructional services to retained students through summer school, after-school, Saturday, and/or intersession instruction. SB 1370 appropriated funding for this supplemental instruction.

Proposition 227. Proposition 227, known prior to its passage as the Unz Initiative, was enacted by California voters in June 1998. It requires that all children in California public schools be placed in "English language classrooms," defined as classrooms "in which the language of instruction used by the teaching personnel is overwhelmingly the English language, and in which such teaching personnel possess a good knowledge of the English language." The proposition also specified that English language learners are to be placed in "sheltered English immersion" for no more than one year. However, parents may request waivers so that their children can be placed in "classes where they are taught English and other subjects through bilingual education techniques or other generally recognized educational methodologies permitted by law." Schools where 20 or more students at any given grade level have received waivers are required to offer such classes.

[1] As of the publication of this report, no such recommendation had yet been made, largely out of a concern that the determination of student proficiency be based on standards-aligned assessments. When the STAR augmentation (Standards-Based Test) has been deemed valid and reliable and is included as a measure on the state's Academic Performance Index (API), then the Superintendent may proceed with the recommendation. Until then, districts are free to make their own determinations of minimum levels of student proficiency, and have been encouraged by CDE to base the determinations on multiple measures of student performance. (R. Anderson, CDE, personal communication, May 23, 2000).

Along with these and other state programs and policies, many district and school policies also are related to structural and student influences on instruction. For example, some districts may have policies affecting how much time may be spent on mathematics instruction (e.g., versus other subject areas), whether students may be grouped by ability, or what happens to students whose behavior repeatedly disrupts the learning of other students.

An in-depth analysis of all of these various policies and their effects on mathematics instruction—not to mention on student achievement—was well beyond the scope of this study. However, teachers' comments made it clear that such policies can and do exert a strong influence, and that mathematics instruction must be considered in the context of such policies.

Time

- **Several teachers said that time-related factors, such as disruptions, lack of planning time, schedule configurations, the need to teach other subjects, and the breadth of the curriculum, presented obstacles to their instruction.**

On the survey, approximately 16% of teachers at both fourth and eighth grade levels identified factors having to do with *time* as being among the biggest obstacles to their mathematics teaching. However, not every teacher shared exactly the same time-related concern. The most common concerns included:

Frequent disruptions to instruction. In the interview question, "Is there anything that gets in the way of your effectiveness as a math teacher?" one eighth-grade teacher replied, "Scheduling—there are so many interruptions and other things going on." A fourth-grade teacher in the same district said, "Yes, anything that takes time away from time on task. The school schedule changes a lot because of assemblies and different events; this takes time away from instruction and what we can get done." On the survey, an eighth-grade teacher in a different district remarked, "Anything that takes away from instruction time is a disservice to our students (assemblies, special days, excessive testing, etc.)" Indeed, as discussed in the chapter on assessment, several other teachers also commented on the problem of testing taking time away from instruction.

Lack of time to plan and prepare. This was particularly an issue at the fourth-grade level. As one teacher who was interviewed said, "As a fourth-grade teacher, we don't have prep time." Several other fourth-grade teachers, on both the survey and in interviews, made similar comments about lacking planning/preparation time.

Schedule configuration. Some eighth-grade teachers indicated on the survey that schedule configuration factors interfered with the effectiveness of their mathematics teaching:

> *Teaching in 45 minute blocks, too limiting*
>
> *Periods too short to do an adequate job of presentation*
>
> *Too long a day which results in tired students and teachers.*
>
> *Block scheduling (one really long day, one really short day, only 4 days total for each student in math)*

Unlike this writer of this last remark, however, other teachers spoke positively about block scheduling.[2] In the answer to the survey question about policies that have helped mathematics instruction, one teacher replied, "Longer periods twice a week. I believe there should be less electives and longer periods of math." A teacher in a different district remarked in an interview, "Two hour blocks would be great once a week so we could do longer activities rather than having them last for four to five days."

Amount of time for mathematics as compared with other subjects. This, meanwhile, was obviously more of an issue at the fourth grade level. The following comments, each from a teacher in a different district, were made in response to the obstacles question on the survey:

> *The time during the day to effectively teach math with many other curriculum areas to cover.*
>
> *Time! I could use about 1 1/2 hours each day just for math.*
>
> *Time. As an elementary school teacher I must also teach other subjects. If a person wants to teach a subject in depth or for understanding it takes TIME.*

The matter of time for mathematics as compared for other subjects was a particular issue in a fourth district, where the district administration had recently mandated a daily three-hour "literacy block" for all elementary students as part of a strong district focus on literacy. "In this district this year," commented the district mathematics coordinator, "there's been no push in mathematics. Everything is literacy." He thought that although some teachers may have used the emphasis on literacy to avoid teaching mathematics, others did continue to teach it.

The fourth-grade teachers from this district who returned the survey did indicate that, on average, they spent as much time on mathematics instruction as teachers from the other

[2] On the eighth-grade survey, 21 teachers indicated a clear block-scheduling arrangement in their answers to questions about minutes per day and days per week of mathematics instruction. Other respondents may also have had block scheduling but not indicated this in their responses.

surveyed districts. However, of the 20 teachers from this district who opted to answer the open-ended survey questions, 8 of them commented that the district's literacy emphasis was having a negative effect on mathematics instruction. Some of the comments were as follows:

> *[cited as obstacle] Time, because our district requires too much time for other subjects… [cited as hindering policy] [District's] implementation of the literacy program.*

> *This year our district is requiring 3 hrs/day of literacy instruction. It is extremely hard to teach all other subjects including math…. The literacy program implemented in our district this year doesn't allow me to teach math when I need to, or spend as much time as I want to.*

> *[cited as hindering policy] Math is second fiddle to reading—and I think it will be that way for the next couple years!*

Lack of time to adequately cover the whole mathematics curriculum. As discussed in the chapter on standards, many teachers commented that they feel the new standards are too ambitious in terms of the amount of material they covered. Concordantly, time to "fit everything in" was a problem cited both by fourth-grade teachers and eighth-grade teachers. Among the fourth-grade survey comments on this topic were the following:

> *[cited as obstacle] Not enough time to cover all strands well.*

> *[cited as obstacle] Increasing the content to be taught, but not the time to be spent teaching. Do I ensure depth of understanding or go on to the next topic to fit it all in?*

> *I am unable to teach all of the new standards to mastery while also teaching long division/fractions and decimals. Plus I need to have it done by April! This leads to poor teaching practices—drill without understanding because of time constraints.*

> *Math—at any elementary level—seems to require too much to be covered. Little time for long projects.*

Eighth-grade teachers' survey comments were similar. They included:

> *[cited as obstacle] Lack of time (classtime) compared to amount of curriculum demanded.*

> *Too much material to cover, not enough time!*

> *[cited as obstacle] Trying to accomplish too much in the time frame allowed.*

Time to meet the needs of individual students. Finally, a few teachers' concerns about time had to do with a lack of time to meet the needs of individual students. For example, one fourth-grade teacher wrote on the survey that her biggest obstacles were "meeting everyone's individual needs" and "time to do this." Another wrote, "Classes with 32 students in them don't allow enough time to meet individuals' remediation or acceleration needs." As demonstrated by this last remark, these types of concerns about time are closely related to teachers' concerns about class size and ability range, discussed in the following section.

Class Size and Ability Range

♦ **Teachers do have concerns about class size, but these concerns appear to be as much about variation in student ability as about large classes *per se.***

One of the questions on the survey asked, "How many students are enrolled in your class?" The mean for all 281 fourth-grade teachers was 29.56; individual district means ranged from 27.43 up to 33.17. Four districts had a mean above 30. For eighth-grade, the mean across all eleven districts (n=116) was 30.27. Individual district means ranged from 28.0 up to 35.6[3]; six districts had a mean above 30. The means for the different eighth-grade course types were comparable to one another.[4]

Perhaps not surprisingly (given that the statewide class size reduction initiative has been for grades K-3, stopping just short of fourth grade), many fourth-grade teachers complained about large class sizes. In fact, large class size/ability range was identified on the survey by more than 25% of responding fourth-grade teachers as being among the biggest obstacles to their mathematics teaching, forming the second largest category (behind curriculum materials) of responses to the obstacles question.

In response to the obstacles and hindrances questions on the survey, 28 fourth-grade teachers gave responses such as "large class size" or "too many students." However, almost half of these teachers *also* included something in their response such as "and too wide a range of abilities." Moreover, *an additional 35* teachers did not mention large class size *per se*, but did discuss wide ability range. Sample responses to the obstacles question, each from a different district, include:

> *Having children who are 2-3 years below grade level, grade level and above grade level. All with different needs.*
>
> *Having 34 students, each at different levels. Having to create lesson plans to challenge the higher students, but that do not frustrate and confuse lower students.*

---

[3] The 35.6 was unusually high. The next highest figure was 32.33.
[4] The mean class size for problem solving courses, at 33.13, was a bit larger than for the other course types, which ranged only from 29.0 to 30.59. However, this may be a function of a relatively small sample size for the problem solving courses (n=8) and the fact that all of these courses were clustered in a district with one of the higher district means (31.87).

[Students'] skills and concepts are all over the board creating multiple needs that are difficult to address when 33 students are in a class.

Thus, it would seem that for most teachers, the concern about class size is not really a concern about large classes *per se,* but rather is about the wide range of abilities within the class. Logically, the larger the class, the more likely there is to be a wide range of abilities within the class, and the more difficult it may be for teachers to meet all students' needs.

Indeed, another survey question asked teachers to describe their class in terms of variation in student ability; nearly 75% of teachers checked the box that said, "heterogeneous with a mixture of two or more ability levels." (The other three options were "fairly homogeneous and low in ability," "fairly homogeneous and average in ability," and "fairly homogeneous and high in ability."

The same findings generally held at the eighth-grade level, but on a slightly lower scale. At the eighth-grade level, responses having to do with class size/grouping practices formed the third largest category of responses to the obstacles question, at 19.4%. Representative comments (again, each from a different district) include:

The range of student abilities: from 2nd-3rd grade levels to high school ability all in one class.

Wide range of ability of students

Large classes with varying abilities and student prep.

I find it hard to meet the needs of my students in a class with such a wide range of abilities and needs.

Many of these types of remarks came from teachers of Math 8 courses—perhaps not surprising, given that Math 8 courses might be more likely than other course types to include students with a wide range of ability. In response to the survey question about variation in student ability, 54.7% of the eighth-grade teachers—including 79.2% of the Math 8 teachers—indicated that the class for which they were completing the survey was "heterogeneous with a mixture of two or more ability levels." About 25% checked "fairly homogenous and high in ability. Of the 29 teachers who checked this box, 19 (65.5%) were teaching algebra, and 5 (17.2%) were teaching integrated math. None of the teachers who checked this box were teaching Math 8.

[text continues on the next page]

Student Preparation and Skill Level

♦ **Students' lack of preparation—particularly in basic mathematics skills—presents another major obstacle for many teachers.**

Teachers' concerns about the wide range of ability within their class relate closely to another major concern: that too many students come to them unprepared or below grade level. On the "obstacles" survey question, approximately 12% of fourth-grade teachers, and 14% of eighth grade teachers, gave responses such as "students unprepared," "students below grade level," or "students behind from previous year."

One eighth-grade teacher who was interviewed, when asked "Is there anything that gets in the way of your effectiveness of a mathematics teacher?" replied:

> *Kids that come in underprepared—kids that come in that are way behind. Especially in math. If you go to other subjects, it's not really that critical, like in history, it's not critical that you know ancient history in order to know U.S. history. You can pick up wherever. But in math, it's like, what are you going to do? If mean, if the kid doesn't know how to add and subtract integers, you've got a problem. That definitely gets in the way. Because, then you have a decision to make. You know, do you get them caught up, at the expense of the people who are ready to move on, or do you not teach them, and they get lost, and then you go on and teach the people who are ahead? So either way, you're kind of losing a group. It's tough to manage.*

This teacher's reference to some students' apparent inability to "add and subtract integers" suggests his perception that the preparation deficit tends to be in the area of basic skills. This perception was shared by a great many teachers. Although a few survey respondents did comment that students lacked sufficient conceptual understanding and problem-solving ability, many more teachers indicated that students' lack of preparation was primarily in the area of basic computational skills and knowledge of "math facts" (e.g., multiplication tables). In fact, on the survey, about 10% of teachers at both grade levels identified "students lacking basic skills" as being among their biggest obstacles. Representative survey comments included:

> *[from a fourth-grade teacher] Students who come to 4th grade without computational skills in the basics!*

> *[from a fourth-grade teacher] The children do not come to me knowing their basic facts, addition, subtraction, and multiplication. I have to reteach everything!*

> *[from a fourth-grade teacher] Students not remembering their +, -, division, x facts*

[from a fourth-grade teacher] Students come not having basic skills of + and -, except to use their fingers.

[from an eighth-grade teacher] Students don't know basic skills—things they should have learned in elementary school.

[from an eighth-grade teacher] A few students lacking basic arithmetic skills.

The new trends in state and district policy toward the implementation of grade-level standards and toward ending social promotion may, in the long run, help alleviate some of these concerns. If teachers at all grade levels have a clear understanding of what students should know by the end of the year, and students who have not sufficiently mastered the expected content do not go on to the next grade, teachers should, at least in theory, experience less of a problem with students coming to them unprepared.

One district mathematics coordinator was optimistic about this, saying that historically, schools have been free to "do their own thing," but that the new emphasis on student outcomes, standards-based instruction, and the end of social promotion have brought about a "push" toward greater uniformity, which she felt is for the best. However, she acknowledged that until the curriculum is aligned with the standards and teachers have really adopted the new standards, the desired effect may remain elusive. And about social promotion, an accountability administrator in a different district commented, "The notion that we're going to punish kids, and hold them over, when they haven't had access to quality instruction, isn't right." The point made by both of these administrators is that for legislation to be effective, it must be accompanied by substantial capacity-building activities.

Student Behavior and Motivation

- ♦ **Poor student behavior and low student motivation are also perceived as major instructional obstacles by a large number of teachers, especially at the eighth-grade level.**

In addition to student preparation and skill level, other student factors—such as poor behavior, low motivation, and low attendance—were also cited by many teachers as being among the biggest obstacles to their mathematics teaching. In fact, at the eighth grade level, such factors were the *most commonly cited* obstacle to mathematics teaching, with 32.3% of teachers listing them. At the fourth-grade level, such factors were cited only by 6.8% of teachers, so this appears mainly to be a middle school issue.

For some, the main problem was student behavior or disciplinary problems. "Student discipline—too much time is wasted dealing with tardies and other violations of school rules," wrote one eighth-grade teacher. Many of these types of responses seemed to attribute the problems to the students themselves. For example, one eighth-grade teacher who was interviewed gave the following response to the question, "Is there anything that gets in the way of your effectiveness as a math teacher?"

> *Some days the kids are a little whiny, and some have a little attitude, or sometimes the discipline problems that do occur. That greatly affects my teaching, because it's very hard to run a class where the kids are looking for trouble.*

Along the lines of "running a class," however, some teachers cited their own struggle with classroom management—often related to student behavior—as an obstacle to their effectiveness. One eighth-grade teacher who was interviewed commented:

> *Just classroom management, apart from the math itself, is a major factor in regards to effectiveness. I mean, I think someone could be very good at math, but if the classroom management isn't there, then it doesn't really matter what the math curriculum is. So that's been a major factor that we've been working on this year. Just kind of on my own personal level of working with the different classes to develop a classroom management that works.*

A few teachers also related student disciplinary problems to school or district policies. In response to the "hindering policies" survey question, one teacher remarked, "Policies that continue to allow students with serious behavior problems back in the classroom." A teacher from a different district wrote similarly, "The unwillingness of the district and the state to deal strictly with the small 'hard core' group of disruptive students (or to allow our school to deal strictly with them)."

Perhaps related closely to the issue of student behavior and classroom management is the matter of student motivation. Low student motivation was the other student-related factor that was cited as an obstacle by many eighth-grade teachers on the survey, as indicated by the following representative remarks:

> *Students with low interest/desire to succeed*

> *Student who don't try and don't care*

> *Lack of student desire to learn*

> *Apathy both in students and parents—an attitude that it's okay to fail.*

Again, similar comments were made in interviews. Although these kinds of comments are by no means new, and the problems of student behavior and motivation will probably never completely vanish, they may not be unrelated to other aspects of mathematics instruction.

For example, for some teachers, altering the instructional approach may increase student motivation, which may in turn bring improved student behavior.

Indeed, in some of the mathematics lessons that were observed, observers did note problems with student behavior and discipline, and often they attributed these problems to the nature of instruction. For example, one observer wrote the following about an observed fourth-grade class:

> *The lack of engagement of students plus their inability to follow what the teacher was teaching led to ongoing disciplinary problems… [The teacher] was reteaching what the high students already knew so they were not paying attention, … and the lower students were lost.*

Another observer wrote about an eighth-grade class in a different district:

> *Behavior "problems" (e.g., students not paying attention, talking, being restless) grew towards the end of the class, most likely signifying students' lack of interest in and engagement with the material, and their increasing boredom.*

On the other hand, observers also witnessed several classes at both grade levels where student behavior was not a problem at all. These tended to be classes in which the teachers seemed to have a good rapport with the students and/or in which the mathematics instruction was kept lively and interesting.

Parent and Home Factors

- **Some teachers identified factors having to do with parents and student home life as being a challenge.**

Another obstacle that was cited on the survey more at the eighth grade level than at the fourth grade level relates to students' parents and home life. Parent and home factors were cited as an obstacle by about 16% of eighth-grade teachers, but only by 6% of fourth-grade teachers. In interviews, however, parent-related concerns were mentioned by more fourth-grade teachers than eighth-grade teachers.

Lack of parent support or reinforcement (for example, with homework) and lack of parent involvement were two of the specific concerns cited. As one eighth-grade teacher put it on the survey, "Lack of parent commitment to assisting their students in being successful. They are unable to even check whether or not student has done homework."

Another parent-related concern that was mentioned by some of the fourth-grade teachers had to do with negative attitudes about mathematics. For example, one teacher wrote that one of her biggest obstacles was, "Students believing what they hear from parents, other teachers, etc. that math is 'hard' or 'boring'." Similarly, a teacher at a different school wrote, "Parents that tell their children, 'I was always bad in math.'"

As with student behavior and motivation, some might assume that these parent-related obstacles are ever-present, insurmountable, and unrelated to mathematics instruction. However, there may be programs and policies that can help. One fourth-grade survey respondent did mention an activity involving parents as being a policy that had *helped* her mathematics teaching: "Family Math nights." An eighth-grade teacher who was interviewed also identified Family Math as being one of the major things that would help him improve his mathematics instruction. Increased communication with parents and other types of programs aimed at fostering increased parent knowledge about and involvement in their children's mathematics education might also be successful.

Language Differences

♦ **Remarkably few teachers indicated that language differences presented a major obstacle to their mathematics teaching.**

Some teachers at both grade levels did express a concern about dealing with students' language differences. "Most students speak limited English; they can't read word problems," put one eighth-grade teacher as an obstacle on the survey; a fourth-grade teacher, meanwhile, wrote, "English language use with LEP students in an all-English class."

However, given the high proportion of English language learners in the surveyed districts and the passage of Proposition 227, the number of teachers who indicated that language-related factors were among their biggest obstacles—3.8% of fourth-grade teachers and 5.4% of eighth-grade teachers—was remarkably small. The relative scarcity of teachers' comments about language barriers was not a result of English language learners being underrepresented in the classes of responding teachers; to the contrary, English language learners were quite well represented in the survey sample. In 9 of the 11 districts for fourth grade and 7 of the 11 districts for eighth grade, the average percentage of English language learners in the responding teachers' classes[5] exceeded the average for the district as a

[5] These figures were based on teachers' self report on the survey, dividing the number of English language learners they reported being in their class by the total number of students they reported being in their class. Only teachers who gave counts for both were included in the calculations.

whole.[6] Moreover, the average percentage of English language learners reported by responding teachers across all 11 surveyed districts slightly exceeded that of the state as a whole.[7]

Most teachers who were interviewed indicated that they do attempt to address the needs of English language learners during mathematics instruction in some way. For example, they said that they speak slowly, repeat directions, make extensive use of visuals, attend particularly to vocabulary, or provide assistance as needed on an individual basis.[8] Others said that they have translators or bilingual aides who help the English language learners; some of the teachers said they themselves are able to translate for the students when necessary, or that they allow the students to write or speak in their native language. In addition, a few of the observed classes were taught partially or primarily in students' native language, these students having received waivers from Proposition 227. On the other hand, some teachers who were interviewed said that their English language learning students were sufficiently English-proficient to need no special provisions during mathematics instruction.

In the Next Chapter

This chapter, along with several of the preceding chapters, identified some of the challenges that teachers face in their efforts to implement effective mathematics instruction. We have also seen that there do not appear to be any "magic bullets" for the improvement of student mathematics achievement. The next chapter builds on all of the findings presented in this report to discuss implications and recommendations for policy.

---

[6] From the Education Data Partnership web site
[7] The average for the classes of responding fourth grade teachers was 33%, and the average for the classes of responding eighth grade teachers was 28%. In the state as a whole, 27.4% of students are reported as being English language learners. All of these figures are for the 1998-1999 school year, when the survey was conducted.
[8] Classroom observers, however, were not always able to confirm that such strategies were in place or that English language learners' needs were truly being met.

(This page intentionally left blank.)

Chapter 9

Recommendations and Conclusions

The purpose of this study was to investigate mathematics policies and instructional practices in California and their effects on student achievement. More specifically, this study was designed to address three questions.

1. What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

2. To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

3. What influence do state and local policies have on instructional practices?

For each of the three questions, a summary of the findings, and the recommendations that emerge from the findings, are presented in the following sections.

Factors Influencing Achievement: Findings and Recommendations

What classroom instructional practices and materials and what staff development are associated with higher mathematics achievement?

A critical component of this study was to investigate the degree to which student achievement (as measured by the SAT-9) was associated with instructional practices and other factors. Neither instructional practices nor teacher background characteristics, when other variables were controlled, bore other than a minimal relationship to student achievement. In sum, the study did not identify specific, powerful classroom instructional practices, instructional materials, or professional development activities that might explain higher mathematics achievement.

What conclusions can be drawn from this? One possibility is that no particular practice is best at raising student achievement across the wide range of educational settings—in other words, it may be that no one type of practice works for all students in all situations at all times. To the contrary, it appears that masterful teachers pick and choose from a variety of practices to maximize their effectiveness. Indeed, many teachers indicated that they need a broad repertoire of instructional approaches that are consistent with their teaching style to meet the needs of their students.

