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ABSTRACT

This publication synthesizes recent research about standards-based education. It is intended to inform efforts to improve low-performing schools and create or sustain standards- based, high-performing learning communities. The five chapters are: (1) "Literacy for All Children" (aspects of literacy, reading, writing, and exemplary literacy teachers and their schools); (2) "Mathematics Standards in Classroom Practice" (mathematics standards, the status of mathematics standards across the states, mathematics standards in classrooms, characteristics of an effective standards-based curriculum, characteristics of effective standards-based mathematics instruction, and diversity and standards-based classroom practices); (3) "Teacher Learning for Standards-Based Education" (teacher knowledge and beliefs for ambitious standards-based reform, teacher learning for effective-standards-based education, effective professional development for standards-based education, accountability in support of teacher learning, organizational supports for effective teacher learning, and teacher learning in high-performing, high-needs schools); (4) "Organizational Policies and Practices Supporting Ambitious Learning for All Students" (e.g., the system context, the importance of local organizational capacity, organizational vision, and leadership and distributed leadership); and (5) "Summary of the Status of Research" (effective standards-based classroom practices and professional development and organizational capacity). An annotated bibliography is included. (Chapters contain references.) (SM)

Standards in Classroom Practice
Research Synthesis

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INTRODUCTION

by
Nancy M. Sanders

According to *Education Week*'s annual review of education, *Quality Counts* (2001), all fifty states have established policies about standards, although Iowa requires only local district standards. All states have student-testing programs in literacy and mathematics, and the state tests are increasingly being used to hold students and educators accountable. The emphasis on standards and accountability is reflected in a great deal of research and a number of major reports that are difficult to aggregate. Although policies about standards have been widely adopted across the country, the policies and standards differ substantially, and their implementation in classrooms varies within and across states (see e.g., Massel, Kirst, & Hoppe, 1997).

The primary purpose of this synthesis is to organize and describe recent research and reports about standards-based education practice. The synthesis is intended to inform efforts to improve low-performing schools and create or sustain standards-based, high-performing learning communities. For this synthesis, we targeted research studies published within the last five or six years. Key reports published earlier were included as necessary to provide a context for more current work and findings. With regard to literacy and mathematics, the examination of literature focuses primarily on studies of effective instruction and exemplary teachers. The chapter on teacher learning includes key studies about characteristics of effective professional development and their relationship to teacher and student learning. Finally, the chapter on organizational policies and practices includes a review of two strands of research related to capacity — capacity for improving students' achievement and organizational capacity for changing classroom practice in ways that are consistent with standards as high expectations for all students. Where possible, findings from studies of high-performing, high-needs schools were included.

The chapters address four major questions about standards-based education practice:

- What classroom practices enable all students to achieve high literacy standards?
- What classroom practices enable all students to achieve high mathematics standards?
- What knowledge, skills, and dispositions do teachers need to ensure that all students achieve standards — and how do they gain this knowledge?
- What organizational capacities are needed to use standards effectively in support of high-performing learning communities?

Each chapter outlines critical issues, identifies major reports and research studies that offer guidance, and provides a synthesis of findings. The last chapter summarizes the findings.

WHICH STANDARDS?

Selecting the literature and reports to be reviewed necessitated specifying which standards were being addressed. The problem in deciding *which* standards is that there are so many kinds and forms

of standards discussed in the literature. The reform movement and widespread adoption of standards derive momentum from the simple idea that clear, measurable goals for what students should know and be able to do would improve education (e.g., National Council on Education Standards and Testing, 1992). Work by the National Council of Teachers of Mathematics (NCTM) over two decades defined and revised standards for mathematics curricula and provided a prototype for developing standards in other subjects and content areas. However, rapid adoption of standards policies and competition among content areas to be included in standards and state tests led to a proliferation of standards and benchmarks in all content areas.

Based on a detailed review of state standards and other documents about standards, Kendall and Marzano (1996) conclude:

> Although there is national dialogue on the development of standards, there is clearly not a consensus across groups as to what form "standards" should take or how they should be used. The result is that the character, scope, and level of detail provided in standards often vary significantly from one subject area to another. (p. 1)

Across 14 areas of study (e.g., mathematics, history, and English language arts) that have been the focus of standards development, the authors reviewed 137 standards documents created by major professional groups or other entities and identified 256 standards and 4,100 benchmarks. Added to that is the nearly infinite number of variations in wording and combinations of ideas in state standards (within and across content areas), resulting in an overwhelming array of learning goals for students.

Focus on High Standards in Literacy and Mathematics

This synthesis reviews literature that is grounded in conceptions of standards for all students that are specifically exemplified in literacy and mathematics. In the research, standards are variously referred to as high, challenging, or ambitious if they go beyond basic skills to include knowledge that is conceptual and higher order and skills to solve problems and apply knowledge to new situations.

