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.*

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[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

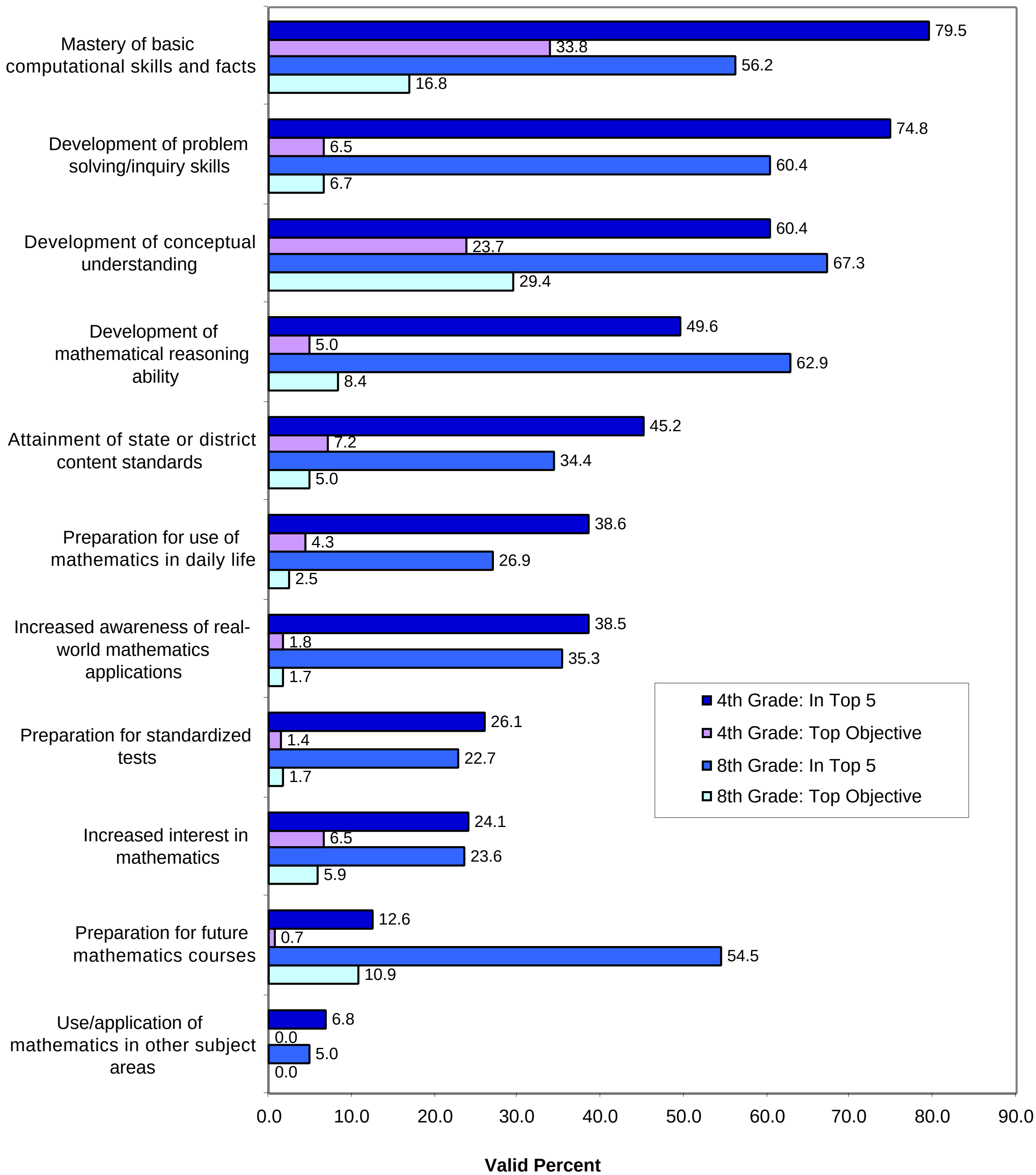
[11] There were also other large categories of responses to the effectiveness question, such as materials and professional development. (See Figure E1 in Appendix E.) These will be discussed in subsequent chapters. Instructional approach and teacher personal characteristics, were, however, the most commonly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

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