Recommendations: As this study did not identify particular instructional methods likely to improve student mathematics achievement, the State should exercise caution regarding the endorsement of instructional methodologies in mathematics. The State Board should support a "balanced" approach to mathematics curriculum and instruction, but should avoid advocacy of particular types of practices, through the adoption of curriculum materials and professional development programs. To the extent that the *Mathematics Framework* adopted in 1998 supports the concept of a balanced instructional approach, it may assist teachers in their implementation of such an approach, provided that it is accompanied by aligned materials and professional development.

Another possibility is that certain practices *do* have an effect on student achievement, but that the measures used in this analysis were not fine enough to adequately capture these relationships. For example, as discussed in Chapter 3, surveys are an imperfect measure of identifying instructional practices, as they are subject to inaccurate responses and do not lend themselves to assessments of *quality* of instruction or implementation of certain types of practices. Moreover, a longer time frame may be necessary to examine sufficiently the effects of student exposure to certain types of practices.

Recommendations: Further research is needed to investigate the relationships between instruction and achievement. Such research should explore the use of alternate methodologies (i.e., in place of or in addition to teacher surveys), such as an enhanced classroom observation component in which the same teachers' classes are observed, and perhaps videotaped, multiple times. Moreover, further research should take a longitudinal approach, spanning at least five years. Care, however, must be taken to avoid overburdening teachers with research demands. The State Board and the Legislature should recognize the need for more in-depth, high-quality research and should commit the necessary funds.

Prevalence of Factors Influencing Achievement: Findings and Recommendations

To what extent are the instructional practices and characteristics that are identified in high performing classrooms prevalent throughout the state?

Since observed and reported instructional practices could not be linked with higher performing classrooms, it was impossible to assess the prevalence of such practices. Classrooms with higher performing students exhibited a broad array of instructional practices and teacher characteristics—as did classrooms with lower performing students. The study did not find prototypical high-performing or low-performing classrooms. As discussed above and in the body of the report, part of the problem may very well lie with the difficulty in conducting this kind of research. In particular, the SAT-9 itself is an incomplete measure and its limitations may render it inappropriate for assessing relationships between practices/characteristics and certain types of achievement.

Recommendations: Future research investigating the relationships between instructional practices and student achievement should carefully define what is meant by "student achievement." If a broad definition is selected, the research methodology should employ a variety of measures to gauge this achievement. For instance, the SAT-9 may be valuable for assessing students' procedural and declarative knowledge, but may be less appropriate for assessing higher-order thinking skills. Thus, to the extent that higher-order thinking skills are deemed an important aspect of achievement, other measures supplementing the SAT-9 may be needed.

Moreover, because the districts that participated in this study were not a random sample of all districts across the state, the results presented herein may not be generalizable to all of the state's students and teachers. This is especially true for districts with small enrollments, as the districts that participated in this study were all relatively large.

Recommendations: If prevalence throughout the state is a key concern, future research should employ a sampling design that selects districts with a wide range of demographic characteristics, such as size, geographic location, and student composition. However, such a design is likely to further raise costs, particularly if (as recommended above) repeat observations constitute a major part of the methodology, and should be weighed against a sampling design in which a greater proportion of the state's total student enrollment is represented (e.g., by sampling primarily from larger districts, as done by this study).

The Influence of Policy: Findings and Recommendations

What influence do state and local policies have on instructional practices?

The study yielded a great deal of information with bearing on this question; survey responses, classroom observations, and interviews with classroom teachers, school site administrators, and district personnel all provided a wealth of data on the influence of policies on instruction. Toward the end of the study, interviews conducted with a variety of other stakeholders on the policy implications of the study's findings lent additional points of view and in some cases provided context for the study's findings. Among those interviewed for this purpose were several policy makers, representing the State Board of Education, the legislature, influential mathematics educators, and organizations representing teachers, school boards, and administrators.

Findings and recommendations on the influences of policy are divided into the following subsections: standards, instructional materials, professional development, assessment, and classroom context. Frequent changes in policy direction and tone of the policy debate also are discussed.

Standards. Teachers generally reported that while they support the idea of standards, the proliferation of competing standards (e.g. district, state, NCTM) has caused confusion and a lack of clarity over what they are expected to teach. Many teachers believe that the current state standards encompass more than can be taught in a given year, and some also report concerns that particular standards may be inappropriate for their designated grade level. Policy makers should also be aware that, as of the 1998–1999 school year, standards appeared to have had less of an impact on classroom practices than had textbooks and assessments.

Recommendations: The State Board should establish a procedure for periodically reviewing the mathematics standards and framework in light of implementation problems. The Board should carefully and systematically evaluate student performance over time, and solicit the advice of classroom teachers who are attempting to implement the standards and framework.

Districts should take care to present teachers with a single standards document, rather than having separate state and district versions. While it is perfectly appropriate for districts to augment state standards with their own additions, these supplements should be merged with the state standards so that teachers can rely on one unambiguous set of standards. Moreover, to maximize the influence of standards on instruction, the standards document should be distributed to individual teachers. This dissemination must be an ongoing process, as new teachers are constantly entering the profession. Finally, teachers need access to performance standards to assist in their implementation of content standards.

If there is interest in assessing implementation of the standards on a system-wide level (as opposed to assessing individual student mastery), the State might consider exploring the development of a matrix sampling test. Such an assessment, which would not be taken by every student in the state but only by samples of students who would see different items, would be able to gauge the implementation of a significantly larger portion of the mathematics standards than would a single assessment administered to all students.

Instructional Materials. Teacher interviews and classroom observations indicated that textbooks are a primary determinant of what is taught. Many teachers find that a single curriculum program is inadequate to meet the range of needs of their students, and supplement the district-adopted text with other books and materials, some of which may not be on the state-approved adoption list. Some teachers in our sample were using texts from earlier adoption cycles. Because the average textbook contains far more lessons than most teachers cover in a school year, teachers pick and choose among the sections and chapters. Thus, even when they use state-adopted texts, there is no assurance that the curriculum actually covered will be congruent with state standards.

> *Recommendations:* The State Board and the Curriculum Commission should ensure that the curriculum materials that are available to teachers are aligned with standards, accommodate the wide range of student needs, and enable the presentation of a balanced instructional approach.
>
> If possible, districts and schools should purchase the materials in ways that are conducive to teacher and student use both in school and at home (e.g., not requiring an excessive amount of photocopying). To maximize the actual use of the materials and the effectiveness of their implementation, teachers should be provided with opportunities and incentives to engage in professional development related to the use of the materials.
>
> Finally, until evidence of widespread implementation of adopted materials becomes available, caution should be exercised in attributing student achievement to the use of particular adopted materials, as adoption alone is no guarantee of actual use in the classroom.

Professional Development. The need for high-quality professional development was consistently indicated by all data sources. Survey results highlighted the particularly telling mismatch between fourth grade teachers' need for training in mathematics content and methodology and the amount provided. Teachers who addressed this point in the policy implications interviews were positive in their assessment of the California Mathematics Project, even though it may have had limited impact relative to statewide need. There also seemed to be a consensus among those interviewed toward the end of the study that the thrust of the Governor's initiative is on point. (The Governor's initiative proposes university-based professional development institutes during the summer, with follow-up instruction and professional feedback during the school year. The focuses are on teachers as learners, the teaching of mathematics content through a variety of instructional strategies, and meeting the needs of students.)

> *Recommendations:* The State should continue to work to provide sufficient resources for every California teacher of mathematics to participate in high-quality, sustained professional development.[1] Professional development should attend both to mathematical content and to pedagogy; both are important. Key aspects of professional development should be the use of materials (as discussed above) and the instructional implementation of the standards and framework in the classroom.

Assessment. The SAT-9 appears to be the dominant driver of instruction. Since it measures only a portion of the standards, even with the augmentation, over time it will have the effect of narrowing the curriculum to what is tested, and the nature of the test may shape the way students are taught. Teachers report spending much time in test preparation, which takes time away from instruction. The current test is not necessarily aligned with grade level curriculum or textbooks, so some students are being tested on material that has not yet been taught.

> *Recommendations:* The State Board should continue to improve and augment the STAR program so that its components are properly aligned with state standards. Were the STAR program fully aligned with the content standards, the emphasis on assessment might help bring about the effect of student mastery of the standards. As long as there is a lack of alignment, improvement in scores may not be truly indicative of the type of student improvement desired.

Classroom Context. Many teachers indicated that the greatest influences on their instruction were policies relating to class size, quantity of time for instruction, and student preparation and promotion. Clearly, the importance of such policies, and their relevance to mathematics instruction, should not be underestimated. These policies operate alongside those that appear more directly related to mathematics (such as those concerning standards or curriculum materials), and cannot be considered “separate” or “unrelated.” At the level of the classroom, the effects of multiple types of policies are intertwined. Thus, it is crucial that the various policies be consistent with one another and, preferably, form a coherent whole.

[1] Some recently enacted legislation is a strong first step. In particular, AB 1331 (passed in 1998) appropriated funds for teachers of mathematics in grades 4–12 to participate in professional development that is aligned with the state standards and framework. (AB 2790, currently pending, would increase the available funds.) AB 2442, also passed in 1998, provides funds for teachers to take mathematics courses at accredited institutions of higher education.

Recommendations: As mathematics instruction does not exist in a vacuum, mathematics policy must be placed in the context of the numerous other education-related policies that exist. The State Board and the Legislature should take care to ensure that all of the current state education policies are aligned with and support one another.

Frequent Changes in Policy Direction. Frequent changes in state policy direction tend to diminish the state's ability to influence the mathematics taught in California classrooms and may in fact impede teachers' efforts to raise student performance. State policy makers tend to call for dramatic changes in mathematics curriculum without assessing the actual level of implementation of the prior approach, without adequate evidence of the causes of the current level of student performance, and without sufficient evidence of the effectiveness of the new approach.

Recommendations: The State should stay the course. Planning should take a long-term view, focusing on developing and revising policies based on feedback, rather than abruptly changing direction at the first hint of less-than-desired student performance. The state should also systematically gather evidence of what mathematics curriculum is being implemented and how it is being taught and seek causal relationships between actual practice and student outcomes. Anecdotal testimony may not accurately portray reality across more than 1000 California school districts.

Tone of the Policy Debate. Stakeholders interviewed toward the end of the study reported that the acrimonious debate associated with the recent changes in mathematics standards, framework, textbook adoption, and professional development has limited the willingness of teachers to participate in policy discussions. Failure to air differences of opinion and seek areas of agreement can lead to balkanization and an unstable agreement on what constitutes appropriate mathematics curriculum and instruction. Ultimate success of any mathematics program requires that teachers understand and support the underlying rationale and have the training and materials necessary to support successful implementation.

Recommendations: The State Board should set a positive tone for professional discussion and policy debate. Representatives of all stakeholder groups should be "at the table," and a wide range of perspectives should be considered.

Conclusion

As this report has indicated, the difficulties of implementing state policy initiatives at the classroom level are substantial. Traditional policy tools, it seems, often are less effective than desired and may have unintended consequences. The State has a number of means by which it can influence mathematics instruction; the question is how to use them, if at all. The overarching message of this report is one of *caution:* caution in attributing reasons for low (or high) student achievement, and caution in making reforms that do not have a clear basis in research.

Nevertheless, as suggested by this chapter, there are a variety of actions the State can take to support teachers' attempts to raise student mathematics achievement. Indeed, there is strong evidence that teachers are dedicated to helping students achieve in mathematics and want to increase their own effectiveness as teachers of mathematics. However, they often feel thwarted in their attempts to be effective by the realities of their teaching situations, including everything from the need to photocopy materials to the lack of professional development funds to the multiple ability levels within their classrooms. Policies and reforms whose rationales may have not been clearly conveyed to teachers and which they may not have bought into—as well as the flux in policy—only add to the difficulties teachers face. Thus, the key will be to include teachers and all stakeholders in the reform process and to ensure that feedback from a wide variety of educators and community members helps guide efforts to improve the mathematics achievement of all of California's children.

References

Anderson, J. (1998). Letter to Yvonne Larsen, Chairman of the State Board of Education, on behalf of the members of the California Mathematics Council. November 10, 1998.

Anderson, N. (1998, December 11). State school board OKs back to basics for math. *Los Angeles Times,* Sec. A.

Becker, J. P. & Jacob, B. (2000). The politics of California school mathematics: The anti-reform of 1997–99. *Phi Delta Kappan, 81*(7), 529–537.

Boser, U. (1999, June 23). Study finds mismatch between California standards and assessments. *Education Week, 18*(41), 10.

California Department of Education. (1998). *Establishing district standards "at least as rigorous as" California's state standards.* Sacramento, CA: Author.

California Department of Education. (1999, February.) *Instructional materials in California: An overview of standards, curriculum frameworks, instructional materials adoptions, and funding.* Manuscript in preparation.

California State Board of Education (1999). *Mathematics content standards for California public schools: Kindergarten through grade twelve.* Sacramento, CA: California Department of Education.

Class size reduction for grades K–3. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/classsize

Criteria for evaluating mathematics instructional resources, adopted by State Board of Education December 1998. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/cilbranch/eltdiv/2001mathcriteria.html

Cohen, D.K., & Hill, H.C. (1998). *State policy and classroom performance*: *Mathematics reform in California* (CPRE Policy Brief). Philadelphia: Consortium for Policy Research in Education.

Ginsburg-Block, M.D., & Fantuzzo, J.W. (1998). An evaluation of the relative effectiveness of NCTM standards-based interventions for low achieving urban elementary students. *Journal of Educational Psychology*, 90, 560-569.

Guth, J. A., Holtzman, D. J., Schneider, S. A., Carlos, L., Smith, J. R., Hayward, G. C., & Calvo, N. (1999). *Evaluation of California's standards-based accountability system: Final report.* Sacramento, CA: California Department of Education. http://www.wested.org/wested/pubs/online/accountability/

Hartocollis, A. (2000, April 27). The new, flexible math meets parental rebellion. *The New York Times,* pp. A1, B5.

Hoff, D. (1999, June 23). California approves math, English textbooks tied to standards. *Education Week, 18*(41), 10.

Martinez, A. (1999, July 27). The great math divide: Dismal scores reveal how far California schools lag in achieving standards called among toughest in U.S. *San Jose Mercury News,* pp. A1, back page.

Martinez, J.G.R. & Martinez, N.C. (1998). In defense of mathematics reform and the NCTM's Standards. *Mathematics Teacher*, *91*(*9*), 746-748.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1985). Sacramento: California Department of Education.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1992). Sacramento: California Department of Education.

Mathematics framework for California public schools: Kindergarten through grade twelve. (1999). Sacramento: California Department of Education.

Mathematics program advisory. (1996). Sacramento: California Department of Education, California Commission on Teacher Credentialing, and California State Board of Education.

Mayer, D. P. (1999). Measuring instructional practice: Can policymakers trust survey data? *Educational Evaluation and Policy Analysis, 21*(1), 29–45.

Mervis, J. (2000). Packard heir signs up for national "math wars." *Science,* 280 (11 February 2000), 956–959.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

O'Neil, J. (2000). Fads and fireflies: The difficulties of sustaining change. *Educational Leadership*, *57*(7), 6–9.

Pupil promotion and retention: Information and resources. (2000). Sacramento, CA: California Department of Education. http://www.cde.ca.gov/ppr/

Stipek, D., Salmon, J.M., Givvin, K.B., Kazemi, E., Saxe, G., & MacGyvers, V.L. (1998). The value (and convergence) of practices suggested by motivation research and promoted by mathematics education reformers. *Journal for Research in Mathematics Education*, *29*(4), 465-488.

Unz, R.K, & Tuchman, G.M. (1997). *The Unz Initiative* (for June, 1998 California Ballot). http://www.catesol.org/unztext.html

U.S. Department of Education, Office of Educational Research and Improvement. (1997). Introduction to TIMSS: The Third International Mathematics and Science Study. In *Attaining excellence: TIMSS as a starting point to examine U.S. Education.* Washington, D.C.: Author.

Verschaffel, L. & DeCorte, E. (1997). Teaching realistic mathematical modeling in the elementary school: A teaching experiment with fifth-graders. *Journal for Research in Mathematics Education*, *28*, *577-601*.

Webb, N.M., & Palincsar, A.S. (1996). Group processes in the classroom. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 841-873). New York: Macmillan.

Wenglinsky, H. (1999). *Does it compute? The relationship between educational technology and student achievement in mathematics* (ETS Policy Information Report). Princeton, NJ: Educational Testing Service.

(This page intentionally left blank.)

RAND

Relationship of Classroom Practices to Student Mathematics Achievement

Vi-Nhuan Le, Daniel McCaffrey, Marika Suttorp, Laura Hamilton, and Stephen Klein

June 2000

At the heart of many efforts to improve student mathematics achievement is a focus on classroom practices that are thought to facilitate student learning. For this reason, professional development and the promotion of good instructional practices are imperative to the success of these efforts. Many of the promoted practices are based on documents such as the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), the *Mathematics Framework for California Public Schools* (California Department of Education, 1992, 1998), and the *Mathematics Content Standards for California Public Schools* (California Department of Education, 1997).

Earlier research has reported small, positive associations between achievement and some types of individual practices. Stipek, Salmon, Givvin, Kazemi, Saxe, and MacGyvers (1998) found that emphases on problem-solving and process-oriented solutions were related to higher scores on a mathematics test of conceptual understanding. Other studies have also found a positive relationship between the teaching of higher-order thinking and achievement (Martinez & Martinez, 1998; Ginsburg-Block & Fantuzzo, 1998). Research has also demonstrated the value of collaboration (Webb & Palincsar, 1996) and of embedding instruction in real-world contexts (Verschaffel & DeCorte, 1997). A study by Austin (1997), for instance, showed that students enrolled in an NCTM standards-based high school math curriculum that focused on application, cooperative learning, and open-ended problem-solving performed better on an end-of-the year test than those enrolled in a more traditional class. Similarly, Cohen and Hill (1998) found that teachers' use of practices consistent with the 1992 California Mathematics Framework was positively related to student achievement.

The goal of the present study is to further explore the relationships between student achievement and instructional practices. We also investigate how teacher familiarity with the NCTM standards, California Mathematics Frameworks, and various other standards documents is related to instructional practices.

This analysis is part of a broader study that investigates the instructional practices used in teaching mathematics in California and the influences of policy on instruction. The present analysis is supplemented with qualitative methods that examine the factors facilitating or impeding effective mathematics teaching. Case studies of teachers and interviews with state policy makers are used to explore the effects of curriculum materials, staff development, and local and state policies on instructional practices. Future policy implications are also considered.

Methods

Data from students and teachers were collected from 136 fourth-grade and 57 eighth-grade schools across 11 California school districts. Participating districts provided the student data, whereas teacher surveys provided most of the teacher data. The following sections present more details regarding the information obtained and the methodology used to analyze the data.

Sample Characteristics

District Sample. A purposive sample of 11 districts was selected. This sample contained districts with moderate to large total student enrollments. Districts were chosen to be geographically dispersed across California, and most had relatively large numbers of minority, low-income, and limited English proficient (LEP) students. We excluded districts that did not want to participate or could not provide the necessary student data files.[1] The sample includes five of the ten largest districts in the state. Taken together, the 11 districts contain 1.2 million students, which is 20.2 percent of all students in the state.

Because the participating districts are not a random sample of all districts, the results of this study may not be representative of all of the state's students and teachers. This is especially true for districts with small enrollments. However, results that pertain to such a large number of students and teachers are likely to be meaningful and any strong relationships found between teaching practices and student outcomes merit further consideration.

School Sample. We selected a random sample of schools within each district. The number of schools selected was designed to provide a target sample of teachers. In the largest district, the targets were 75 fourth-grade teachers and 38 eighth-grade

[1] Two large and four moderate sized districts declined to participate in the study. One moderate sized district agreed to participate, but was unable to provide the necessary student data.

teachers. The corresponding targets in the five other large districts were 50 and 25.[2] The targets were 40 and 20 in the remaining districts. Because eighth-grade teachers teach multiple classes, fewer eighth-grade teachers were needed to represent the same number of students. Hence, fewer eighth-grade teachers were targeted. However, because of difficulties in obtaining data on teaching practices for multiple classes per teacher, the final sample consisted of only those students from the teacher's first mathematics class during the day in which a majority of the students were eighth-graders.

For fourth grade, we estimated the number of teachers using the number of fourth grade teacher equivalents (FTE) listed in the 1997 California Basic Educational Data System (CBEDS) data.[3] This database does not provide the number of math teacher equivalents by grade. We therefore used the total number of math teacher equivalents in the school divided by the number of grades in that school to obtain an estimate of the number of eighth-grade math teachers. In several districts, all of the eligible schools were selected in order to meet the targeted number of teachers for the sample.

We used systematic sampling to select a diverse set of schools in terms of students' socioeconomic status, ethnicity, and language proficiency. Within each district, schools were sorted by the percent of LEP and the percent of students from families eligible for Aid to Families with Dependent Children (AFDC). Then starting with a random draw (between 1 and *k*) every *k*th school on the list was selected where *k* equals the number of eligible schools in the district divided by the number of schools in the sample. For instance, if the district has 70 eligible elementary schools and the sample size is 14 then k equals 5. See Cochran (1977) for details on systematic sampling.[4]

For the fourth-grade sample, eligible schools included all schools classified as elementary (ELEM) schools with 10 or more fourth-grade students in the 1997 CBEDS file. For the eighth-grade sample, eligible schools included all schools classified as elementary (ELEM), middle (MIDD), junior high (JRH) or high (HIGH) schools with 10

---

[2] The target sample sizes for fourth grade provide sufficient statistical power to detect small effects of approximately .10 standard deviation units.

[3] In some schools the number of fourth grade teacher FTE's was small relative to the number of teachers. In these schools we estimated the number of teachers by dividing the number of fourth-grade students by 35 rather than by the number of fourth-grade teacher FTE's.

[4] In the largest district, we selected a stratified systematic sample where schools were stratified by the number of teachers (1 or 2; 3 or 4; or 5 or more). We used a stratified sample to control for the variability in the number of teachers in sampled schools.

or more eighth-grade students in the 1997 CBEDS data. These criteria excluded alternative and community schools. In addition, to avoid excessive burden on teachers, elementary schools selected for the California Class Size Evaluation Projects were excluded from this study.

We augmented the original samples to include replacement schools for those that declined to participate. In large districts, the replacement school was the next school in the sampling frame used to select the systematic sample. In smaller districts, replacement schools included any school that was not included in the original sample.

The final sample of participating schools contained 136 elementary and 57 middle schools.[5] As shown in Table 1, the sampled schools are generally similar to the other schools in the 11 districts, although there were slightly fewer minority and AFDC students in our sample.