The focus on literacy and mathematics reflects their central role in accountability systems and in the identification and improvement of low-performing schools. All states have standards and test students in these two areas, so the findings are relevant across differences in state policies. More important, achievement in literacy and mathematics is most often the basis for high-stakes accountability, so improvement in these areas is critical for low-performing schools. The National Educational Research Policy and Priorities Board's (1999) first "priority for research in education must be *high achievement for all students* [emphasis in original], and, within that domain, the initial emphasis should be on reading and mathematics achievement" (p. 11).

In Chapter 1, Apthorp synthesizes research offering guidance about classroom reading and writing practices. She notes that literacy standards describe literacy as the ability to learn to read, read to learn, read and write to get something done or for enjoyment, and read and write a wide variety of materials for various purposes and across different situations. Based on current understanding of how people learn, literacy includes awareness about the significant content and processes of reading and

writing; it also encompasses the ability to reflect on how people use language to communicate with and influence others.

Florian and Dean's description of mathematics standards in Chapter 2 is specific to the content of the discipline, requiring students to understand and appropriately use basic and advanced mathematics concepts and topics, such as numbers and operations (e.g., addition, multiplication), algebra, geometry, measurement, and how to represent and analyze data. The standards also require students to apply basic and advanced mathematics skills including computation, estimation, and mathematical reasoning. Students should use a variety of strategies to solve routine and nonroutine problems, explain their reasoning and methods, and understand mathematics as an emerging field of inquiry with connections to other content areas.

The literature reviewed in these two chapters is based on current knowledge in the fields of literacy and mathematics education and the most recent research about how people learn (e.g., Bransford, Brown, & Cocking, 1999). Darling-Hammond (1997) declares that "the fundamental premise of today's standards-based reform is that challenging education goals and contemporary knowledge about how people learn can be incorporated into practice when standards guide decisions about curriculum, teaching and assessment" (p. 212).

HIGH STANDARDS ARE FOR ALL STUDENTS

The achievement gap is a key target of the standards movement. A significant part of the motivation for standards comes from the accumulation of evidence that all students in this country are not expected to learn the same content or at the same levels, and that they receive different opportunities to learn. In particular, poor and minority students are not expected to achieve at high levels, especially in mathematics, and they are not expected to take higher level coursework in secondary schools. The NCTM standards for curriculum and teaching (NCTM, 1989, 1991, 2000) were designed explicitly to include all students in learning mathematics and to close the achievement gap.

The descriptions of literacy and mathematics standards provided in this synthesis represent high, but achievable, goals for all students. They raise expectations for traditionally low-performing students such as those in poverty, ethnic minorities, and students with special needs. O'Day and Smith (1993) were early, influential advocates for standards-based systemic reform to close the achievement gap for poor and minority students. As they note, the need for equity must be coupled with the call for raised expectations:

> At the heart of content-based systemic reform is the tenet that *all* children should have access to the new challenging content and, moreover, should be expected to learn this content to a high standard of performance. (p. 262) [italics in original]

O'Day and Smith argue that "simple justice dictates that skills and knowledge deemed *necessary* for basic citizenship and economic opportunity be available to all future citizens" (p. 263). This synthesis reviews research and makes recommendations for classroom practice that enable all students, especially high-needs students, to meet standards. High-needs students are those who enter

school needing additional support because of linguistic or cultural differences, disabilities, poverty, mobility, or other characteristics that affect learning.

STRUCTURE OF THE REPORT

Figure 1 illustrates the relationships among the chapters of this synthesis. The starting point is standards for student learning in literacy and mathematics. In Chapter 1, Helen Apthorp describes high standards in literacy and synthesizes the literature on classroom practices necessary for all students to become literate. Chapter 2, by Judy Florian and Ceri Dean, describes high standards in mathematics and synthesizes the literature on classroom practices necessary for all students to meet them. In order to carry out these kinds of practices in literacy and mathematics, research indicates that teachers must learn a great deal of content and pedagogy. In Chapter 3, Patricia Lauer synthesizes current research about how teachers can learn what they need to know and do to carry out the practices described in the first two chapters. Based on the complexity and challenge in helping teachers learn and carry out needed practices in classrooms, organizational capacity becomes a critical component in implementing standards. In Chapter 4, Ravay Snow-Renner describes the organizational capacity that is needed for teachers to carry out their work and for students to meet standards. The conclusions describe ambitious expectations for the adults in the education system who are responsible for ensuring that all students meet high learning goals.

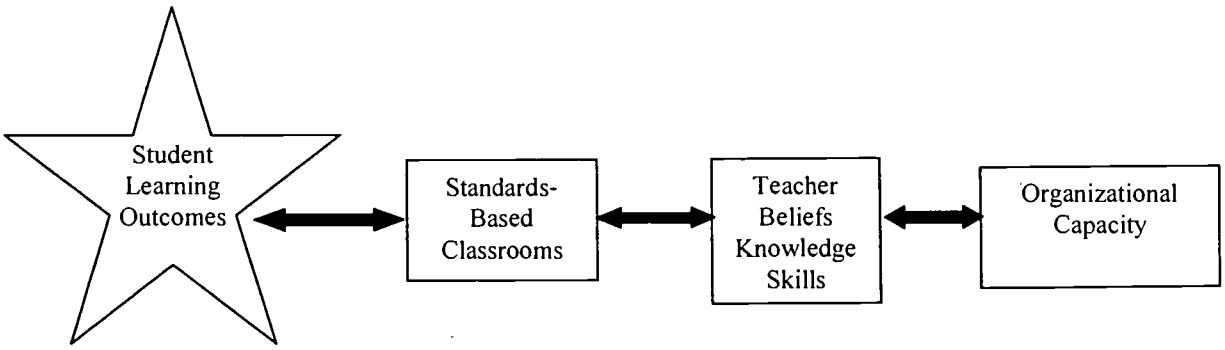

Figure 1. Relationship between the chapter topics.