Table 1. Sample and District Characteristics

	Elementary Schools		Middle Schools	
	District	Sample	District	Sample
Number of Schools	867	136	181	57
Average Percent Minority Students	76%	63%	75%	65%
Average Percent LEP Students	40%	28%	28%	23%
Average Percent AFDC Eligible Students	27%	24%	24%	21%

Teacher Sample

The fourth-grade and eighth-grade samples contained 570 and 235 teachers, respectively. Overall, 310 (54.4%) fourth-grade teachers and 139 (59.1%) eighth-grade math teachers completed surveys. We excluded the surveys of fourth-grade teachers who

[5] The sample size for the participating schools is the total number of schools from which teachers actually returned the questionnaires, and does not represent the number of schools to which questionnaires were sent.

did not teach at least one class where one-third of the students were fourth graders (13), could not be matched to their students because they shared classroom responsibilities (10), did not teach at least half of the school year (3), or had students lacking test scores (3). This left us with a sample of 281 fourth-grade teachers.

For the eighth-grade sample, we excluded teachers who did not teach at least one class where one-third of the students were eighth graders (10), failed to have identifiable rosters (4), did not teach at least half of the school year (3), or had students lacking test scores (3). We also excluded a teacher who taught geometry to a class of gifted students because the study's results were overly sensitive to this teacher and her students' data. The final eighth-grade analyses included 118 teachers.

Student Data

The 281 fourth grade teachers had a total of 6,885 students with valid Stanford Achievement Test, Version 9 (Stanford-9) multiple choice test scores.[6] The 70 students in this sample who were missing demographic data were excluded from further analyses. Thus, the fourth-grade student sample consisted of 6,815 students from 281 classrooms. The 118 eighth-grade teachers had 3,063 students, but 30 were missing student demographic data. Thus, our final eighth-grade sample contained 3,033 students.

The following information was available for the students in both the fourth grade and eighth grade analysis samples: 1998 and 1999 Stanford-9 math scores, 1998 and 1999 Stanford-9 reading scores, and student background information, including gender, racial/ethnic group, home language, and whether the student participated in a gifted program, a special education program, and/or a free or reduced price lunch program.

Table 2 provides descriptive statistics for each student sample. At both grades, approximately 60 percent of the students are members of a minority group and nearly one-third are Hispanic. In addition, 26.7 percent of the fourth graders and 20.7 percent of the eighth graders are classified as LEP. Nearly half (47.0 percent) of the fourth-grade sample and over one-third of the eighth-grade sample are eligible for free and reduced price lunches.

[6] Scores of 0 and 999 on the base Stanford-9 test were treated as invalid. We did not analyze scores on the augmented items.

Table 2. Percentage of Students with Various Background Characteristics.

	Fourth Grade	Eighth Grade
Racial/Ethnic Group		
African-American	11.1	9.0
Asian	13.6	14.3
Hispanic	33.2	29.3
White	37.5	40.7
Other	4.6	6.7
Limited English Proficient	26.5	20.7
Eligible for Free or Reduced Price Lunches	47.0	36.7

Measures

Teacher Questionnaire

Teachers completed a questionnaire that inquired about the frequency with which they used various instructional practices, the amount and type of professional development activities they received, their opinions about teacher collaboration, and their familiarity with certain mathematics standards and frameworks documents. Most of the questions regarding the frequency of activities used a 5-point Likert scale. Teachers' scores could range from 1 ("never use this practice") to 5 ("engage in this practice almost daily"). Questions that solicited opinions used a variation of a 4-point Likert scale. These items typically ranged from 1 ("disagree strongly") to 4 ("agree strongly"), but teachers were also allowed to choose an "I don't know" response. The teachers also answered several questions about their demographic characteristics, including information regarding gender, racial/ethnic group, certification, highest degree received, coursework in mathematics, and years of teaching experience.

Questionnaire Scales

The questionnaire items were grouped into 12 scales. This was done using a combination of judgments about item content and empirical analysis. Specifically, we grouped questions that were intended to measure the same construct. We then evaluated these judgments with an empirical analysis involving item intercorrelations. We found that an item usually correlated more strongly with the other items on the scale to which it was assigned than it did with items on other scales. The final 12 scales are listed below:

1. Teacher-Centered Practices
2. Problem-Solving
3. Computational Practices
4. Applications
5. Group Work
6. Individual Work [7]
7. Computer Use
8. Familiarity and Influence of Mathematics Frameworks and Standards
9. Alignment with District Standards
10. Perceived Teacher Support
11. Perceived Teacher Collaboration
12. Professional Mathematics Development

Appendix A1 contains the items in each scale.

Curriculum Variables

The teacher questionnaire also contained a list of mathematics topics. Teachers were asked to specify which of these topics were not covered in their class, and which five topics were given the most emphasis. We then created a variable indicating the total number of topics taught that were also cited in the *Mathematics Content Standards for California Public Schools, Kindergarten Through Grade 12*. We also constructed variables that made distinctions among the emphasis given to each topic (specifically, no coverage, some coverage, and great coverage). For some concepts, there was not enough variation to examine differences between teachers who emphasized a given topic and

[7] It is important to note that the individual work and group work scales are not opposites of one another, and that teachers can engage in both types of activities and thereby receive high scores on both scales; i.e., if their students frequently work collaboratively as well as independently. Similarly, teachers can receive low scores on both scales if they frequently engage in other activities that are not represented on either scale.

those who taught it but did not make it their focus. In such cases, our analysis distinguished between teachers who covered the topic and those who did not.

Teacher Background Variables

To assess teachers' mathematics experience, we added the number of mathematics courses they said they took at the high school and college levels. The teachers were also asked whether they had a mathematics, general, or emergency/internship teaching credential.[8] We treated the credential categories as mutually exclusive by using the following decision rules: (i) teachers who possessed a mathematics credential and any another kind of credential were categorized as possessing a mathematics credential, (ii) teachers who possessed both a general and an emergency/internship credential were categorized as possessing a general credential, and (iii) all other teachers were classified as having an emergency/internship credential.

Imputation of Missing Values

In general, less than 3% of the responses on any given teacher questionnaire item were invalid or missing. Missing values on an item were imputed using a regression procedure that considered the responses to other items. A complexity arose in estimating values for the opinion items that contained an "I don't know" option because this response resulted in a non-continuous metric. This option was chosen frequently on two items concerning teachers' perceptions of whether their district was aligned with specific mathematics frameworks. For these two questions, we compared the characteristics of teachers who chose this option to those who did not. For the remaining items, we treated the "I don't know" choice as missing, and imputed a value based on responses to the other questionnaire items within the same scale.

At each grade, a small number of teachers were missing values on all the items comprising one or more of the scales. In addition, a small number of teachers were

[8] Mathematics credentials refer to those with single subject credentials in mathematics, standard secondary credential in mathematics, and/or supplementary authorization in mathematics. General credentials refer to teachers with: multiple-subject teaching, general or standard elementary, single subject credential not in mathematics, and/or standard secondary credential not in mathematics. Emergency/internship credentials refer to teachers with: emergency multiple subject teaching permit, emergency teaching permit in

missing values for some of the teacher background variables that were included in our models. We imputed these values using teacher responses on the other scales and background variables.

We also imputed missing 1998 Stanford-9 reading and math scores for students in a teacher's classroom. In fourth grade, about 18 percent of students were missing at least one prior year's test scores and in eighth grade roughly 14 percent of students were missing either the 1998 math or reading score.

A four-step process was used to impute missing student and teacher data. First, we imputed values for the missing test scores using student background variables, teacher background variables, and the scales completed by all teachers. The models also included district indicator variables. We imputed multiple values using Bayesian models for multivariate clustered data as described in Schafer (1997). We used the PAN software for Splus to fit the models and draw imputed values (Schafer, 1997). We created 10 sets of imputed values. Creating multiple sets of imputed values allowed us to adjust the standard errors of our estimates to account for missing data.

Next, we created teacher level data sets with one observation per teacher. These data sets included all the teacher scales and classroom averages for student variables including test scores. We included the imputed values in the classroom averages for test scores. We created one teacher level data set for each set of imputed test scores.

In Step 3, we imputed the missing teacher scales using a multivariate normal model. We used this model even for the missing education indicator variable. Although indicator variables do not conform to the multivariate normal model, previous research has shown that this approach to imputation does not tend to produce biased results. We used the NORM software (Schafer, 1999) to fit the models and draw imputed values. We drew one set of imputed teacher scales for each set of imputed test scores.

Finally, we used the observed student and teacher data and the imputed teacher scales to impute new sets of test scores. We generated one set of imputed test scores for each of the ten sets of imputed teacher scales. We again used Bayesian models for multivariate clustered data as described in Schafer (1997).

---

mathematics, internship credential (multiple subject), internship credential in mathematics, credential waiver, and/or other kinds of credentials.

Analysis

The primary purpose of this study was to investigate the degree to which student achievement was associated with differences in instructional practices. We explored these relationships using linear regression analysis. This approach enabled us to control for differences in student and teacher background characteristics. We fit these models using individual student data, with all the students from the same classroom receiving the same values on each of the teacher questionnaire scales, and we used an adjusted standard error estimate to account for possible correlation among responses from students with the same teacher (McCaffrey & Bell, 1997). We also standardized test scores and teacher scales so that the reported coefficient is the expected difference in test score standard deviation units for a one standard deviation unit increase in scale scores.

Distributions of Teacher Questionnaire Scales

Table 3 shows the mean, standard deviation, and reliability (coefficient alpha) of each teacher scale at each grade level. The table shows the same rank ordering of the instructional practices across grade levels. For example, at both grades 4 and 8, teacher-centered practices were used often while computers were used infrequently. Teachers were inclined to emphasize problem-solving and computational skills, but were less likely to focus on math applications. Group work was also emphasized more often than individual work.

Table 3. Mean, Standard Deviation, and Reliability Coefficient for Each Teacher Questionnaire Scale at Each Grade Level [9]

Scales[10]	Fourth Grade				Eighth Grade		
	Mean	SD	Alpha		Mean	SD	Alpha
1. Teacher-Centered	4.45	.51	.49		4.69	.39	.35
2. Problem-Solving	3.88	.46	.80		3.68	.44	.71
3. Computational Practices	3.56	.54	.59		3.45	.49	.52
4. Applications	2.85	.47	.53		2.73	.43	.43
5. Group Work	2.81	.71	.69		2.37	.59	.65
6. Individual Work	2.42	.74	.58		1.93	.58	.62
7. Computer Use	1.82	.75	.86		1.48	.55	.86
8. Familiarity and Influence of Mathematics Frameworks and Standards	2.54	.67	.78		2.70	.70	.82
9. Alignment with District Standards	3.20	.58	.70		3.35	.49	.50
10. Perceived Teacher Support	3.23	.51	.68		3.41	.49	.76
11. Perceived Teacher Collaboration	2.19	.56	.75		2.42	.50	.72
12. Professional Mathematics Development	2.23	.90	.87		2.86	1.04	.84

Most teachers believed their school was moderately aligned with district standards, but they tended not to know whether their district was aligned with either the NCTM standards or California Mathematics Frameworks. Teachers also believed such documents had little influence on their practices. They reported having a fair amount of support from the administration and their colleagues, but did not collaborate often with their peers. Additionally, teachers reported receiving little mathematics professional development.

---

[9] The descriptive statistics and reliabilities are based on the observed data and do not include imputed values.

[10] Scales 1-7, 11, and 12 used a 5-point Likert scale. Scale 8 used a 4-point Likert scale and scales 9-10 used a variation of the 4-point Likert scale.

There was considerable variation across schools in the teachers' reported use of particular instructional practices. This is undoubtedly due to a variety of factors, some of which were related to variables in our survey (e.g., teacher and classroom demographics) and some of which were not (e.g., preservice training, personal style, etc.).

Relationships of Student Characteristics to Instructional Practices

Teachers' decisions about instructional practices may be related to student characteristics. For instance, teachers with higher-ability examinees may focus on problem-solving more often than teachers with lower-ability students. To explore this and other scenarios, we used a regression analysis to predict instructional practices from student demographics.

We found that at the fourth grade, teachers with a higher proportion of gifted students were less likely to use computers or have students work individually. Teachers with a homogenous group of average ability students were more likely to use group work. Teachers with a higher proportion of gifted, LEP, and special education students were also less likely to focus on math applications.

Our regression models for the eighth grade were similar to those at the fourth grade, but we controlled for differences in courses.[11] Teachers with a homogenous group of high-ability students were more likely to incorporate computers in their lesson plans, while teachers with a homogenous group of low-ability examinees were less likely to engage in teacher-centered practices. Teachers with a higher proportion of female students reported emphasizing computational practices less frequently, but those with a higher proportion of Black students focused on computational practices more often.

Relationships of Teacher Characteristics to Instructional Practices

To investigate the role of teacher demographics, we examined whether a teacher's reported use of instructional practices was related to that teacher's ethnicity, gender, perceptions of teacher support and collaboration, hours of professional development time

[11] There were three course types: Math 8, algebra, and integrated math. Math 8 consisted of several mathematics courses, including pre-algebra, Math 7/8, Math 8, and problem-solving.

spent on specific mathematics-related activities, years of teaching experience, credential type, degree, and mathematics coursework.

At the fourth grade, teacher ethnicity and gender were related to instructional practices. Female teachers tended to focus on computational skills. Black teachers reported using group work less frequently, while Hispanic teachers reported engaging in individual work less often. Hispanic teachers were also less likely to emphasize applications and to use computers in instruction.

Fourth-grade teachers who collaborated with one another and whose instructional practices were influenced by national and state standards were more likely to emphasize group work, individual work, applications, and higher-order thinking skills. Greater collaboration was also positively related to computer use, as was more mathematics professional development. Additionally, teachers who had taken more mathematics courses tended to use group work more frequently.

At the eighth grade, greater influence of national and state standards on teaching practices and more mathematics professional development were positively related to problem-solving practices. Integrated math teachers were more likely than either Math 8 or algebra teachers to incorporate computers into their lessons, and were less likely to engage in teacher-centered practices.

Relationship between Teacher Characteristics and Student Achievement

After controlling for student demographics, teacher background characteristics (such as ethnicity, gender, certification type, degree, and mathematics coursework) were not related to student test scores. The one exception to this finding was that the total number of years teaching had a significant positive relationship with student outcomes. A one-unit standard deviation increase in years teaching was associated with a .074 standard deviation unit gain in scores at the fourth grade, and a .043 standard deviation unit gain in achievement at the eighth grade.

Relationship between Instructional Practices and Achievement

Our analyses of the relationships between the teacher questionnaire scales and student achievement controlled on some variables but not others. Specifically, we did not consider teacher background variables (such as ethnicity, gender, certification type, degree, and mathematics course work) because in preliminary analyses they were not related to student outcomes. For the same reason, we eliminated variables pertaining to the differences in the number of students per class, the amount of instructional time devoted to mathematics, and the number of topics taught that were consistent with the current mathematics standards for California.

To address the effects of specific mathematics concepts, we conducted analyses that controlled for the emphasis given to each topic. Differences in emphases tended to be unrelated to achievement, but at the fourth grade, some coverage of probability was positively associated with higher scores (i.e., a .088 standard deviation unit increase in scores). We retained this topic for further analyses, but eliminated the others.[12]

We explored the data using several regression models, some of which included the total number of years teaching as an independent variable. Although the total number of years teaching is positively related to test scores, it is also moderately related to instructional practices (i.e., correlations up to .35). Because the two variables are correlated, if we adjust for total years teaching, the effects of instructional practices on achievement will be reduced. For our final analysis, we used two models, one with the total number of years included, and one without.

Our independent variables for the fourth-grade models included: districts, student ethnicity, student gender, participation in a gifted program, participation in a special education program, free or reduced lunch status, LEP status, prior year scores in math and reading, and coverage of probability. Our independent variables at the eighth grade were virtually identical to those of the fourth-grade. However, we did not control for coverage of probability and instead controlled for course differences.

Figure 1 shows the estimated coefficients for our fourth-grade analysis that included number of years teaching. Figure 2 presents the results for the analysis that excluded this variable. Figures 3 and 4 show the eighth-grade regression results with and without total years teaching, respectively.

[12] At the eighth grade, increased coverage of some topics was negatively associated with achievement, but this counterintuitive finding appeared to be a result of teachers' efforts to tailor the curriculum to students' ability levels (i.e., teachers spending more time on some mathematical topics with lower-achieving students than with higher-achieving examinees).

For the fourth-grade models, participation in a gifted program was positively associated with test scores, as was being female or Asian. In contrast, African-American race/ethnicity and participation in a special education program were negatively related to achievement. Additionally, some exposure to probability was associated with higher scores.

The majority of the teacher scales at the fourth-grade level did not show a statistically significant relationship with outcomes. When controlling for total years teaching, only one scale, practices emphasizing applications, was related to achievement, such that a one-unit standard deviation increase on this scale was associated with a .036 standard deviation unit gain in scores. This very weak relationship, however, was not significant when we excluded total years teaching. Under the model that did not control

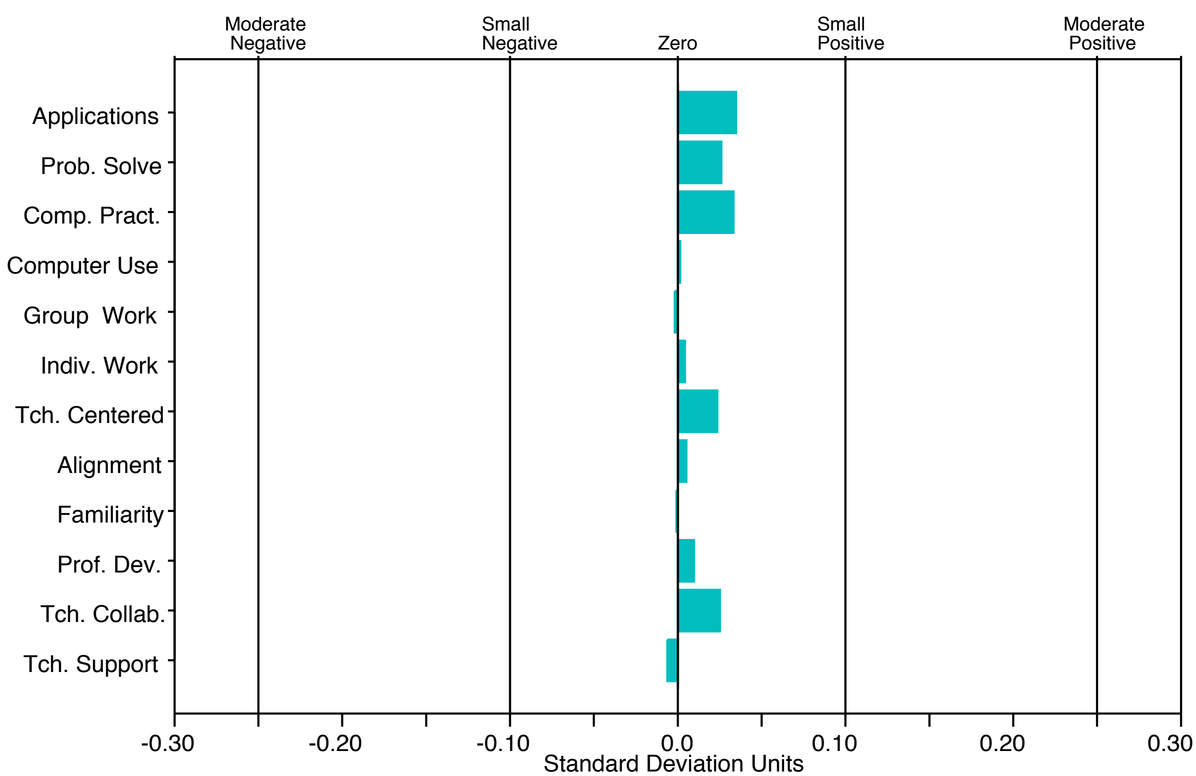


Figure 1: Regression Coefficients for Fourth-Grade Models with Total Years Teaching

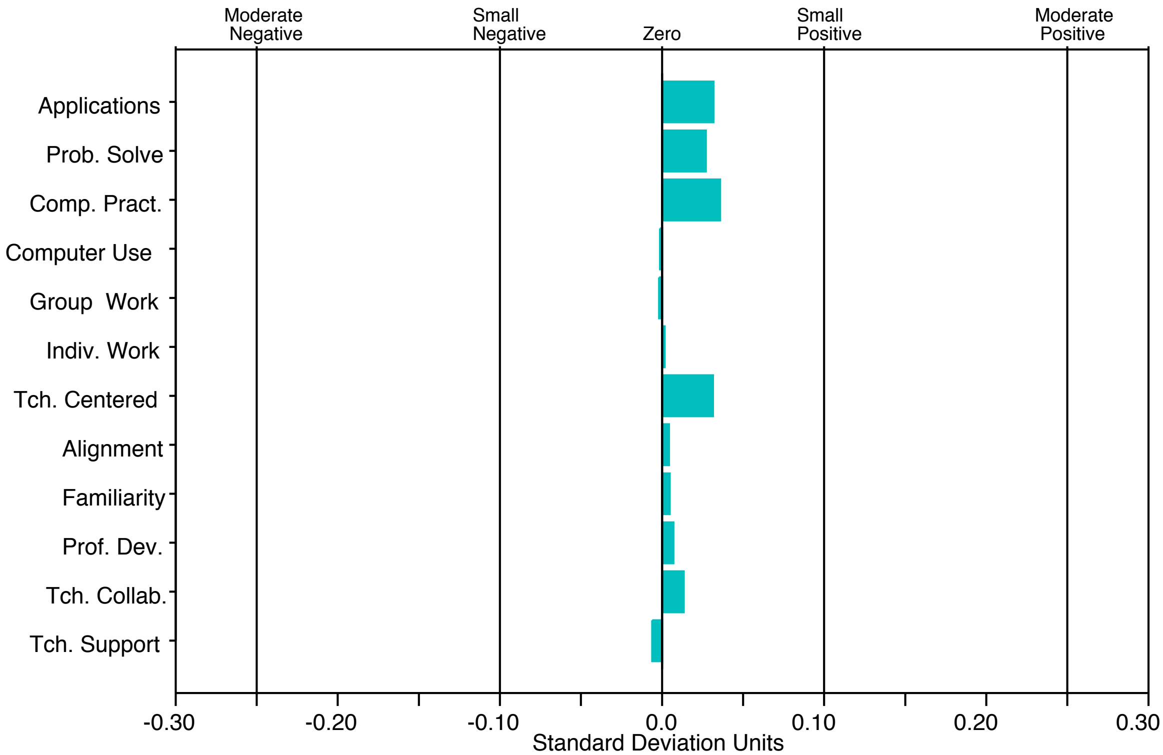


Figure 2: Regression Coefficients for Fourth-Grade Models without Total Years Teaching

for teaching experience, the use of computational skills was very slightly positively associated with achievement. But again, this effect was quite small (i.e., about the same magnitude as was found for the applications scale).

At the eighth grade, the regression models that controlled for total years teaching yielded similar results to models that excluded this variable. African-Americans, Hispanics, females, and Math 8 students received lower scores, whereas examinees participating in a gifted program received higher scores. Greater reported use of computers in instruction was negatively related to outcomes, but again, the effect was quite small—a one-unit standard deviation increase on the computer use scale was associated with a .041 standard deviation unit decrease in test scores. No other scale showed a significant main effect, but an interaction between the teacher-centered practices and course was found. Specifically, the teacher-centered scale was positively related to test scores for algebra courses, but such practices were unrelated to outcomes for Math 8 courses.

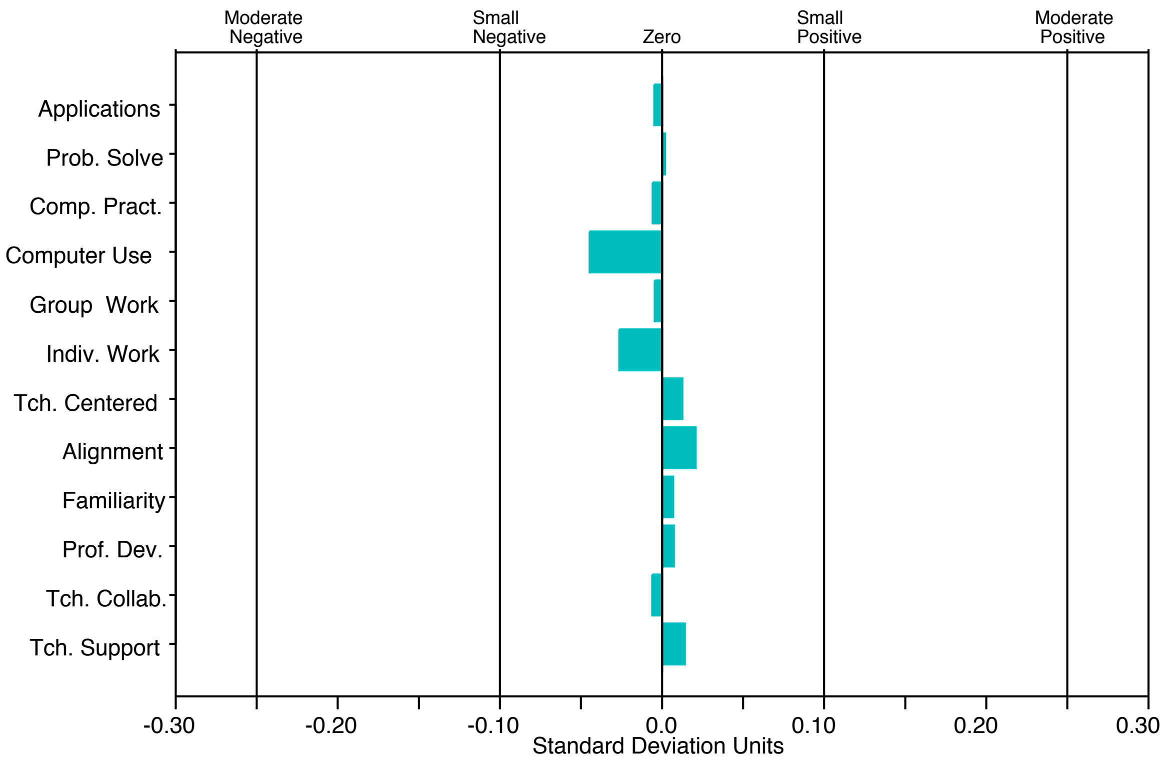


Figure 3: Regression Coefficients for Eighth-Grade Models with Total Years Teaching

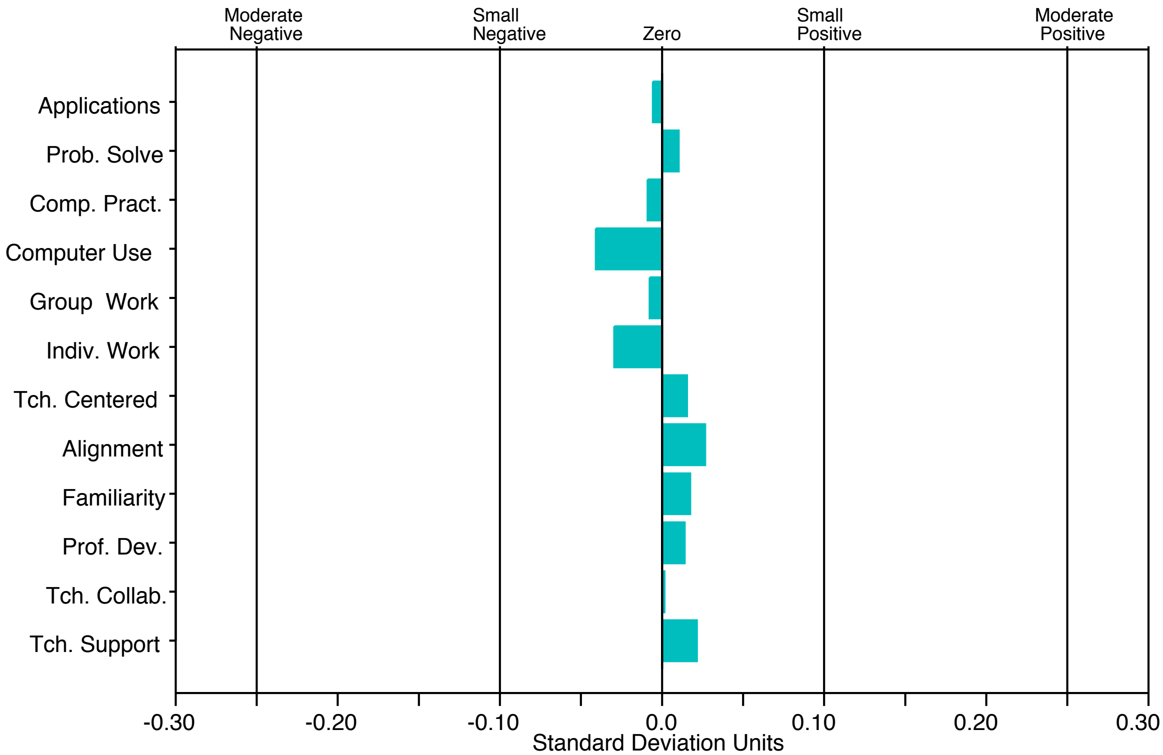


Figure 4: Regression Coefficients for Eighth-Grade Models without Total Years Teaching

Teacher Familiarity with Standards

Several questionnaire items asked teachers how familiar they were with the NCTM standards, California Mathematics Content Standards, California Mathematics Frameworks, California Mathematics Program Advisory, and their local district guidelines. Most teachers were very familiar with their own district standards, but were less knowledgeable about the state and national frameworks. Approximately 39% of fourth-grade teachers and 17% of eighth-grade teachers were unfamiliar with the 1989 NCTM standards. Furthermore, only 49% of fourth-grade teachers and 36% of eighth-grade teachers reported being aware of the California Mathematics Program Advisory. Teachers also said they were not familiar with the California Mathematics Content Standards and the California Mathematics Frameworks, particularly versions earlier than 1998. For instance, 15% and 14% of fourth- and eighth-grade teachers, respectively, were not familiar with the California Mathematics Content Standards. In a similar vein, 25% of fourth-grade teachers and 21% of eighth-grade teachers reported that "they had never heard of" the 1985 California Mathematics Frameworks. Given these numbers, it is not surprising that many teachers believed these frameworks had little influence on their teaching practices.

Nearly 44% of the fourth-grade and 25% of the eighth-grade teachers did not know whether their district standards were aligned to the NCTM standards. Similarly, 38% and 32% of the fourth- and eighth-grade teachers, respectively, indicated that they did not know whether the district had provided professional development workshops based on the 1992 California Mathematics Framework. Because teachers who know whether their district is aligned with the national and state standards are likely to be different from those who do not, we examined the characteristics of the two groups.

At the fourth-grade, teachers who did not know whether their district was aligned with the NCTM standards or the California Mathematics Framework had fewer hours of mathematics professional development and reported less collaboration. The teachers responding "I don't know" were also less likely to focus on individual work and problem-solving. Additionally, uncertainty of district alignment with the NCTM standards was associated with less frequent use of group work and a lower likelihood of possessing a general credential, while uncertainty of district alignment with the 1992 California Mathematics Framework was associated with fewer years of teaching experience. Considering that it has been 8 years since the 1992 California Mathematics Framework was published, the latter finding is not surprising.

We found similar results at the eighth grade. For example, teachers who were unsure of the influence of the NCTM standards and California Mathematics Framework on their district had less professional development and lower perceptions of teacher support.

Discussion

After controlling for student background characteristics, only a few instructional practices had statistically significant correlations with test scores. At the fourth grade, coverage of probability was positively associated with achievement, as were emphases on applications and computational skills. At the eighth grade, the use of computers in instruction was negatively related to outcomes. However, all of these effects were quite small, particularly in relation to other student characteristics such as race/ethnicity. Moreover, given the large number of variables investigated, some may actually be due to chance.

The finding that the probability, applications, and computational skills scales were positively related to student achievement is logical given the content of the Stanford-9, which includes many contextualized statistics items that require procedural and declarative knowledge. Because the test focuses on problems that are solvable via heuristics, it may not be the most appropriate measure to assess higher-order thinking skills. Thus, the failure to find a significant association between problem-solving practices and achievement might stem from limitations of the Stanford-9 as opposed to a lack of relationship per se.

The negative relationship between the use of computers and achievement may be attributable to several sources. Students who receive computer instruction may spend more time "playing with" the computer than actually using it to solve mathematics problems. In a related manner, teachers who use computers may need to devote more instructional time to logistics (e.g., explaining how to use the computer), which might translate to less time explaining mathematics concepts. Other research has shown that computers can have positive or negative effects on achievement, depending upon how they are used (Wenglinsky, 1998). Alternatively, the Stanford-9 items may not be sensitive to detecting the effects of computer instruction. Some mathematics problems that can be presented via a computer are less feasible on a paper-and-pencil test. It might be the case that students who receive computer instruction are encountering different kinds of mathematics problems in their classrooms than those presented on the Stanford-9. More information about the nature of computer instruction is needed to better explain the association between the use of computers and test scores.

The finding that teacher-centered instruction is positively related to scores for algebra but not for Math 8 merits further attention. This may be due to differences in the content of each course. Math 8 typically entails ideas that have been introduced in prior mathematics classes. In contrast, algebra tends to involve skills, concepts, and frameworks that are unfamiliar and qualitatively different from those previously learned.

Hence, teacher-centered practices, such as going over homework or demonstrating how to solve a problem, may be more beneficial with algebra than with Math 8. This interaction illustrates the importance of considering course content when evaluating the relationship between achievement and instruction, as particular practices may be more effective with one course than another.

Certain teacher characteristics were also associated with different kinds of classroom practices. Teachers who said their teaching was influenced by the NCTM standards or California Mathematics Frameworks were more likely to engage in instruction espoused by these documents, such as practices focusing on group work, applications, and problem-solving. As is consistent with previous research, teachers who reported more frequent collaboration with their colleagues were also more likely to engage in this kind of instruction with their students (McLaughlin & Talbert, 1993). Notably, these practices are typically identified by many current reform efforts as facilitating student learning. Such practices, however, are not solely dependent upon teacher characteristics, as variations in student demographics were also related to teaching style.

In comparison to those who had some knowledge of the NCTM standards and California Mathematics Frameworks, the teachers who were not familiar with these standards tended to have less teaching experience, participated in fewer professional development programs, and reported less collaboration. Perhaps as a result of their lack of exposure to the standards, these teachers did not engage as frequently in practices that have been endorsed by the NCTM standards or California Mathematics Frameworks. However, there are many other factors that influence teaching practices, and more research needs to be conducted in order to better understand why teachers choose to use (or not use) certain kinds of practices.

Limitations

There are several caveats that need to be considered when interpreting the results of this study. First, the teachers and students who participated in this study are not representative of others in the state. Consequently, the relationships (or lack thereof) that were found in this research cannot be generalized beyond our sample of students, teachers, and schools. Furthermore, because we did not use an experimental design, we cannot be certain that the observed relationships are attributable solely to classroom practices. There may be other systematic student, teacher, and schools variables that we did not measure but which nevertheless affect what teachers do and what students learn.

A second limitation of our study concerns the lack of information on what led teachers to use particular practices. Although we investigated the relationships between classroom instruction and teacher and student demographics, we have not explored the full range of factors that could influence practices, such as district policies or local community climate. Our initial intent was not to determine the reasons underlying teachers' use of practices, but this information would be helpful to those who are designing and implementing professional development programs and other interventions and policies.

The lack of significant relationships, particularly between many of the scales and test scores, should be interpreted cautiously because the low reliability of some of these scales makes it difficult to detect effects. More importantly, all the scales depended on the accuracy of teacher perception of what they did and this perception may be less than 100 percent.

Another possible explanation for the lack of effects stems from our focus on students' exposure to practices during a single academic year, which does not allow us to follow changes in teachers' practices or examine the effects of student exposure to these practices across several years. Some practices may have been implemented only a short time ago, in accordance with recently released standards (e.g., California Mathematics Framework, 1998). Teachers may need more time before they can effectively implement the practices, or students may need to be exposed to the practices for more than a single year before the effects of these practices on achievement become clearly evident.

As mentioned earlier, the content of the Stanford-9 may render it an inappropriate measure for assessing relationships between certain classroom practices and achievement. However, beyond its content limitations, there were concerns that its validity may have been compromised by efforts to "drill" students on the specific skills required by the exam. Approximately 71% of fourth-grade teachers and 81% of eighth-grade teachers strongly agreed with the statement that "There is a school-wide effort to improve student mathematics achievement on the Stanford-9." If teachers are indeed narrowing their curriculum to the topics found on the Stanford-9, serious questions arise regarding the inferences that can be drawn from the scores. This problem is likely to be exacerbated as the stakes attached to the Stanford-9 increase (Stecher & Barron, 1999).

Finally, the use of surveys is an imperfect method of assessing instructional practices. Like any such measure, the items are subject to inaccurate responses, particularly those that reflect social desirability. More importantly, the questions addressed only the frequency with which teachers used particular practices and did not address the way in which they were used or the overall quality of instruction. This problem is alleviated with classroom observations and teacher interviews, but this type of data collection is typically feasible only on a small-scale basis and the findings are not widely generalizable to other populations.

References

Austin, J.D. (1997). Integrated mathematics interfaced with science. *School Science and Mathematics*, *97*(1), 45-59.

California Department of Education. (1992). *Mathematics framework for California public schools*: *Kindergarten through grade twelve*. Sacramento, CA: Author.

California Department of Education. (1997). *Mathematics content standards for California public schools*. Sacramento, CA: Author.

California State Department of Education. (1998). *Mathematics framework for California public schools*: *Kindergarten through grade twelve*. Sacramento, CA: Author.

Cochran, W.G. (1977). *Sampling Techniques*. 3rd edition. New York: Wiley.

Cohen, D.K., & Hill, H.C. (1998). *State policy and classroom performance*: *Mathematics reform in California* (CPRE Policy Brief). Philadelphia: Consortium for Policy Research in Education.

Ginsburg-Block, M.D., & Fantuzzo, J.W. (1998). An evaluation of the relative effectiveness of NCTM standards-based interventions for low achieving urban elementary students. *Journal of Educational Psychology*, *90*, 560-569.

Martinez, J.G.R. & Martinez, N.C. (1998). In defense of mathematics reform and the NCTM's Standards. *Mathematics Teacher*, *91*(9), 746-748.

McCaffrey, D. & Bell, R. (1997). *Bias reduction in standard error estimates for regression analyses from multi-stage designs with few primary sampling units*. Paper presented at the Joint Statistical Meetings, Anaheim, CA.

McLaughlin, M.W. & Talbert, J.E. (1993). *Contexts that Matter for Teaching and Learning*: *Strategic Opportunities for Meeting the Nation's Educational Goals*. Stanford University: Center for Research on the Context of Secondary School Teaching.

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

Schafer, J.L. (1997). Imputation of missing covariates under a general linear mixed model. Technical report, Dept. of Statistics, Penn State University. Available at www.stat.psu.edu/~jls/#res

Schafer, J.L. (1999) NORM for Windows 95/98/NT Version 2.02. Available at www.stat.psu.edu/~jls/misoftwa.html#win.

Stecher, B. M., & Barron, S. I. (1999). Quadrennial milepost accountability testing in Kentucky (CSE Report 505). Los Angeles: Center for Research on Evaluation, Standards, and Student Testing.

Stipek, D., Salmon, J.M., Givvin, K.B., Kazemi, E., Saxe, G., & MacGyvers, V.L. (1998). The value (and convergence) of practices suggested by motivation research and promoted by mathematics education reformers. *Journal for Research in Mathematics Education*, *29* (4), 465-488.

Verschaffel, L. & DeCorte, E. (1997). Teaching realistic mathematical modeling in the elementary school: A teaching experiment with fifth-graders. *Journal for Research in Mathematics Education*, *28*, *577-601*.

Webb, N.M., & Palincsar, A.S. (1996). Group processes in the classroom. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 841-873). New York: Macmillan.

Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics* (ETS Policy Information Report). Princeton, NJ: ETS.

Appendix A1
Questionnaire Items in Each Scale

Teacher-Centered Practices
Go over homework with the class
Demonstrate how to solve a particular type of problem
Listen to teacher presentation of a new topic or procedure

Computer Use
Use a computer to present, simulate, or demonstrate concepts and techniques to the class
Use computers to run simulations or demonstrations
Use computers to practice basic skills
Use computers to learn concepts
Use computers to collect data
Use computers as an analytic tool (e.g., spreadsheets)
Use computers to play mathematics game

Problem-Solving
Make provisions for students to work at their own pace or level
Check for student understanding at the end of a lesson or class period
Assign special challenges/enrichment as homework
Justify their answer or explain their reasoning when giving an answer
Discuss different ways to solve a particular problem
Generalize from particular problems to other situations
Work on non-routine, higher-order problems
Use manipulative materials or models to solve problems or explore concepts
Work problems mentally
Engage in class discussion about mathematics or models to solve problems or explore concepts
Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)
Performance tasks for assessment purposes

Applications
Introduce/teach topics in the context of everyday situations
Do mathematics in conjunction with other subjects
View or participate in mathematics demonstrations or investigations
Watch mathematics-related films, filmstrips, videotapes, or television programs
Go on mathematics-related trips

Computational Practices
Practice computational procedures
Memorize mathematics facts, rules, definitions, or formulas
Read or work problems from a textbook
Complete worksheets
Read aloud from a mathematics textbooks
Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)
Tests made up of computational and/or word problems

Individual Work
Work on individual projects that take several days
Make individual presentations to the rest of the class
Write in a mathematics journal
Work individually at activity stations
Work individually at computers

Group Work
Work in pairs or small groups on mathematics problems/exercises
Work on group projects that extend for several days
Make group presentations to the rest of the class
Work in pairs or small groups at activity stations
Work in pairs or small groups at computers

Familiarity and Influence of Mathematics Frameworks and Standards
NCTM Curriculum and Evaluation Standards (1989)
NCTM Standards 2000 (1998 discussion draft)
California Mathematics Framework (1985)
California Mathematics Framework (1992)
California Mathematics Framework (1998)
California Mathematics Program Advisory (1996)
California Mathematics Content Standards adopted by the State Board (1998)
Local district mathematics content standards/curriculum guidelines

Alignment with District Standards
Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards
There is a school-wide effort to implement our district mathematics standards
There is a school-wide effort to improve student mathematics achievement on the Stanford-9
Our district has provided workshops/professional development based on our district mathematics standards
Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching

Perceived teacher support
Teachers in this school support one another in trying innovations in teaching mathematics
The school administration promotes innovations in mathematics education
My way of teaching mathematics is supported by school administrators
My way of teaching mathematics is supported by the parents of my students
I feel that I belong to a professional community of mathematics educators at a regional, state, or national level
I have some control over my mathematics teaching

Perceived teacher collaboration
Suggestions or ideas from other teachers in your school
Suggestions or ideas from a mathematics specialist at the school, district, or county office
Ideas from an in-service, workshop, institute, professional meeting, or conference
Teachers share ideas about mathematics instruction
Teachers observe one another teaching mathematics
Teachers work together to develop mathematics curriculum
Teachers work together to coordinate the mathematics content of different courses
A specialist in mathematics education works with teachers in this school

Professional Mathematics Development
Mathematics content
Mathematics instructional techniques or strategies
Use of particular mathematics curricula or curriculum materials
Use of technology in mathematics instruction
Mathematics standards
Mathematics assessment/testing

Survey of Mathematics Instructional Practices in California

4th Grade
Teacher Questionnaire

February 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers are being surveyed as part of this study.

<u>About this Questionnaire</u>

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in Your Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Gloria Guth, Project Director, WestEd, (650) 470-0403, gguth@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What grade(s) do you currently teach? ______________

2. To how many different classes per day do you teach mathematics? _______

3. Do you teach in a self-contained classroom (i.e., are you responsible for teaching all or most academic subjects to a single class)?

   ❑ yes ❑ no

II. Mathematics Instruction in Your Class*

4. How many days per week and minutes per day does your class meet for mathematics?

   a. Days per week *(check one)*: ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

   b. Average minutes per day: _______ minutes

5. How many total students are enrolled in your class? _______

6. How many 4th grade students are enrolled in your class? _______

7. How would you describe your class in terms of variation in student mathematics ability? *(Check one.)*

   ❑ fairly homogeneous and low in ability
   ❑ fairly homogeneous and average in ability
   ❑ fairly homogeneous and high in ability
   ❑ heterogeneous with a mixture of two or more ability levels

8. How many students in your class are formally classified as each of the following? (Estimate if necessary.)

   a. English Learner/LEP _____ b. Special Education _____ c. Gifted and Talented _____

---

* Note: If you are a mathematics specialist and teach more than one mathematics class, please answer the questions in this section for ***your first mathematics class of the day in which at least half of the students are in 4th grade,*** and indicate here the class period during which this class meets: _______

9. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____% b. in pairs or groups? _____% c. individually? _____%

10. About how often do ***you*** do the following as part of mathematics instruction **in your class**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b.	Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c.	Make provisions for students to work at their own pace or level	1	2	3	4	5
d.	Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e.	Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f.	Assign homework for students to get practice	1	2	3	4	5
g.	Assign special challenges/enrichment as homework	1	2	3	4	5
h.	Go over homework with the class	1	2	3	4	5
i.	Demonstrate how to solve a particular type of problem	1	2	3	4	5
j.	Assess student progress to determine the need for additional instructional support	1	2	3	4	5

11. About how often do you ask **your students** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b.	Practice computational procedures	1	2	3	4	5
c.	Do mathematics in conjunction with other subjects	1	2	3	4	5
d.	Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e.	Read or work problems from a textbook	1	2	3	4	5
f.	Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g.	Discuss different ways to solve a particular problem	1	2	3	4	5
h.	Generalize from particular problems to other situations	1	2	3	4	5
i.	Complete worksheets	1	2	3	4	5
j.	Work on non-routine, higher-order problems	1	2	3	4	5
k.	Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l.	Work problems mentally	1	2	3	4	5

12. About how often do you ask **your students** to participate in each of the following **whole-class** activities as part of mathematics instruction? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b. Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c. View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d. Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e. Read aloud from a mathematics textbook	1	2	3	4	5
f. Go on mathematics-related field trips	1	2	3	4	5
g. Participate in class mathematics contests or games	1	2	3	4	5
h. Other: ____	1	2	3	4	5

13. About how often do you ask **your students** to participate in each of the following **group** activities as part of mathematics instruction? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Work in pairs or small groups on mathematics problems/exercises	1	2	3	4	5
b. Work on group projects that extend for several days	1	2	3	4	5
c. Make group presentations to the rest of the class	1	2	3	4	5
d. Work in pairs or small groups at activity stations	1	2	3	4	5
e. Work in pairs or small groups at computers	1	2	3	4	5
f. Other: ____	1	2	3	4	5

14. About how often do you ask **your students** to participate in each of the following **individual** activities as part of mathematics instruction during class? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Work individually on mathematics problems/exercises	1	2	3	4	5
b. Work on individual projects that take several days	1	2	3	4	5
c. Make individual presentations to the rest of the class	1	2	3	4	5
d. Write in a mathematics journal	1	2	3	4	5
e. Work individually at activity stations	1	2	3	4	5
f. Work individually at computers	1	2	3	4	5
g. Other: ____	1	2	3	4	5

15. About how often do you ask **your students** to participate in each of the following **technology-related activities** as part of mathematics instruction (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

16. About how often do you test **your students** using each of the following types of **assessment** (for mathematics)? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of computational and/or word problems	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

17. On average, how often do **you** use each of the following in mathematics instruction in your class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

18. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in your class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	_______
b.	Increased awareness of real-world mathematical applications	_______
c.	Mastery of basic computational skills and facts	_______
d.	Development of problem solving/inquiry skills	_______
e.	Preparation for future mathematics courses	_______
f.	Attainment of state or district content standards	_______
g.	Preparation for use of mathematics in daily life	_______
h.	Increased interest in mathematics	_______
i.	Development of mathematical reasoning ability	_______
j.	Preparation for standardized tests	_______
k.	Use/application of mathematics in other subject areas	_______
l.	Other: ____	_______

19. Listed below are a number of topics that might be taught in 4th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 arithmetic (whole numbers)	☐ 10 measurement	☐ 19 relationships among operations
☐ 2 decimals	☐ 11 negative numbers	☐ 20 relationships between numbers
☐ 3 equations	☐ 12 operations properties	☐ 21 rounding
☐ 4 estimation	☐ 13 patterns & relationships	☐ 22 set theory
☐ 5 factors & multiples	☐ 14 percent	☐ 23 statistics/use of data
☐ 6 fractions	☐ 15 perimeter & area	☐ 24 use of variables
☐ 7 geometry & spatial sense	☐ 16 place value	other: ________________________
☐ 8 graphs, tables, & charts	☐ 17 polynomials	other: ________________________
☐ 9 mathematical symbols	☐ 18 probability	other: ________________________

20. a. Which of the following do you use as your **main curriculum resource** (for mathematics) in your class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in your class?

Title ____

Publisher ___________________________________ Copyright Date (if known) _____________

21. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only class to which I teach mathematics.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in my other mathematics classes.

22. Are there any special circumstances or unusual conditions related to the teaching of mathematics in your class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

23. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

24. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b.	Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c.	The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d.	The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e.	There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f.	There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g.	Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h.	Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i.	Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j.	Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k.	The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l.	The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m.	The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

25. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

a. Estimated number of **total** math professional development hours: ______ hours

b. Estimated number of these hours **required by district**: ______ hours

26. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ________________	1	2	3	4	5

27. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

28. About how often does each of the following occur at your school? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Teachers share ideas about mathematics instruction.	1	2	3	4	5
b. Teachers observe one another teaching mathematics.	1	2	3	4	5
c. Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d. Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e. A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

29. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics
- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: __________________

College Mathematics
- ❑ Calculus
- ❑ Linear algebra
- ❑ Discrete mathematics
- ❑ Probability and statistics
- ❑ Other: ____________________

Mathematics Education
- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Mathematics for elem. sch. teachers
- ❑ Other: ______________________

30. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Master's Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Doctoral Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

31. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❑ multiple subject teaching credential
- ❑ general or standard elementary credential
- ❑ emergency multiple subject teaching permit
- ❑ emergency teaching permit in mathematics
- ❑ internship credential (multiple subject)
- ❑ internship credential in mathematics
- ❑ credential waiver
- ❑ single subject credential in mathematics
- ❑ single subject credential *not* in mathematics
- ❑ standard secondary credential in mathematics
- ❑ standard secondary credential *not* in mathematics
- ❑ general secondary credential
- ❑ other: _______________________________

b. Do you have a supplementary authorization in mathematics? ❑ yes ❑ no

32. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____ d. at 4th grade? _____

VI. Teacher Demographic Information

33. Are you: ❑ male ❑ female

34. Are you:

- ❑ African American (not of Hispanic origin)
- ❑ American Indian or Alaskan Native
- ❑ Asian or Pacific Islander
- ❑ Hispanic
- ❑ White (not of Hispanic origin)
- ❑ Other: ______________________

VII. Additional Comments (Optional)

35. What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?

____

____

____

____

36. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

37. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

38. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

39. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Survey of Mathematics Instructional Practices in California

8th Grade
Teacher Questionnaire

February 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers are being surveyed as part of this study.

About this Questionnaire

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in a Particular Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Gloria Guth, Project Director, WestEd, (650) 470-0403, gguth@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What grade(s) do you currently teach? ______________

2. To how many different classes per day do you teach mathematics? _______

3. Do you currently teach any subjects other than mathematics? ❑ yes ❑ no

   If yes, what other subject(s) do you teach? ____

II. Mathematics Instruction in a Particular Class

If you teach more than one mathematics class, please answer the questions in this section for *your first mathematics class of the day in which at least half of the students are in 8th grade,* and indicate here the class period during which this class meets: _______

4. What is the title of this class? ____

5. Which of the following best describes the duration of this class? *(Check one.)*

   ❑ year-long ❑ one-semester ❑ other: ___________________

6. How many days per week and minutes per day does this class meet (for mathematics)?

   a. Days per week *(check one):* ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

   b. Minutes per day: _______ minutes

7. How many total students are enrolled in this class? _______

8. How many 8th grade students are enrolled in this class? _______

9. How would you describe this class in terms of variation in student mathematics ability? *(Check one.)*

   ❑ fairly homogeneous and low in ability
   ❑ fairly homogeneous and average in ability
   ❑ fairly homogeneous and high in ability
   ❑ heterogeneous with a mixture of two or more ability levels

10. In this class, how many students are formally classified as each of the following? (Estimate if necessary.)

    a. English Learner/LEP? _____ b. Special Education? _____ c. Gifted and Talented? _____

11. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____%   b. in pairs or groups? _____%   c. individually? _____%

12. About how often do ***you*** do the following as part of mathematics instruction **in this class**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b.	Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c.	Make provisions for students to work at their own pace or level	1	2	3	4	5
d.	Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e.	Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f.	Assign homework for students to get practice	1	2	3	4	5
g.	Assign special challenges/enrichment as homework	1	2	3	4	5
h.	Go over homework with the class	1	2	3	4	5
i.	Demonstrate how to solve a particular type of problem	1	2	3	4	5
j.	Assess student progress to determine the need for additional instructional support	1	2	3	4	5

13. About how often do you ask **students in this class** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b.	Practice computational procedures	1	2	3	4	5
c.	Do mathematics in conjunction with other subjects	1	2	3	4	5
d.	Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e.	Read or work problems from a textbook	1	2	3	4	5
f.	Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g.	Discuss different ways to solve a particular problem	1	2	3	4	5
h.	Generalize from particular problems to other situations	1	2	3	4	5
i.	Complete worksheets	1	2	3	4	5
j.	Work on non-routine, higher-order problems	1	2	3	4	5
k.	Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l.	Work problems mentally	1	2	3	4	5

14. About how often do you ask **students in this class** to participate in each of the following **whole-class** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b.	Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c.	View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d.	Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e.	Read aloud from a mathematics textbook	1	2	3	4	5
f.	Go on mathematics-related field trips	1	2	3	4	5
g.	Participate in class mathematics contests or games	1	2	3	4	5
h.	Other: ____	1	2	3	4	5

15. About how often do you ask **students in this class** to participate in each of the following **group** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work in pairs or small groups on mathematics problems/ exercises	1	2	3	4	5
b.	Work on group projects that extend for several days	1	2	3	4	5
c.	Make group presentations to the rest of the class	1	2	3	4	5
d.	Work in pairs or small groups at activity stations	1	2	3	4	5
e.	Work in pairs or small groups at computers	1	2	3	4	5
f.	Other: ____	1	2	3	4	5

16. About how often do you ask **students in this class** to participate in each of the following **individual** activities during class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work individually on mathematics problems/exercises	1	2	3	4	5
b.	Work on individual projects that take several days	1	2	3	4	5
c.	Make individual presentations to the rest of the class	1	2	3	4	5
d.	Write in a mathematics journal	1	2	3	4	5
e.	Work individually at activity stations	1	2	3	4	5
f.	Work individually at computers	1	2	3	4	5
g.	Other: ____	1	2	3	4	5

17. About how often do you ask **students in this class** to participate in each of the following **technology-related activities** (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

18. About how often do you test **students in this class** using each of the following types of **assessment**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of computational and/or word problems	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

19. On average, how often do **you** use each of the following in your mathematics instruction in this class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

20. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in this class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	_______
b.	Increased awareness of real-world mathematical applications	_______
c.	Mastery of basic computational skills and facts	_______
d.	Development of problem solving/inquiry skills	_______
e.	Preparation for future mathematics courses	_______
f.	Attainment of state or district content standards	_______
g.	Preparation for use of mathematics in daily life	_______
h.	Increased interest in mathematics	_______
i.	Development of mathematical reasoning ability	_______
j.	Preparation for standardized tests	_______
k.	Use/application of mathematics in other subject areas	_______
l.	Other: ____	_______

21. Listed below are a number of topics that might be taught in 8th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 absolute value	☐ 12 irrational numbers	☐ 23 relationships among operations
☐ 2 arithmetic (whole numbers)	☐ 13 logarithms	☐ 24 relationships between numbers
☐ 3 decimals	☐ 14 mathematical symbols	☐ 25 rounding
☐ 4 equations & inequalities	☐ 15 measurement	☐ 26 sequences & series
☐ 5 estimation	☐ 16 negative numbers	☐ 27 set theory
☐ 6 exponents and roots	☐ 17 percent	☐ 28 simplification of expressions
☐ 7 factors & multiples	☐ 18 perimeter, area, volume	☐ 29 statistics/use of data
☐ 8 fractions	☐ 19 polar coordinate system	☐ 30 use of variables
☐ 9 functions & patterns	☐ 20 polynomials	other: ________________________
☐ 10 geometry & spatial sense	☐ 21 probability	other: ________________________
☐ 11 graphing	☐ 22 ratio & proportion	other: ________________________

22. a. Which of the following do you use as your **main curriculum resource** in this class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in this class?

Title ____

Publisher ___________________________________ Copyright Date (if known) _____________

23. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only mathematics class I teach.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in all of my other mathematics classes.
- ❑ My teaching in this class is representative of *some* of my other mathematics classes.

24. Are there any special circumstances or unusual conditions related to the teaching of mathematics to this class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

25. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

26. Indicate your opinion about each statement below. *(Circle one number on each line.)*

	Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a. Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b. Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c. The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d. The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e. There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f. There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g. Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h. Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i. Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j. Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k. The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l. The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m. The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

27. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

a. Estimated number of **total** math professional development hours: ______ hours

b. Estimated number of these hours **required by district**: ______ hours

28. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ______________________________	1	2	3	4	5

29. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

30. About how often does each of the following occur at your school? *(Circle one number on each line.)*

	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a. Teachers share ideas about mathematics instruction.	1	2	3	4	5
b. Teachers observe one another teaching mathematics.	1	2	3	4	5
c. Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d. Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e. A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

31. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics
- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: __________________

College Mathematics
- ❑ Calculus
- ❑ Linear algebra
- ❑ Discrete mathematics
- ❑ Probability and statistics
- ❑ Other: _____________________

Mathematics Education
- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Mathematics for elem. sch. teachers
- ❑ Other: ________________________

32. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Master's Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

Doctoral Degree
- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: ___________________

33. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❑ multiple subject teaching credential
- ❑ general or standard elementary credential
- ❑ emergency multiple subject teaching permit
- ❑ emergency teaching permit in mathematics
- ❑ internship credential (multiple subject)
- ❑ internship credential in mathematics
- ❑ credential waiver
- ❑ single subject credential in mathematics
- ❑ single subject credential *not* in mathematics
- ❑ standard secondary credential in mathematics
- ❑ standard secondary credential *not* in mathematics
- ❑ general secondary credential
- ❑ other: ______________________________

b. Do you have a supplementary authorization in mathematics? ❑ yes ❑ no

34. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____ d. at 8^{th} grade? _____

VI. Teacher Demographic Information

35. Are you: ❑ male ❑ female

36. Are you:
- ❑ African American (not of Hispanic origin)
- ❑ American Indian or Alaskan Native
- ❑ Asian or Pacific Islander
- ❑ Hispanic
- ❑ White (not of Hispanic origin)
- ❑ Other: _____________________

VII. Additional Comments (Optional)

37. What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?

____

____

____

____

38. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

39. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

40. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

41. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Mathematics Implementation Study
Classroom Observation Protocol
Outline for Qualitative Write-Up[1]

1. **Content of Lesson.** Describe chronologically the main academic areas that were part of the lesson. Include a descriptive label, a brief description of the tasks for each mathematical area, the number of minutes spent on each task, the percentage of class time devoted to each task, and the amount of class time that was *not* spent on mathematics instruction (e.g., nonacademic time: taking role, etc.). Also discuss whether the teacher demonstrated an understanding of the content. Did the teacher appear confident in the material? Was the content accurate?

2. **Organization of Students.** Describe how the teacher organized the students during the course of the lesson. When and for how long did students meet as a whole class, divide into pairs or small groups, work individually at their seats, etc.? Describe the activities that students engaged in during each organizational "phase" of the lesson, the ways that the teacher interacted with students during each phase of the lesson, and the ways that students interacted with one another. For example, during group work, did the teacher circulate among all the groups, focus on just one or two of the groups, or remain at his or her desk? Did students work collaboratively, or were some students more active than others? During whole-class discussion, did a few students dominate the discussion, or did everyone participate?

3. **Purpose of Lesson.** Describe the primary purpose of the lesson (e.g., learning or practicing computational procedures, discovering underlying concepts, framing problems, making conjectures, looking for patterns, connecting math to everyday life or to other subjects, etc.)

4. **Representations, Tools, and Resources.** Identify the representations and tools used by teachers or students and mathematical ideas the representations were targeting.[2] Also identify other resources and materials used during the lesson (e.g., textbooks, worksheets, calculators, computers, etc.) Give specific titles if possible (e.g., textbook title, type of manipulative, software program).

5. **Assessment During Lesson.** Describe the extent to which the teacher attempted to monitor student understanding or engaged in assessment activities aimed at informing instruction and/or gaining knowledge about individual students. Examples include asking questions aimed at identifying students' thinking patterns, interviewing students individually to assess their knowledge, or having students write in a journal as a way to assess understanding.

---

[1] This protocol was adapted, with substantial modification, from the classroom observation protocol used by the Consortium for Policy Research in Education (CPRE) in their study "From Congress to the Classroom."
[2] Representations are anything used to convey some aspect of mathematics and include, but are not limited to, chalkboard drawings, concrete models, manipulatives, graphs, formulas, videos, classroom or household objects, etc.

6. **Focus of Classroom Discourse.** Identify the primary focuses of classroom discourse. To what extent did classroom discourse focus on "getting the right answers" or "doing it the right way"? To what extent did classroom discourse focus on "making sense" of mathematics? Give examples, and include a description of how the teacher stimulated the discourse (e.g., by posing questions or tasks that were "real" problems, by asking students to clarify and justify their ideas, having students talk to each other). Were students directed to or encouraged (either explicitly or implicitly) to a) initiate problems or questions; b) select or invent their own representations; c) select their own technological tools? If so, give examples, and discuss the extent to which students actually did a, b, or c. Also, how much "wait time" did the teacher leave for students to answer questions?

7. **Language Differences.** If applicable, describe the extent to which language differences appeared to play a role in patterns of interaction (teacher-student and student-student) during the class and during each phase of the lesson (e.g., group work, whole-class discussion, etc.) For example, did teacher interaction with LEP students appear to be different than with other students? Did students from all language backgrounds participate in the lesson more or less equally?

8. **Students with Other Special Needs.** Describe the extent to which the teacher attempted to address the needs of students having difficulty, gifted and talented students, and any other students appearing to have special needs. Were these students fully integrated in the lesson's main tasks or did they engage in different activities? Were they seated with the other students or were they physically separated? What accommodations (if any) were made for them, in terms of both materials/resources and in patterns of interaction (teacher-student and student-student) within the classroom?

9. **Behavior and Discipline.** Did student behavior or teacher disciplinary action appear to interfere with the effectiveness of the lesson or the understanding of particular students? If so, how?

10. **Other.** Did you observe anything else that seemed to be important but was not addressed in this protocol? Please describe with specific examples. Why was it important?

Mathematics Implementation Study
Interview Protocol: Teachers

[Record district name, school name, teacher name, and date and time of interview.]

Pre-Observation Interview

Thank you very much for filling out our questionnaire and for allowing me to come see you teach. Before the observation, there are just a few questions that I'd like to ask you.

1. What has the class been doing in math recently?

2. What do you anticipate doing in your math class today?

3. What do you hope students will learn from the lesson?

4. Is there anything in particular that I should know about the group of students I will be observing?

5. Do you have any LEP students in your class? How many? Can you tell/show me where they sit? Do you have anything special planned for them?

After the observation, I'd like to speak with you again and ask you some more questions, if that's okay.

Post-Observation Interview

Thanks again for allowing me to observe your classroom teaching and for speaking with me today. The purpose of this interview is to gain an understanding of your perceptions of the lesson that I observed and also to ask you some other questions related to your mathematics teaching. More specifically, we are studying how policies and reforms have influenced math instruction in your classroom.

[if taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

<u>Questions about the Observation</u>

First, I have some questions about the lesson that I observed.

1. Overall, how do you feel the lesson went?

2. Were there any ways in which the lesson was different from what you planned?

3. What did the lesson tell you about what the students are learning or still need to know in math?

4. What do you plan on doing tomorrow?

5. Would you say that today was a typical day? Why or why not?

Math Instruction: Philosophy and Practice

Now I'd like to ask you some general questions about your math teaching.

1. Can you briefly describe your general approach to teaching math with this class? *[E.g., basic skills, connection to daily life, preparation for SAT-9, etc.]*

2. What types of materials do you generally use when you teach math? Which do you use most often? How do you decide which materials to use? How do you acquire instructional materials within your school? How much input do you have in selecting instructional materials and resources? *[probe on who is involved in materials selection (e.g., teacher, school, district), accessibility to resources/materials, etc.]*

3. How do you decide generally if your students are progressing in math? How do you decide when a student needs special help or extra help, and what kind of help is provided?

4. *[If applicable]* What do you do to address the needs of English language learners in your classroom during math instruction?

Math Instruction: Influences

The next few questions are about things going on in math education today, what you think of them, and what influences your math instruction.

1. Are you particularly aware of any recent national, state, or district developments in math education? If so, can you summarize these developments in your own words and tell me what you think of them?

2. What documents and/or policies have had the greatest impact on your teaching? In what ways, if any, have policy decisions from the state of California (State Board, legislature, California Department of Education) influenced what and how you teach? How about policy decisions from your district?

3. These days there is a lot of talk about accountability. How would you describe your district's accountability system? Are there ways in which it influences your teaching?

4. How do you decide what mathematics to teach? What types of interactions do you have with other teachers or administrators in your building in terms of curriculum planning and development for math instruction? How do curriculum decisions get made in your school? *[Probe for who is involved]*

5. Do you have professional development opportunities related to math instruction? *[Probe for professional communities and teacher networks as well as staff development/in-service.]* If so, do these professional development activities enhance your effectiveness in teaching math? How?

6. Do you have access to people or resources that can help you with your math instruction? *[Probe on specific resources, e.g., curriculum specialists, Title I, special education]*

7. Is your school currently participating in any special programs or initiatives related to math instruction? If so, how does this influence your practice?

8. Did you do anything special to help your students prepare for this year's SAT-9 (mathematics)? If so, what, and for how long prior to the test? If not, are there any ways in which the SAT-9 influences your math teaching?

Effectiveness in Teaching Math

My final few questions are about how effective you feel your math teaching is.

1. What kinds of indicators do you use to gauge your effectiveness in teaching mathematics?

2. How comfortable do you feel teaching math at this grade level? Why?

3. Is there anything that gets in the way of your effectiveness as a math teacher? If so, what?

4. What, if anything, would help you improve your math instruction?

5. Is there anything else you would like to talk about that we haven't covered?

Thank you for your time; you've given us some really valuable information. I really appreciate it and have enjoyed talking with you.

Mathematics Implementation Study
Interview Protocol: Principals

[Record district name, school name, principal name, and date and time of interview.]

Thank you very much for authorizing your school's participation in this study, for allowing us to come observe here and talk with some teachers, and for speaking with me today. The study that I am working on is about the kinds of school and classroom practices that contribute to high mathematics achievement, and the influence of state and local policies on mathematics instruction.

[If taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

1. Tell me about your school's mathematics instructional program. *[Probe for underlying philosophy, scope and sequence (e.g., grade levels the same across schools in district, articulation, etc.)]*

2. Has the school undertaken any new initiatives recently that seem likely to have an effect on mathematics instruction? *[Probe for details on status of, changes in, and reasons for:*

   - *changes in curriculum materials and assessment*
   - *differentiated curriculum and instruction for students with special needs (LEP, special education, Title I, GATE, etc.)*
   - *the way teachers' time is organized to facilitate planning, professional development, collaboration, or other goals*
   - *school time or structure*
   - *the way students are scheduled and organized*
   - *student support services]*

3. To what extent has district policy required, encouraged, and/or supported these changes? What kinds of resources and assistance does the district make available to you?

4. How much discretion does the school have in determining its math curriculum? math textbooks and other instructional materials? curriculum coverage and pacing?

5. How much discretion do individual teachers have in these areas? Are there any committees within the school that make decisions about these issues?

6. What factors do you think exert the greatest influence over mathematics instruction in this school? *[Probe for state and district policies, SBE and district standards, SAT-9, other assessments, national influences (e.g., NCTM standards), professional development, teacher preparation, student demographic characteristics, etc.]*

7. What role does the school play in providing professional development in mathematics instruction for teachers? Do you have any particular priorities and goals for professional development in math? *[Probe for whether teachers are required to participate, how often, whether they have any choices, compensation, who sponsors, and who provides PD.]*

8. What do you think are the most effective kinds of professional development for your teachers in mathematics?

9. What factors do you think exert the greatest influence over *student achievement* in mathematics in this school? [*Probe for professional development, instructional strategies, school characteristics, student characteristics, parent involvement, etc*.]

10. What measures do you use to assess student mathematics achievement in your school? [*Probe for local state and national assessments, percentage of students meeting grade levels standards, etc*.]

11. Generally speaking, how would you rate student mathematics achievement in your school as a whole? *[Probe: what makes you think so?]*

12. Thinking about your school as a whole, what changes do you think are needed to improve math instruction? *[Probe for changes in how teachers work together, funding and other material resources (e.g., technology), parent involvement, and district or state policies.]*

13. These days there is a lot of emphasis placed on accountability. Have you felt that your school has been held accountable? If so, what have you been held accountable for and to whom? What impact, if any, has the state or district accountability system had on your school (not just in math instruction, but in general)?

Thank you so much for your time; you've given us some really valuable information. Can I get copies of the following materials you mentioned? Is there anyone else I should talk to in your school to get a perspective on the kinds of things that we have talked about?

Mathematics Implementation Study
District Curriculum Coordinator/Math Specialist
Interview Questions

[Record district name, interviewee's name, interviewee's title, and date and time of interview.]

Thank you very much for speaking with me today. The study that I am working on is about the kinds of instructional practices that contribute to high mathematics achievement, and the influence of state and local policies on mathematics instruction.

[if taping the interview] With your permission, I would like to tape record the interview so that I can concentrate on what you are saying rather than on note-taking, The tape recording will remain confidential. Is that okay?

Do you have any questions before we begin? Okay.

1. **Description of Instruction.** Tell us about your district's mathematics program.

    - *[Probe for underlying philosophy, scope and sequence (e.g., is it district-wide, K-12 articulated, etc.), when it was adopted/revised, any recent changes and reasons for changes, materials adopted, etc.]*
    - How much discretion and authority do schools and teachers have in determining curriculum? instructional methods? textbook and other instructional materials (e.g., calculators, manipulatives, etc.)? curriculum coverage and pacing?

2. **Influences.** Tell us about the factors influencing what mathematics gets taught—and how it gets taught—in this district.

    - What major policies does the district use to guide curriculum and instruction in mathematics?
    - In what ways, if any, have state actions or policies influenced the nature of mathematics instruction in your district? *[Probe for the 1998 SBE standards, the Mathematics Frameworks, program advisories, SAT-9, Prop. 227, CSR, Social Promotion, etc.]*
    - What other influences have helped shape district mathematics instruction? *[Probe for national influences (e.g., NCTM), local influences, research findings, assessments, professional development, teacher preparation, student demographic characteristics, etc.]*
    - What people/groups have been, and are currently, involved in shaping district mathematics instruction?
    - Which of the influences shaping district mathematics instruction would you describe as the most important?
    - Are there any incentives or disincentives for schools and teachers to follow district and/or state decisions regarding mathematics instruction? (e.g., schools

get less money if they depart from the textbooks or materials adopted by the district, or laws require schools to make the decisions)

3. **Content Standards.** Tell us about the use of mathematics content standards in your district.

   - Has the district developed local content standards for math? When? Who was involved? Are there any plans to create/revise them? In what grades? Do they differ from the state content standards, and if so, how and why? How are standards used in the district?
   - What, if anything, does the district do to assist schools and teachers in understanding and implementing the math content standards?
   - What assessments does the district use for math? How were they selected?
   - Do you think district standards, curriculum-planning documents, instructional materials, and assessments are well aligned with each other? Why or why not?

4. **Professional Development.** Tell us about mathematics professional development in your district.

   - What professional development does the district provide for teachers and/or school administrators in mathematics instruction? Do you have any particular priorities and goals for professional development in math? *[Probe for whether teachers/administrators are required to participate, how often, whether they have any choices, compensation, who sponsors, and who provides PD.]*
   - What do you think are the most effective kinds of staff development for teachers/administrators in mathematics? *[Probe: what makes you think so?]*
   - What financial resources do you have available for professional development? *[Probe for Eisenhower, other grants, etc.]*

5. **Student Achievement.** Tell us about student mathematics achievement in your district.

   - Generally speaking, how would you rate student mathematics achievement in the district as a whole?
   - What factors do you think exert the greatest influence over student achievement in mathematics in the district? *[Probe for professional development, instructional strategies, school characteristics, student characteristics, parent involvement, etc.]*
   - What measures do you use to assess student achievement across the district and to evaluate your overall mathematics program? *[Probe for local, state, and national assessments, percentage of students meeting grade level standards, etc.]*

6. **Strengths and Weaknesses.** Tell us about what you see as being the strengths and weaknesses of your district mathematics instruction.

- What do you think are the strengths and weaknesses of mathematics instruction in your district? Do you feel that all students across the district have access to quality math instruction? *[Probe for evidence.]*
- What do you see as the biggest challenges to improving student mathematics achievement in your district? *[Probe for shortage of math certified teachers, teacher preparation, instructional materials, student characteristics, etc.]*
- Thinking about your district as a whole, what changes do you think are needed to encourage improvement in math instruction and achievement? *[Probe for changes in how schools/ teachers work together, funding and other material resources (e.g., technology), and district or state policies.]*
- Specifically, what assistance or additional resources, and from whom, would help? *[Probes: if funding, how would it be spent? If time, how would the time be allocated?]*

7. **Accountability.** Tell us about accountability in your district.

- What influence has the state accountability system (including standards and testing) had over mathematics instruction in your district?
- How do you interpret and use data?
- Are these good indicators for determining student achievement?
- What are the major issues and challenges with this performance data?

Thank you so much for your time; you've given us some really valuable information. Can I get copies of the following materials you mentioned? Is there anyone else I should talk to in your district to get a perspective on the kinds of things that we have talked about?

Mathematics Implementation Study
Policy Implications Interview Protocol

General Background
What is your opinion of the current level of mathematics achievement of California students? On what is your opinion based?

What do you see the two or three most important factors explaining the level of mathematics achievement among CA students?

Appropriate State Role
What is the appropriate role of state policy makers in improving mathematics instruction in CA? (Be specific about each entity: legislature, Governor/secretary of education, SPI/CDE, State Board of Education)

How should state government's role be related to the roles of local superintendents/school boards, high school mathematics educators, elementary classroom teachers, and teacher training institutions?

Appropriateness of State Strategy
What is (your understanding) the current (or near term future) state strategy for improving the level of mathematics achievement among CA students?

What is your opinion of the likely outcomes of the current state strategy? Why?

Over the past decade which state interventions have been <u>most helpful</u> in improving mathematics education in CA public schools?

Over the past decade which state interventions have been <u>least helpful</u> in improving mathematics education in CA public schools?

Specific Findings

Standards
Survey respondents support the notion of standards. They also believe standards are important in helping improve mathematics instruction. However, many reported that the new math standards were too ambitious and that there were often competing sets of standards—which generated confusion. Also many respondents reported that too much reform was occurring too fast—that there was insufficient time to assimilate all the changes. What is the appropriate state policy response to these concerns?

Respondents also reported that standards were less powerful in driving the math curriculum than was the SAT9. Several expressed resentment about the powerful impact of testing on the curriculum. What state policies are appropriate for shifting the emphasis to the standards.

A common finding from survey respondents is that there is a lack of alignment between state standards, frameworks, texts, and the SAT9. How can the state best address this concern?

Instructional Materials
Inadequate or insufficient instructional materials (including textbooks) were identified as biggest hindrance to mathematics instruction by 4th grade teachers. Recently, sufficient dollars have been appropriated by the state for the purchase of instructional materials. What, if anything, should the state do to enhance the quality and relevance of these materials?

Instructional Practice
Overall, there appears to be high degree of consensus on objectives for math instruction but little consensus on what constitutes effective math instructional practice. Is there an appropriate state policy role on this issue. If so, what is it?

Professional Development
Survey respondents also reported professional development activities and teacher preparation as important forces but found an inadequate connection between standards and professional development activities. 4th grade teachers want more math professional development. 8th grade teachers reported that math professional development was very helpful. Is professional development an appropriate state role? If so, how can the state most effectively create professional development opportunities for local teachers?

Teacher Involvement
Many respondents felt they were inadequately involved in the development of standards, tests, and instructional material. A common sentiment across all levels (school, district & state) is that teacher buy-in is necessary for reform to work. How can/should the state go about gaining teacher support for its reforms? Do you perceive this as a problem? If so, how should the state go about resolving it?

Survey of Mathematics Instructional Practices in California

10th Grade
Teacher Questionnaire

Pilot Test Version

November 1999

REMOVE LABEL BEFORE RETURNING QUESTIONNAIRE

[removable mailing label here]

WestEd
935 El Camino Real
Menlo Park, CA 94025

Survey of Mathematics Instructional Practices in California

This questionnaire is part of a research study being conducted for the California Department of Education by WestEd in collaboration with Management Analysis and Planning, Inc. (MAP) and the RAND Corporation. The purpose of the study is to examine the instructional practices used in teaching mathematics in California. Approximately 500 fourth-grade teachers and 300 eighth-grade mathematics teachers have already been surveyed as part of this study. This questionnaire is part of an exploratory research and development effort about mathematics teaching at the tenth-grade level.

<u>About this Questionnaire</u>

This questionnaire contains the following sections:

I. Current Teaching Situation
II. Mathematics Instruction in a Particular Class
III. Recent Developments in Mathematics Education
IV. Professional Development and Support
V. Professional Background
VI. Teacher Demographic Information
VII. Additional Comments

The time needed to complete the questionnaire is approximately 30 minutes. Of course, we welcome further written comments in any section of the questionnaire. It is important that all individuals receiving this questionnaire participate in the survey so that the results will fairly represent mathematics teachers in the sampled regions. **Please fold the completed questionnaire and return it in the enclosed postage-paid envelope as soon as possible.**

YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL. No information identifying individual teachers will be reported under any circumstances. Please remove the name label on the front cover before returning the completed questionnaire.

Thank you for contributing your time and thoughtful responses to this study.

For Further Information

If you have any questions about this questionnaire or about the study in general, please feel free to contact us:

Deborah Holtzman, Research Assistant, WestEd, (650) 470-0407, dholtzm@WestEd.org
Dr. Tania Madfes, Project Director, WestEd, (415) 615-3103, tmadfes@WestEd.org

Survey of Mathematics Instructional Practices in California

I. Current Teaching Situation

1. What courses do you currently teach? ________________________ ________________________

________________________ ________________________

2. To how many different classes per day do you teach mathematics? _______

3. Do you currently teach any subjects other than mathematics? ❑ yes ❑ no

If yes, what other subject(s) do you teach? ____

II. Mathematics Instruction in a Particular Class

If you teach more than one mathematics class, please answer the questions in this section for *your first mathematics class of the day in which at least half of the students are in 10th grade,* and indicate here the class period during which this class meets: _______

4. What is the title of this class? ____

5. Which of the following best describes the duration of this class? *(Check one.)*

❑ year-long ❑ one-semester ❑ other: ____________________

6. How many days per week and minutes per day does this class meet (for mathematics)?

a. Days per week *(check one):* ❑ 1 day ❑ 2 days ❑ 3 days ❑ 4 days ❑ 5 days

b. Minutes per day: _______ minutes

7. How many total students are enrolled in this class? _______

8. How many 10th grade students are enrolled in this class? _______

9. How would you describe this class in terms of variation in student mathematics ability? *(Check one.)*

❑ fairly homogeneous and low in ability
❑ fairly homogeneous and average in ability
❑ fairly homogeneous and high in ability
❑ heterogeneous with a mixture of two or more ability levels

10. In this class, how many students are formally classified as each of the following? (Estimate if necessary.)

a. English Learner/LEP? _____ b. Special Education? _____ c. Gifted and Talented? _____

11. Over a typical week, about what percentage of mathematics class time do you ask students to work or meet…

a. as a whole class? _____% b. in pairs or groups? _____% c. individually? _____%

12. About how often do ***you*** do the following as part of mathematics instruction **in this class**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Introduce/teach topics by explaining the concepts themselves	1	2	3	4	5
b.	Introduce/teach topics in the context of everyday situations	1	2	3	4	5
c.	Make provisions for students to work at their own pace or level	1	2	3	4	5
d.	Check for student understanding at the end of a lesson or class period	1	2	3	4	5
e.	Use a computer to present, simulate, or demonstrate concepts and techniques to the class	1	2	3	4	5
f.	Assign homework for students to get practice	1	2	3	4	5
g.	Assign special challenges/enrichment as homework	1	2	3	4	5
h.	Go over homework with the class	1	2	3	4	5
i.	Demonstrate how to solve a particular type of problem	1	2	3	4	5
j.	Assess student progress to determine the need for additional instructional support	1	2	3	4	5

13. About how often do you ask **students in this class** to do each of the following as part of mathematics instruction, homework, or assessment? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Justify their answer or explain their reasoning when giving an answer (oral or written)	1	2	3	4	5
b.	Practice computational procedures	1	2	3	4	5
c.	Do mathematics in conjunction with other subjects	1	2	3	4	5
d.	Memorize mathematics facts, rules, definitions, or formulas	1	2	3	4	5
e.	Read or work problems from a textbook	1	2	3	4	5
f.	Read or work problems from a published instructional program that is not a textbook	1	2	3	4	5
g.	Discuss different ways to solve a particular problem	1	2	3	4	5
h.	Generalize from particular problems to other situations	1	2	3	4	5
i.	Complete worksheets	1	2	3	4	5
j.	Work on non-routine, higher-order problems	1	2	3	4	5
k.	Use manipulative materials or models to solve problems or explore concepts	1	2	3	4	5
l.	Work problems mentally	1	2	3	4	5

14. About how often do you ask **students in this class** to participate in each of the following **whole-class** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Listen to teacher presentation of a new topic or procedure	1	2	3	4	5
b.	Engage in class discussion about mathematics concepts or problems	1	2	3	4	5
c.	View or participate in mathematics demonstrations or investigations	1	2	3	4	5
d.	Watch mathematics-related films, filmstrips, videotapes, or television programs	1	2	3	4	5
e.	Read aloud from a mathematics textbook	1	2	3	4	5
f.	Go on mathematics-related field trips	1	2	3	4	5
g.	Participate in class mathematics contests or games	1	2	3	4	5
h.	Other: ____	1	2	3	4	5

15. About how often do you ask **students in this class** to participate in each of the following **group** activities? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work in pairs or small groups on mathematics problems/ exercises	1	2	3	4	5
b.	Work on group projects that extend for several days	1	2	3	4	5
c.	Make group presentations to the rest of the class	1	2	3	4	5
d.	Work in pairs or small groups at activity stations	1	2	3	4	5
e.	Work in pairs or small groups at computers	1	2	3	4	5
f.	Other: ____	1	2	3	4	5

16. About how often do you ask **students in this class** to participate in each of the following **individual** activities during class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Work individually on mathematics problems/exercises	1	2	3	4	5
b.	Work on individual projects that take several days	1	2	3	4	5
c.	Make individual presentations to the rest of the class	1	2	3	4	5
d.	Write in a mathematics journal	1	2	3	4	5
e.	Work individually at activity stations	1	2	3	4	5
f.	Work individually at computers	1	2	3	4	5
g.	Other: ____	1	2	3	4	5

17. About how often do you ask **students in this class** to participate in each of the following **technology-related activities** (in class or in school lab)? *(Circle one number on each line.)*

		No Access	Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Use calculators to perform basic calculations	0	1	2	3	4	5
b.	Use calculators to learn concepts	0	1	2	3	4	5
c.	Use computers to run simulations or demonstrations	0	1	2	3	4	5
d.	Use computers to practice basic skills	0	1	2	3	4	5
e.	Use computers to learn concepts	0	1	2	3	4	5
f.	Use computers to collect data	0	1	2	3	4	5
g.	Use computers as an analytic tool (e.g., spreadsheets)	0	1	2	3	4	5
h.	Use computers to play mathematics games	0	1	2	3	4	5
i.	Other: ___________________________________	0	1	2	3	4	5

18. About how often do you test **students in this class** using each of the following types of **assessment**? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Short-answer tests (e.g., multiple choice, true/false, fill-in-the-blank)	1	2	3	4	5
b.	Tests made up of short problems to solve	1	2	3	4	5
c.	Tests requiring open-ended responses (e.g., descriptions, justifications of solutions)	1	2	3	4	5
d.	Performance tasks for assessment purposes	1	2	3	4	5
e.	Other: ____	1	2	3	4	5

19. On average, how often do **you** use each of the following in your mathematics instruction in this class? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Lessons or problems you have created	1	2	3	4	5
b.	Teacher's edition or guide (from textbook or other instructional program)	1	2	3	4	5
c.	Published supplementary curriculum materials	1	2	3	4	5
d.	Suggestions or ideas from other teachers in your school	1	2	3	4	5
e.	Suggestions or ideas from a mathematics specialist at the school, district, or county office	1	2	3	4	5
f.	Ideas from an in-service, workshop, institute, professional meeting, or conference	1	2	3	4	5
g.	Test preparation materials (e.g., commercial materials, items from upcoming or past state or district tests, etc.)	1	2	3	4	5
h.	Other:____	1	2	3	4	5

20. Listed below are a number of possible objectives for mathematics instruction.

a. **Circle the letters of the five objectives** on which you place the most emphasis **for students in this class**.

b. **Rank order the five objectives you selected** from 1 to 5 in terms of the emphasis you place on each one (1=greatest emphasis and 5=least emphasis).

	Objective	Rank Order
a.	Development of conceptual understanding	_______
b.	Increased awareness of real-world mathematical applications	_______
c.	Mastery of basic computational skills and facts	_______
d.	Development of problem solving/inquiry skills	_______
e.	Preparation for future mathematics courses	_______
f.	Attainment of state or district content standards	_______
g.	Preparation for use of mathematics in daily life	_______
h.	Increased interest in mathematics	_______
i.	Development of mathematical reasoning ability	_______
j.	Preparation for standardized tests	_______
k.	Use/application of mathematics in other subject areas	_______
l.	Other: ____	_______

21. Listed below are a number of topics that might be taught in 10th grade mathematics courses.

a. **Circle the names of the five topics** on which you anticipate **having spent the most time** by the end of this year. Fill in the "other" spaces if your top five topics are not on the list.

b. **Check the box to the left of every topic that you DO NOT teach in this class**.

☐ 1 absolute value	☐ 12 logarithms	☐ 23 sequences and series
☐ 2 binomial theorem	☐ 13 matrices	☐ 24 set theory
☐ 3 complex numbers	☐ 14 negative numbers	☐ 25 similar figures
☐ 4 congruent figures	☐ 15 polyhedra	☐ 26 simplification of expressions
☐ 5 coordinate geometry	☐ 16 polar coordinate system	☐ 27 statistics
☐ 6 deductive reasoning	☐ 17 polynomials	☐ 28 systems of equations
☐ 7 equations and inequalities	☐ 18 probability	☐ 29 trigonometric functions
☐ 8 exponents and roots	☐ 19 proofs	☐ 30 trigonometric identities
☐ 9 functions	☐ 20 quadratic equations	other: ________________________
☐ 10 inductive reasoning	☐ 21 quadratic formula	other: ________________________
☐ 11 irrational numbers	☐ 22 rational numbers	other: ________________________

22. a. Which of the following do you use as your **main curriculum resource** in this class? *(Check one.)*

- ❑ one or more textbooks
- ❑ one or more published instructional programs that are not textbooks
- ❑ curriculum resources that are neither textbooks nor published instructional programs
- ❑ other: ____

b. What mathematics textbook, published instructional program, or curriculum resource do you use the most in this class?

Title ____

Publisher ___________________________________ Copyright Date (if known) _____________

23. If you teach more than one mathematics class, is your mathematics teaching in this class representative of your teaching in your other mathematics classes? *(Check one.)*

- ❑ Not applicable—this is the only mathematics class I teach.
- ❑ Yes, my teaching in this class is representative of all of my other mathematics classes.
- ❑ No, my teaching in this class is different than in all of my other mathematics classes.
- ❑ My teaching in this class is representative of *some* of my other mathematics classes.

24. Are there any special circumstances or unusual conditions related to the teaching of mathematics to this class (e.g., team teaching)? If so, please specify:

____

III. Recent Developments in Mathematics Education

25. Please indicate how familiar you are with each of the documents listed below. (We have included the publication dates after each document.) *(Circle one number for each document.)*

	Document	Have NOT heard of this	Have heard of or skimmed this, but it has not influenced my teaching	Have read much or all of this, but it has not influenced my teaching	Has influenced my teaching
a.	NCTM Curriculum and Evaluation Standards (1989)	1	2	3	4
b.	NCTM Standards 2000 (1998 discussion draft)	1	2	3	4
c.	California Mathematics Framework (1985)	1	2	3	4
d.	California Mathematics Framework (1992)	1	2	3	4
e.	California Mathematics Framework (1998)	1	2	3	4
f.	California Mathematics Program Advisory (1996)	1	2	3	4
g.	California Mathematics Content Standards adopted by the State Board (1998)	1	2	3	4
h.	Your local district mathematics content standards/curriculum guidelines	1	2	3	4

26. Indicate your opinion about each statement below. *(Circle one number on each line.)*

	Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a. Our district mathematics standards are aligned with the 1998 California Mathematics Content Standards.	1	2	3	4	9
b. Our district mathematics standards are aligned with the NCTM standards.	1	2	3	4	9
c. The principal of this school is well-informed about our district mathematics standards.	1	2	3	4	9
d. The principal of this school is well-informed about the 1998 California Mathematics Content Standards.	1	2	3	4	9
e. There is a school-wide effort to implement our district mathematics standards.	1	2	3	4	9
f. There is a school-wide effort to improve student mathematics achievement on the SAT-9.	1	2	3	4	9
g. Our district has provided workshops/ professional development based on our district mathematics standards.	1	2	3	4	9
h. Our district has provided workshops/ professional development based on the 1992 California Mathematics Framework.	1	2	3	4	9
i. Our district has provided or has plans to provide workshops/professional development based on the 1998 California Mathematics Content Standards.	1	2	3	4	9
j. Curriculum and instructional materials aligned with district mathematics standards are readily available for use in my teaching.	1	2	3	4	9
k. The NCTM standards have influenced my teaching for the better.	1	2	3	4	9
l. The 1992 California Mathematics Framework has influenced my teaching for the better.	1	2	3	4	9
m. The 1998 California Mathematics Content Standards are likely to influence my teaching for the better.	1	2	3	4	9

IV. Professional Development and Support

27. **Since January 1998,** *approximately* how many hours have you spent in **mathematics professional development**, and how many of these hours were required by your district? Include attendance at workshops, extension courses, professional meetings or conferences, and any other relevant experiences.

a. Estimated number of **total** math professional development hours: ______ hours

b. Estimated number of these hours **required by district**: ______ hours

28. **Since January 1998**, *approximately* how much time have you spent in professional development activities related to **each topic** listed below? For activities that covered more than one of the topics, split the time evenly among the topics covered. *(Circle one number on each line.)*

		None	Less than 4 hours	4–8 hours	1–3 days	More than 3 days
a.	Mathematics content	1	2	3	4	5
b.	Mathematics instructional techniques or strategies (e.g., cooperative learning, manipulatives, etc.)	1	2	3	4	5
c.	Use of particular mathematics curricula or curriculum materials (e.g., a particular textbook)	1	2	3	4	5
d.	Use of technology in mathematics instruction (e.g., calculators or computers)	1	2	3	4	5
e.	Mathematics standards (state and/or district) or framework	1	2	3	4	5
f.	Mathematics assessment/testing	1	2	3	4	5
g.	Other topics related to mathematics or to the teaching of mathematics (please specify): ___________________________	1	2	3	4	5

29. **Over the past five years**, which of the following have you participated in? *(Check all that apply.)*

- ❑ California Math Project
- ❑ Urban Systemic Initiative
- ❑ Local Systemic Initiative
- ❑ MathMatters
- ❑ Math Renaissance
- ❑ MRK12
- ❑ Woodrow Wilson Workshops
- ❑ Other: ___________________
- ❑ none

30. Indicate your opinion about each statement below. *(Circle one number on each line.)*

		Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly	Don't know
a.	Teachers in this school support one another in trying innovations in teaching mathematics.	1	2	3	4	9
b.	The school administration promotes innovations in mathematics education.	1	2	3	4	9
c.	My way of teaching mathematics is supported by school administrators.	1	2	3	4	9
d.	My way of teaching mathematics is supported by district personnel, including district mathematics specialists (if any).	1	2	3	4	9
e.	My way of teaching mathematics is supported by the parents of my students.	1	2	3	4	9
f.	I feel that I belong to a professional community of mathematics educators at a regional, state, or national level.	1	2	3	4	9
g.	I have some control over my mathematics teaching (e.g., selecting content, selecting materials, setting the pace, etc.).	1	2	3	4	9

31. About how often does each of the following occur at your school? *(Circle one number on each line.)*

		Never	A few times a year	Once or twice a month	Once or twice a week	Almost daily
a.	Teachers share ideas about mathematics instruction.	1	2	3	4	5
b.	Teachers observe one another teaching mathematics.	1	2	3	4	5
c.	Teachers work together to develop mathematics curriculum.	1	2	3	4	5
d.	Teachers work together to coordinate the mathematics content of different courses (e.g., across grade levels or across subject areas).	1	2	3	4	5
e.	A specialist in mathematics education (e.g., mentor teacher or district mathematics coordinator) works with teachers in this school.	1	2	3	4	5

V. Professional Background

32. Which of the following high school and college courses have you completed? Include both semester and quarter courses. *(Check all that apply.)*

High School Mathematics

- ❑ Algebra I
- ❑ Algebra II
- ❑ Geometry
- ❑ Trigonometry or Precalculus
- ❑ Calculus
- ❑ Other: ________________

College Mathematics

- ❑ Calculus (# of smstrs: _______)
- ❑ Linear algebra
- ❑ Modern algebra
- ❑ Discrete mathematics
- ❑ Real analysis
- ❑ History of mathematics
- ❑ College geometry
- ❑ Computers in mathematics
- ❑ Probability and statistics
- ❑ Other: ____________________

Mathematics Education

- ❑ Student teaching (mathematics)
- ❑ Mathematics teaching methods
- ❑ Instructional use of computers
- ❑ Other: ______________________

33. Describe the subject area of your degree(s). *(Check one in each column.)*

Bachelor's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: __________________

Master's Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: __________________

Doctoral Degree

- ❑ none
- ❑ mathematics
- ❑ mathematics education
- ❑ education
- ❑ humanities
- ❑ social sciences
- ❑ sciences
- ❑ other: __________________

34. Describe your teaching credential(s).

a. Which of the following teaching credential(s) do you have? *(Check all that apply.)*

- ❑ multiple subject teaching credential
- ❑ general or standard elementary credential
- ❑ emergency multiple subject teaching permit
- ❑ emergency teaching permit in mathematics
- ❑ internship credential (multiple subject)
- ❑ internship credential in mathematics
- ❑ credential waiver
- ❑ single subject credential in mathematics
- ❑ single subject credential *not* in mathematics
- ❑ standard secondary credential in mathematics
- ❑ standard secondary credential *not* in mathematics
- ❑ general secondary credential
- ❑ other: ________________________________

b. Do you have a supplementary authorization in mathematics? ❑ yes ❑ no

35. Including this year, how many years have you taught full-time in a regular teaching position…

a. total? _____ b. in this district? _____ c. in this school? _____

VI. Teacher Demographic Information

36. Are you: ❑ male ❑ female

37. Are you:

- ❑ African American (not of Hispanic origin)
- ❑ American Indian or Alaskan Native
- ❑ Asian or Pacific Islander
- ❑ Hispanic
- ❑ White (not of Hispanic origin)
- ❑ Other: _______________________

VII. Additional Comments (Optional)

38. What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?

____

____

____

____

39. What are the biggest obstacles to your mathematics teaching?

____

____

____

____

40. If there are specific state, district, or school policies that have **helped** your mathematics teaching, please describe.

____

____

____

____

41. If there are specific state, district, or school policies that have **hindered** your mathematics teaching, please describe.

____

____

____

____

42. Do you have additional comments about any topic addressed by this questionnaire or any topic you think should have been included in this questionnaire?

____

____

____

____

Thank you for participating in this survey!

Appendix C

Profiles of Selected Top-Quartile Classes

Fourth-Grade Observed Top-Quartile Classes

Eighth-Grade Observed Top-Quartile Classes

Fourth-Grade Observed Top-Quartile Classes: Profile #1

Classroom Profile

School 1999 API Ranking: 1 (statewide); 2 (similar schools)
Class Size (according to questionnaire): 29 fourth-grade students
Classroom Composition (according to STAR data): Of 25 test-takers, 32% African American, 68% Hispanic; 48% LEP, 92% Free/Reduced Lunch; 8% Sp. Ed.
Mathematics SAT-9 Average Scaled Scores: 594 in 1999, up from 547 in 1998

The lesson observed in this classroom focused on equivalent fractions and the reduction of fractions to their simplest form. During the 30 minutes of observation time, the teacher engaged in instruction with the class as a whole. She appeared confident with the material and fluent with the use of manipulatives, which she modeled constantly to demonstrate how fractions "look" and to help students make sense of this mathematical concept.

The primary level of discourse in this classroom was between student and teacher. Class participation was initiated and maintained by the teacher calling on a variety of students to solve problems, both teacher-generated and textbook-derived. Individual students were asked to compute a problem on the board while the other students were working individually in their seats. After asking the student at the board to explain his/her answer, the teacher surveyed the class by asking students to raise their hands if they thought the problem on the board was solved correctly. If the answer was correct, the entire class applauded.

At times, the teacher would ask students individually to provide short answers to questions such as, "When you cut something in half, you divide by what?" Some wait time was used; however, if a student did not respond fairly quickly, the teacher would ask another student. One real-world application was used, in making a reference to a pie and eating portions of it.

During the lesson, the teacher circulated throughout the room to observe each student's work. Students were attentive and focused on the lesson.

In this classroom where approximately half of the students are LEP, the teacher used English when speaking with the class as a whole. The use of mathematical terminology was emphasized: the teacher used math terms frequently while posing questions to students, and students were asked to use the terminology in their explanation of how they arrived at an answer. The use of synonyms to describe concepts and the repetition of clear and concise terms were methods used by this teacher to address remedial needs. The teacher also "checked in" with particular students to see if they had questions or were unclear about something. During the interview, the teacher noted that the manipulatives are helpful in overcoming language barriers, and that she works one-on-one with two students who have very limited English skills.

Fourth-Grade Observed Top-Quartile Classes: Profile #2

Classroom Profile

School 1999 API Ranking: 4 (statewide); 10 (similar schools)
Class Size (according to questionnaire): 31 fourth-grade students
Classroom Composition (according to STAR data): Of 23 test-takers, 100% Hispanic; 91.3% LEP, 100% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 631 in 1999, up from 571 in 1998

The lesson observed in this classroom dealt with computational exercises, with a focus on the conversion of measurements. The teacher seemed to have a good understanding of and confidence in mathematics. For the first quarter of the lesson (25 minutes), the students worked on problems individually. During this time, the teacher circulated among the students. Following this was a whole-class review of the problems using an overhead projector (another 25 minutes of the lesson), during which the teacher questioned students about methods used to solve the problems.

The teacher then proceeded to provide instruction in measurement conversion, for another 20 minutes, through reviewing equations and applying them in sample problems which involved real-world examples (i.e., converting Shaquille O'Neil's height from feet to inches, and a baby's height from inches to feet). She then introduced, gave instructions, and did a demonstration for an activity where students were to figure out their own height in inches. For 15 minutes, students worked in pairs using rulers to measure each others' heights in feet and inches and then convert their height into inches. Following this, for 15 minutes, the teacher guided a whole-class graphing activity using data derived from the student measurements to create a histogram.

The focus of classroom discourse was on getting the right answers. There were some instances where some sense was being made of the mathematical concepts. In the second component of the lesson, the teacher exhibited equitable treatment for all segments of the class (e.g., gender, language ability, ethnicity) and provided students with ample wait time when they were called upon to respond to questions. To encourage all students to focus on the problems, while also providing LEP students the opportunity to hear and simultaneously see the problems, the teacher had students read the problems on the board aloud before addressing how they solved them. In addition, students were allowed to interpret for each other.

Assessment took place when the teacher interacted with students individually to monitor their understanding of a problem, and when she posed questions to students while reviewing their work.

The students in this classroom were very well behaved, and most seemed engaged and on-task. When asked in a follow-up interview to attribute the reasons for her students' success on the SAT-9, the teacher replied:

> *I really believe that once you've introduced a new concept in math, whether it be addition or subtraction, you can't just introduce it, work on it for a couple of weeks, and expect the children to have acquired the knowledge… It's not possible for them—they need time to practice. So, I essentially begin with addition, and begin to build. So, once I have completed addition, and move on to subtraction, I'll have subtraction problems daily, but I also have addition-subtraction. So it's like building a house. I lay the foundation, and I don't take away that foundation, I begin to build on top of that foundation. We never take away anything. So math gets progressively longer as the year goes on, because there's a lot more to do…. I never let go of a concept that has been taught prior to the new concept. And so by the end, they feel so comfortable, and they know exactly what to do, in every circumstance, because they've had months to practice…. I never stop reviewing—it's like a daily thing.*

Fourth-Grade Observed Top-Quartile Classes: Profile #3

Classroom Profile

School 1999 API Ranking: 4 (statewide); 7 (similar schools)

Class Size (according to questionnaire): 28 fourth-grade students

Classroom Composition (according to STAR data): Of 24 test-takers, 100% Asian; 50% LEP, 16.7% GATE, 87.5% Free/Reduced Lunch

Mathematics SAT-9 Average Scaled Scores: 658 in 1999, up from 629 in 1998

During this classroom observation, the teacher began the lesson with 10 minutes' worth of teacher-directed warm-up exercises involving number "puzzles." In the first one, the teacher wrote "4-1=5-1=6-1=7-1=8" on the board and asked, "Is this true?" He then related the puzzle to the number of sides of various polygons that would be generated if a corner were to be cut off. For the second exercise, the teacher asked, "If we cut a cake three times, what is the greatest number of pieces you can get? Imagine." In response, a few students went up to the board to draw diagrams producing 6 "pieces" and then 8 "pieces."

Following these puzzles, the teacher used the board and spent three minutes modeling how to solve equations involving fractions. (As the teacher sat on a stool, several students were unable to see the board because they were blocked by the teacher's body.) He then involved students in an interactive activity involving fractions, where students holding fraction cards were asked to pair up with fellow students holding a card with the same value, and then pair up with other fellow students to add up to 1. When students made mistakes, the teacher probed to a limited extent. About 3/4 of the students participated in this activity at first, during which time those who remained seated seemed to pay attention but the teacher did not involve them. The teacher brought up to the board one group that was having difficulty, and asked one student if he knew why 1/3 + 1/3 + 2/6 = 1. When the student replied "no," the teacher said that he would talk with him later. To address the dilemma that one group of students had refrained from participating in the activity, the teacher asked the group to come to the front of the room so that other students could help them do the activity. When the two groups changed places, those who returned to their seats spent the time socializing.

The teacher then proceeded to model and review some problem-solving techniques on the board, which included drawing pictures and reviewing the meaning of the symbols for "more than" and "less than." Students were then given a worksheet that involved comparing fractions and recognizing equivalent fractions. Most students began working on the worksheet. During this time, the teacher brought a student up to the board and showed him how to solve a problem, explaining the concepts in Chinese.

The students did not ask questions during the lesson. The discourse in this classroom was limited to the teacher asking closed-ended questions at several points during the lesson. The students were all extremely well-behaved.

Fourth-Grade Observed Top-Quartile Classes: Profile #4

Classroom Profile

School 1999 API Ranking: 8 (statewide); 10 (similar schools)
Class Size (according to questionnaire): 31 students total; 15 fourth-grade students (4/5 combo)
Classroom Composition (according to STAR data): Of 13 fourth-grade test-takers, 7.7% Hispanic, 92.3% white; 23.1% Free/Reduced Lunch; 7.7% Sp. Ed.
Mathematics SAT-9 Average Scaled Scores: 664 in 1999, up from 624 in 1998

At the beginning of this observation, the class was starting the group lesson after spending 30 minutes doing their daily *Excel* worksheet. The lesson began as a whole-class discussion which focused on percentages and used about 1/3 (17 minutes) of the observation time. The purpose of the lesson was for students to gain a better understanding of what fractional parts look like. The teacher first elicited ideas about how to find the area of a rectangle without counting the boxes inside. This led to a discussion of how one might shade a percentage of the box. The teacher called on many students during the discussion in an attempt to determine their level of understanding prior to the activity. When questions were posed, many students were allowed to explain their reasoning, and the teacher often probed for clarity or deeper understanding. She made generous use of "wait time." The discussion introduced and included instructions for the activity that followed.

In the remainder of class time (33 minutes), students worked in pairs to draw different shapes and shade a percent of each one. Students were allowed to choose their own representations of percents. During this time, the teacher circulated throughout the room. Within and between groups, students discussed and shared ideas and explanations. The two LEP students in the class were paired together so they could work with the classroom aide.

Assessment was ongoing through the lesson. The teacher called on many students during the discussion, and during the activity she visited each group and monitored understanding, asking students to explain their thinking. Students were asked to reflect on what they learned: as homework, students were to describe in their journal what they know about size and percent. The class was well-behaved and respectful.

During the interview, the applicability and relevancy of the lesson became apparent. The teacher explained that the students had been doing math surveys and will need to graph their results, and she feels they will be able to interpret their results with more understanding if they have a clear conceptual understanding of fractions and percent.

Eighth-Grade Observed Top-Quartile Classes: Profile #1

Classroom Profile

School 1999 API Ranking: 7 (statewide); 6 (similar schools)
Class Size (according to questionnaire): 36 eighth-grade students
Classroom Composition (according to STAR data): Of 31 test-takers, 9.7% African American, 12.9% Asian, 22.6% Hispanic, 51.6% white; 19.4% LEP, 19.4% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 689 in 1999, up from 659 in 1998
Course: Math 8

The purpose of the lesson observed was to extend the concept of combining like terms when adding polynomials. This included checking homework for the first l4 minutes of class. After the homework review was finished, a worksheet was handed out and the teacher modeled several problems using the overhead projector. He told those who understood to continue alone or with a partner while he continued to model more problems. The organization of the class remained the same throughout the period: the teacher remained at the overhead and demonstrated problems while the students worked at their desks. The teacher encouraged students to draw models to simplify the problems but there was no dialogue around the models. Most of the work was practice of a procedure.

The teacher monitored student understanding throughout the lesson by asking individual students to talk him through a problem or by asking for a show of hands from those who either did or did not understand. He did not probe for students to explain their thinking but asked questions that elicited simple responses (e.g., "Which one should I do?" "What is the answer?")

The teacher was very organized and his expectations were very clear. The students seemed very comfortable with the class—even those who were struggling.

Eighth-Grade Observed Top-Quartile Classes: Profile #2

Classroom Profile

School 1999 API Ranking: 3 (statewide); 4 (similar schools)
Class Size (according to questionnaire): 28 eighth-grade students
Classroom Composition (according to STAR data): Of 23 test-takers, 26.1% African American, 39.1% Hispanic, 8.7% white, 26.1% other; 4.4% LEP, 21.8% GATE, 56.5% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 690 in 1999, up from 676 in 1998
Course: Integrated Math 1

The lesson observed in this classroom focused on building student understanding of factoring binomial expressions.

This teacher-guided, demonstration lesson built upon students' previous work with solving algebraic equations. With the use of Algebra tiles, students connected the abstract distributive property to the concrete by relating the dimensions of the rectangle formed with Algebra tiles to the area of the entire rectangle. Following some vocabulary review, the class used the tiles to "work backwards" to find common factors in the area of the rectangle to come up with the dimensions of the rectangle. Students extended this process to factor more complex binomial expressions.

The class began with a five-problem warm-up displayed on the overhead. The students worked on the problems and then the teacher explained the solutions to the problems using traditional algebraic algorithms.

Next a transparency was used to display the answers to the previous day's assignment. The teacher responded to questions and explained procedures. At one point, a student corrected an error the teacher made and was rewarded with a piece of candy.

The teacher then reviewed how Algebra tiles can be used to find areas (the distributive property) and segued into how the tiles can be used to factor (undo the distributive property). The teacher provided examples of expressions and asked for common factors. She provided one factor and asked students to find the others. Students were engaged as they worked on these examples—some worked independently and asked for harder problems while others clearly needed the assistance being provided by the teacher.

At the end of the period, the teacher used the previous day's homework as the base for a short quiz. She put the numbers for five of the homework problems on the board and asked students to copy their solutions to these five problems on a separate sheet of paper.

The teacher seemed both confident and competent in her teaching, using terminology such as "numerical coefficients" accurately and describing processes correctly. She guided the students at a seemingly quick pace, asked questions that required short answers, and did not encourage discussions or student explanations (which may have been due to this being a review). The classroom discourse was primarily teacher directed.

Eighth-Grade Observed Top-Quartile Classes: Profile #3

Classroom Profile

School 1999 API Ranking: 3 (statewide); 3 (similar schools)
Class Size (according to questionnaire): 34 eighth-grade students
Classroom Composition (according to STAR data): Of 27 test-takers, 100% Hispanic; 96.3% LEP, 81.5% Free/Reduced Lunch
Mathematics SAT-9 Average Scaled Scores: 650 in 1999, up from 628 in 1998
Course: 8^{th} Grade Math Bilingual

The purpose of the lesson observed was to introduce students to the use of tree diagrams in solving probability problems.

At the beginning of the period, the students worked individually on warm-up problems while the teacher moved around the room checking homework and talking with students about individual problems. The warm-up problems involved supplying the missing measures of angles and sides in right triangles when the length of two sides was given. When the warm-up problems were completed, the class discussed them as a whole.

A brief presentation by the teacher on tree diagrams preceded the main class activity. In the remainder of the class the students worked through two extensive examples of tree diagrams: one involved the various combinations of three different types of dolls and the other had to do with a three-color spinner and a coin. For each example, the students constructed the tree diagram by starting as a class and then finishing it individually. They then answered several questions about probabilities based on the diagram, such as "What is the probability of spinning red and flipping heads?" Some students used calculators.

Throughout the activity, the teacher assessed student understanding by questioning students and listening carefully to their answers. When students provided an incorrect answer, the teacher probed for understanding and led the students to the correct answer. Later on, when one student said he didn't understand something, the teacher provided an explanation.

The students appeared to be comfortable answering questions, discussing answers, correcting each other, and asking questions. The entire class was conducted in Spanish. The teacher was confident and inspired confidence on the part of her students. During the interview she said, "Anybody is able to do mathematics, as long as they put the effort in."

Eighth-Grade Observed Top-Quartile Classes: Profile #4

Classroom Profile

School 1999 API Ranking: 6 (statewide); 6 (similar schools)

Class Size (according to questionnaire): 35 students total; 23 eighth-grade students (7/8 combo)

Classroom Composition (according to STAR data): Of 24 eighth-grade test-takers, 12.5% Asian, 41.7% Hispanic, 33.3% white, 12.5% other; 16.7% GATE, 45.8% Free/Reduced Lunch

Mathematics SAT-9 Average Scaled Scores: 699 in 1999, up from 672 in 1998

Course: Algebra Topics

The primary purpose of the lesson observed was for students to learn that there may be more than one way to approach a problem and that for some problems there may be multiple solutions. The specific focus was on the use of diagrams as a tool for solving problems.

The first few minutes of the period were spent on taking roll and preparing for the homework review. Students checked their homework problems as the teacher provided the correct answers. Whenever a student had a question, the teacher would work the problem using the overhead projector; other students would assist the teacher as she solved the problem. One problem involved pattern recognition and estimation as a way to save time in finding the correct answer. The teacher had students guess a number she had picked to show how high and low estimations were used to inform subsequent estimations. She likened the estimation process to the game show "The Price is Right." The homework review lasted 20 minutes.

The next activity was a game where students formed four groups of 6 to 8 students each. Each person was to join hands with another non-adjacent person in the group. When all connections were completed, the group was to untangle itself to form a circle. When the game ended, the teacher explained that how quickly a group got untangled was a function of how the arms were joined and not a function of how smart they were. She also noted that in each group someone usually emerges as a leader.

Following the group-building exercise, the class focus was on solving story problems from the textbook. The teacher, with student input, demonstrated how to approach some of the problems using the overhead projector. These problems had more than one possible solution and involved the use of diagrams. Then students worked individually on the remainder of the problems as homework.

The teacher appeared confident and knowledgeable about the material. She could easily explain mathematical concepts in a variety of ways to help students understand.

In terms of making sense of mathematics, the teacher was good at providing alternative examples and real world applications for students, yet never required students to come up with their own examples.

When asked in a follow-up interview to attribute the reasons for the success of this class, the teacher commented that previously, the students had not been challenged, having been in classes that had not been “stretching their abilities.” She also mentioned her 30 years of teaching experience and the inclusion on the SAT-9 of many of the topics covered in the class. The school principal, when asked the same question, discussed efforts made by the mathematics department as a whole:

> *The year before, the students [in the school] didn’t do well on computation and context. As a department, the math teachers got together, and put more emphasis on computation as well as the other concepts, and it paid off…We gained about 13 percentile points in math. So, it was just working with the students, taking them from where they are, and moving from that point to get them to succeed. It was a schoolwide phenomenon.*

Indeed, the other class observed in this school also fell into the top achievement quartile.

Eighth-Grade Observed Top-Quartile Classes: Profile #5

Classroom Profile

School 1999 API Ranking: 10 (statewide); 5 (similar schools)
Class Size (according to questionnaire): 32 students total; 22 eighth-grade students (7/8 combo)
Classroom Composition (according to STAR data): Of 22 eighth-grade test-takers, 45.5% Asian, 13.6% Hispanic, 36.4% white; 40.9% GATE
Mathematics SAT-9 Average Scaled Scores: 751 in 1999, up from 747 in 1998
Course: Integrated Math 1

The lesson began with a 13-minute warm-up exercise that connected the concept of volume to the story of *Gulliver's Travels.* The students worked individually and then the entire class reviewed the problems. Next, the teacher asked if there were any questions about the homework from the previous night. There were none, so the next homework assignment was discussed for a few minutes.

The remainder of the period focused on building a conceptual understanding of volume and the relative volumes of various three-dimensional shapes (prism, cone, and pyramid). A review of the names of the shapes took place and then the students were asked to guess how many of the cones could fit into a cylinder (with bases of the same diameter). Two student volunteers then filled the cylinder and cone with water to determine the relative volumes of each container. Then the class discussed the relative volume of different sized-cones. This activity involved work on two problems displayed on a transparency: one concerning two cones with the same size base but one of twice the height; the other was about two cones having the same height but one having a base with half the radius of the other.

Next the students worked in groups of four where each student had a specific role. They concentrated on a problem from the textbook about the relationship in volume between a pyramid and a rectangular prism where they needed to construct each type of shape using stiff paper, scissors, and tape and use rice to compare volumes. Most of the students were engaged in the activity and interacted collaboratively within their groups and with other groups. During this time, the teacher circulated, monitoring the activity and addressing student questions. The students did not finish the exercise, largely due to an error that nearly all of the groups made in constructing their shapes. At the end of the class, students put their materials away and were told they would talk about what went wrong tomorrow. The class ended with a brief discussion of question, "What would you *expect* for the volume of the pyramid as compared to the prism?"

Classroom discourse focused on making sense of mathematics and the students were invited to hypothesize about answers to problems.

Appendix D

Findings from the Grade 10 Exploratory Study

Preliminary Findings

Major Issues

Recommendations

Preliminary Findings

The sample used in this exploratory study was very small—four teachers and two school sites within a single district—and thus the data cannot be generalized at all to the larger population of high school mathematics teachers. Nonetheless it is interesting to note several themes that emerged through interviews of the teachers, their department chairs, and principals:

- Articulation is an important issue for high school mathematics teachers. Teachers are concerned with vertical articulation, such as how middle schools prepare students for success in high school mathematics and how content flows from course to course within the high school program. Teachers' decisions about pacing and emphasis of topics are also affected by horizontal articulation stemming from departmental agreements about scope and sequence of individual courses.
- A great deal of collaborative planning and sharing of materials exists within mathematics departments.
- Professional development opportunities are valued as long as they do not take teachers away from their classrooms; the previously funded staff development days are missed.
- Teachers' practices have been greatly influenced by national forces such as the NCTM Standards, listserves for calculus teachers, and the online Math Forum at Swarthmore.
- High school teachers are familiar with the pressures of several accountability forces: WASC accreditation, college entrance requirements, the mathematics portion of the Scholastic Aptitude Test (SAT), Golden State Exams, the state's STAR program and SAT-9, the upcoming high school exit exam, and teachers of the next course.
- The ninth-grade class size reduction policy has had a positive impact on Algebra classes.
- High school mathematics teachers are quite articulate when describing how they decide what they are going to teach in a course and how they determine the emphasis to be placed on particular content or processes.

Major Issues

A major issue for conducting a study at the high school level is whether to focus on the grade level, such as tenth grade, or on a single course. If the focus were to be on tenth grade, then the study would provide a snapshot of the various mathematics courses in which tenth grade students enroll and the data from the mathematics portion of the tenth-grade (base)

SAT-9 could be used. In such a study, however, specific teacher attribution for student achievement would not be possible because the test does not reflect the curriculum of individual courses. If the focus of the study were to be on a course in which many tenth-grade students are enrolled, then data concerning teacher practice, materials, and policy influences are easier to compare. Also, student data from the augmented portion of STAR might be useful for relating student achievement to instruction. However, the augmented tests are not norm-referenced, and the (base) SAT-9 would still not be useful for correlating instructional practice to achievement.

Another issue for a grade 10 study involves the growing number of high schools that use some variation of block scheduling and whether to include or exclude them from the sample. In schools where an entire yearlong course is completed in one semester, a number of issues arise concerning teacher practice and timing of the SAT-9. In such a school, some students would have completed the entire geometry course before taking the SAT-9 in spring and others would only be halfway through the course. In such a school, teacher practice may be quite different than in schools with more traditional yearlong courses.

Recommendations

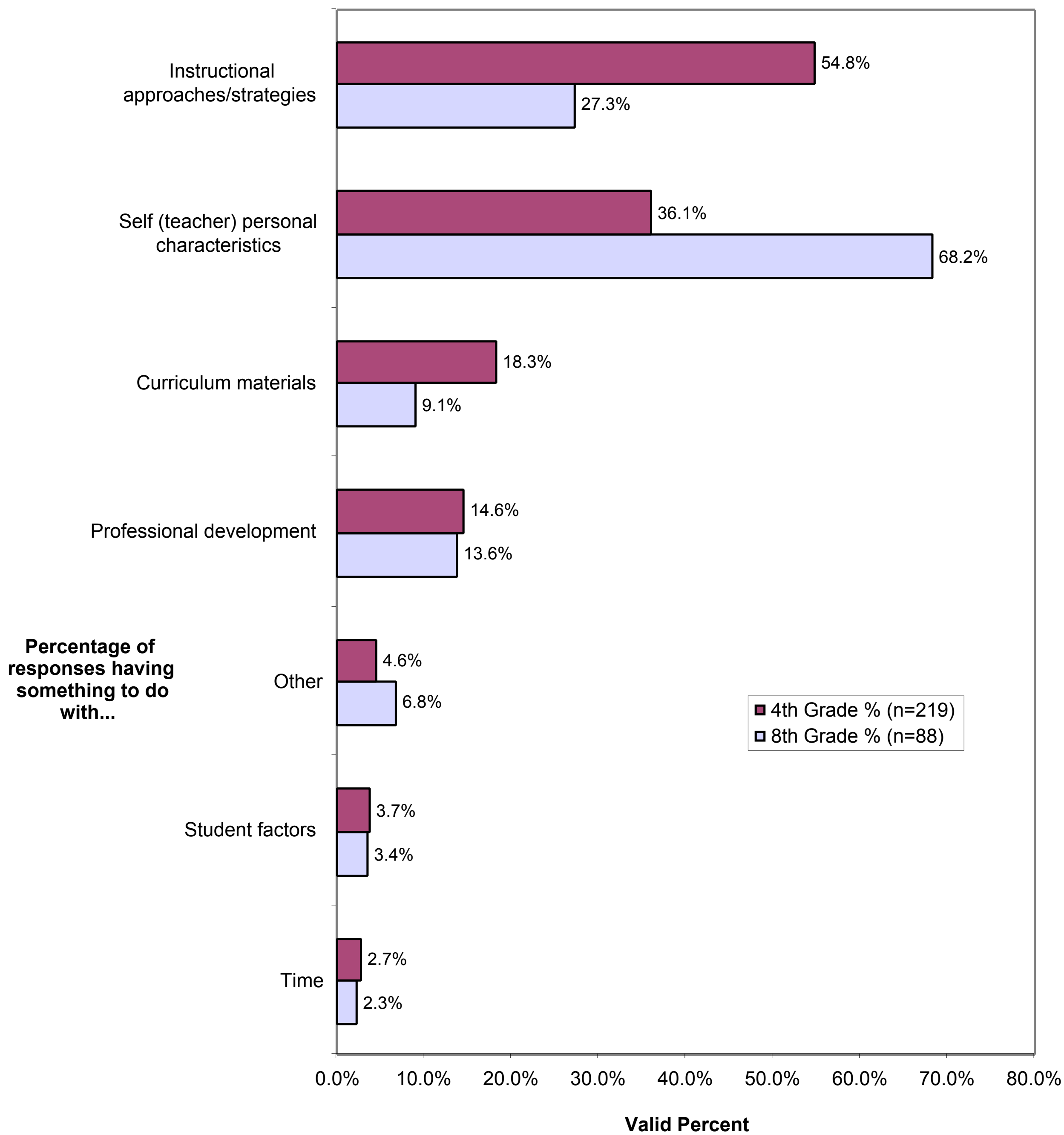
As previously discussed, several issues are involved in a study that uses student achievement data from the SAT-9 to look at the relationship between student achievement in mathematics and teacher practice, instructional materials, and policy at the high school level. One possibility for dealing with these issues is to consider a study that focuses on entire mathematics departments instead of individual teachers. A mail survey similar to that used in the fourth- and eighth-grade study could be conducted using a revised teacher survey instrument. A subset of schools would be chosen for further data collection through interviews and classroom observations that would help form a more complete profile of mathematics departments. Student achievement scores in mathematics for ninth- through twelfth-grade students could then be analyzed in relation to the influence of the mathematics department as an entity.

(This page intentionally left blank.)

Appendix E

Additional Figures

Figure E1
Responses to "What one or two things do you believe contribute the most to the effectiveness of your mathematics teaching?"[1]



[1] On the eighth-grade questionnaire, the question was, "What one or two things do you believe contribute the most to your effectiveness as a mathematics teacher?"

Figure E2
Responses to "What are the biggest obstacles to your mathematics teaching?"

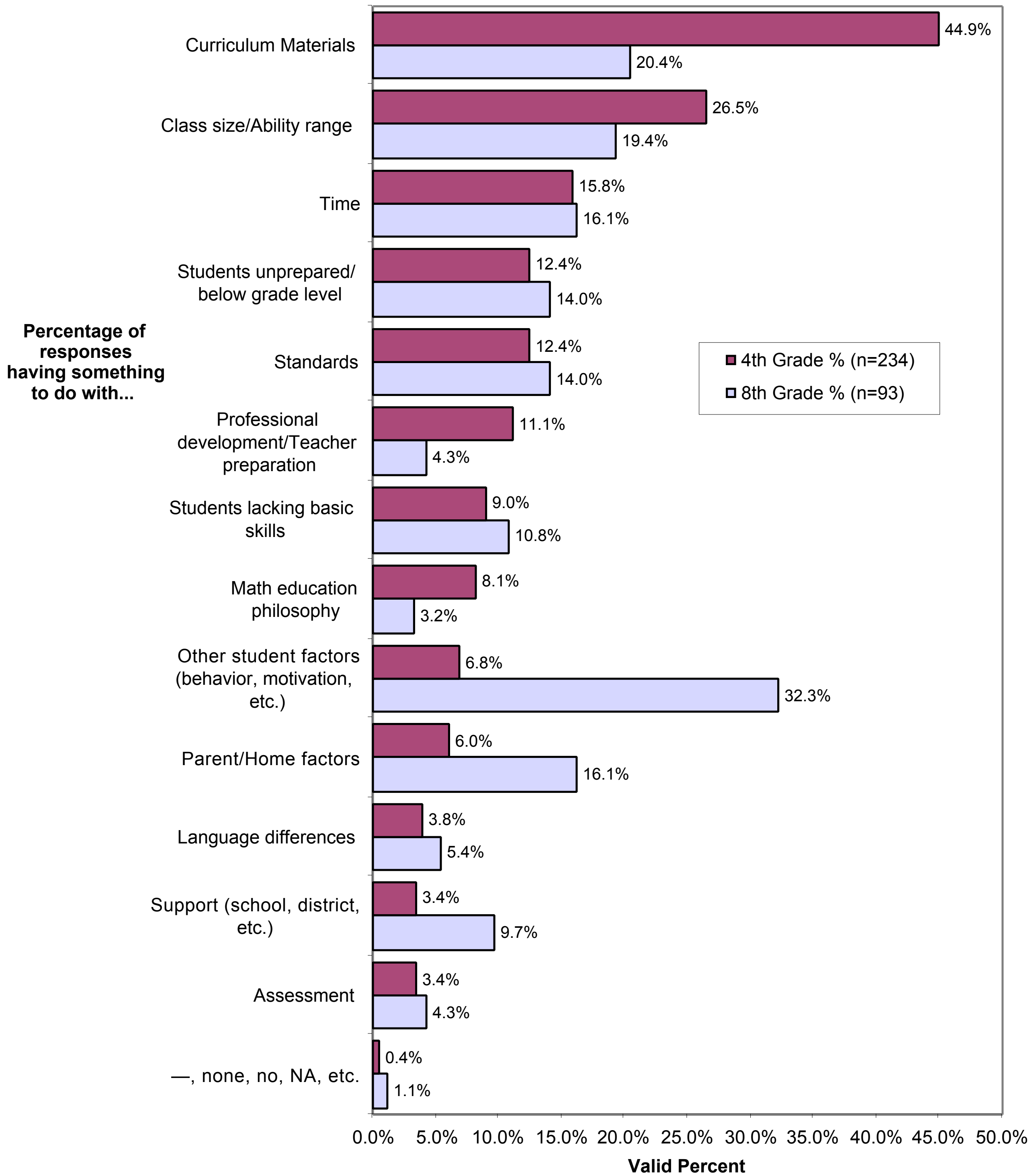


Figure E3
Responses to "If there are specific state, district, or school policies that have *helped* your mathematics teaching, please describe"

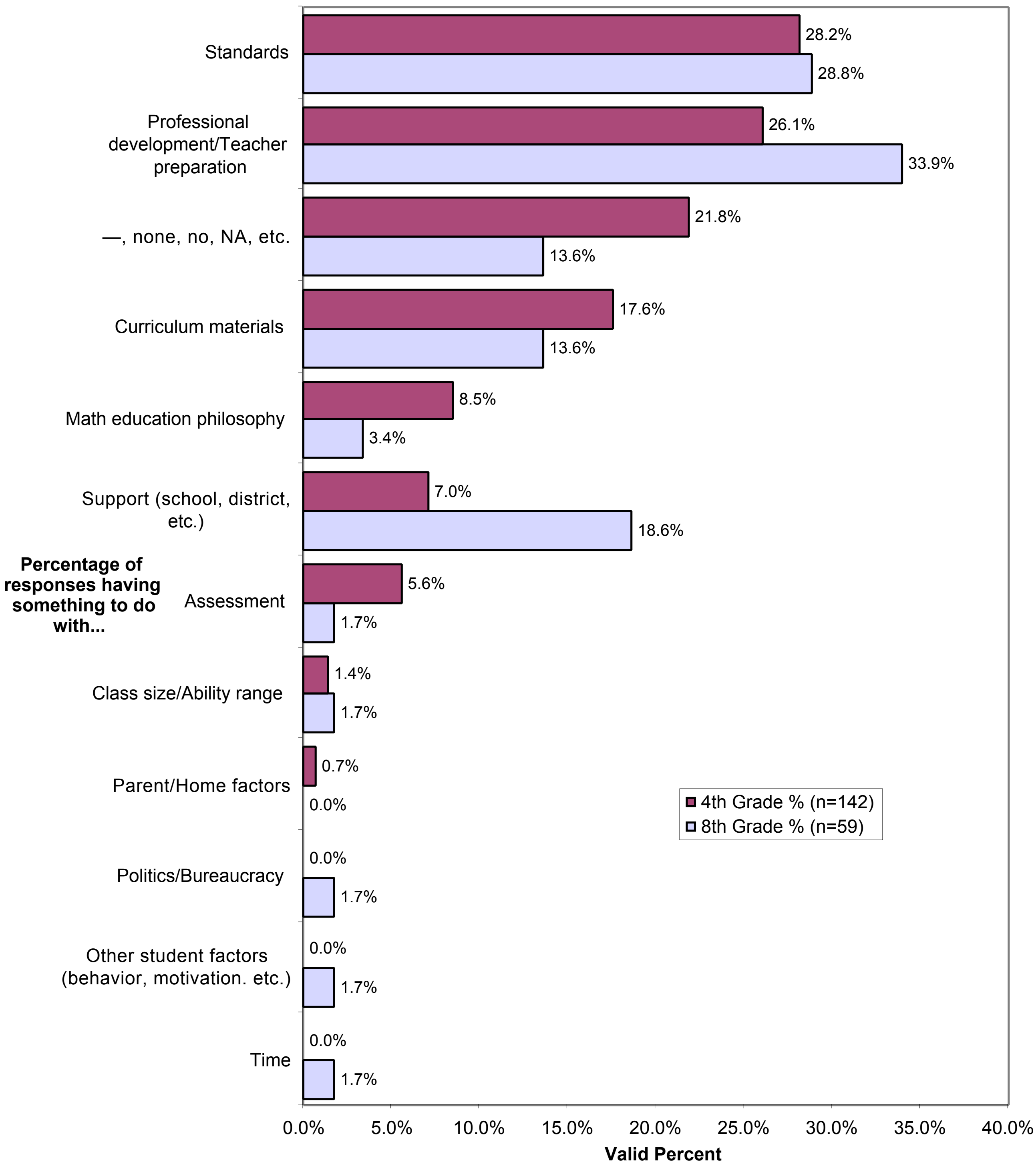
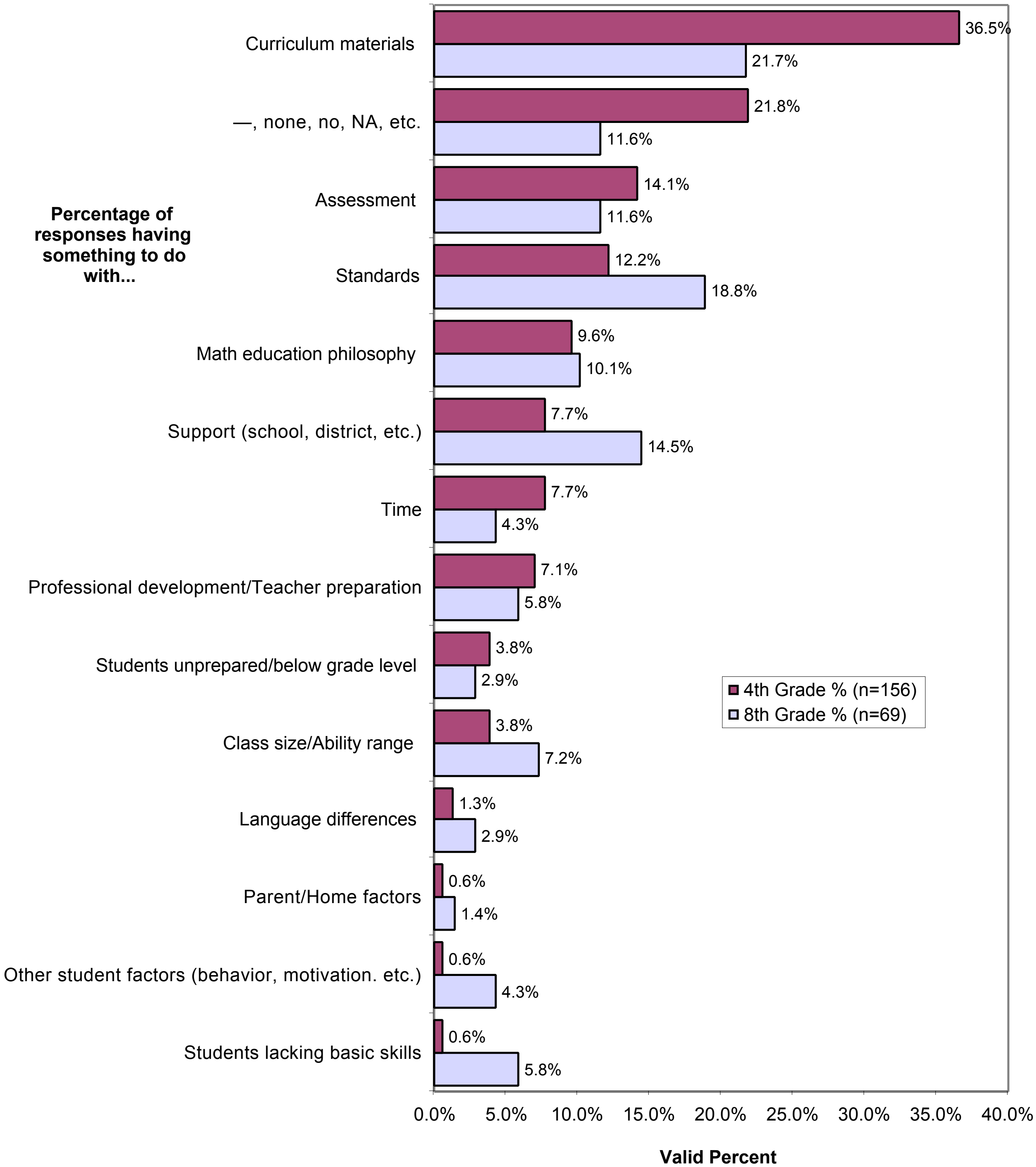


Figure E4
Responses to "If there are specific state, district, or school policies that have *hindered* your mathematics teaching, please describe"



(This page intentionally left blank.)