Although there are some common themes in the literature reviewed in this synthesis, the findings are not always easy to implement in policy or practice. The challenges facing policymakers and practitioners are substantial. They must find creative ways to use standards to significantly improve low-performing schools and increase students' achievement. However, the guidance offered in this synthesis should help researchers, policymakers, and educators cope with some of the critical issues associated with implementing standards, particularly the complexity of the changes that are needed in classrooms and schools to ensure that all students meet high standards.

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CHAPTER 1

LITERACY FOR ALL CHILDREN: A SYNTHESIS OF RESEARCH AND PERSPECTIVES ON EFFECTIVE PRACTICES AND CLASSROOM CONDITIONS

by
Helen S. Apthorp

Ensuring that all students become effective users of language is a primary goal of American public education. We want students to be able to select their reading materials, talk about what they're reading, write and communicate ideas with confidence, and read textbooks and primary source materials with understanding. The evidence, however, suggests that this is not happening. Nearly 40 percent of fourth graders on the most recent National Assessment of Educational Progress (NAEP, 2001) did not demonstrate understanding of the overall meaning of what they read, scoring in the "below basic" range, the lowest of four ranges (advanced, proficient, basic, below basic). The most recent *Nation's Report Card* (Donahue, Finnegan, Lutkus, Allen, & Campbell, 2000), in fact, heightens concern about equal educational opportunity for all children. From 1992 to 2000, while the highest performing fourth-grade students (at the 75th percentile and above) made steady gains in reading, the lowest performing students (at the 10th percentile and below) lost ground, demonstrating lower and lower performance on the fourth-grade NAEP reading assessment.

Although the rhetoric behind standards reforms and accountability systems emphasizes higher achievement for all students, the reality is that students with high needs, related either to poverty, language, or disability, often are excluded. In general, students with high needs fail to meet proficiency levels on the schedules set by accountability systems at much higher rates than students without these characteristics.

Of particular concern is the plight of children from low socioeconomic (SES) homes. Researchers (Whitehurst & Lonigan, 1998) found that many of these children attended and benefited from high-quality early childhood programs, but then experienced a significant deceleration in their early reading performance when they entered first grade in a school primarily serving low-SES children. Moreover, gaps in reading achievement related to socio-economic differences continue to increase in the intermediate and higher grades (Chall, 1996; Snow, Barnes, Chandler, Goodman, & Hemphill, 1991). Trend data indicate that in American elementary schools since 1992, gaps in performance between whites and blacks and between whites and Hispanics have not changed. In 2000, NAEP fourth-grade reading scores for blacks, Hispanics, and American Indian students fell disproportionately below the 50th percentile, while the same scores for whites tended to fall above the 50th percentile (Phillips, 2001). It should be noted, however, that these results do *not* indicate that racial differences in any way explain achievement differences. In fact, differences in achievement related to race/ethnicity mask relationships between socioeconomic status and achievement. Of the fourth-grade students eligible for free/reduced-price lunch, 14 percent performed at or above proficiency in NAEP reading compared to 41 percent of students who were noneligible (Phillips, 2001).

The reality is that students with high needs often receive ineffective and inaccurate instruction and interact with poor quality and low quantities of literacy materials in their classrooms. For instance, studies (e.g., Duke, 2000) have found that the total number of books, and informational books in particular, is significantly lower in the first-grade classrooms of schools in low-SES neighborhoods compared to those in mid- to high-SES neighborhoods. Vocabulary assignments are often limited to copying sentences rather than learning terms and phrases at the deep level needed to ensure that students are able to recall them for future use (Valdes, 1998). Instruction usually involves only checking comprehension rather than demonstrating, explaining, and coaching how to read with comprehension (Snow et al., 1991). Another inequity is suggested in research on special test-preparation writing courses for students who previously failed state writing exams (Ketter & Pool, 2001). Ketter and Pool observed instructional aides denying students in these courses access to the full complement of strategies used by expert writers. Finally, individualizing the selection of reading material is rarely seen for students attending low-income schools (Snow et al., 1991); as a result, students rarely are exposed to the challenging and repeated reading across a variety of genres and topics that they need to become literate.

This chapter synthesizes research on what needs to happen in classrooms for all students to become literate. This synthesis describes research-based knowledge related to reading and writing. Although other competencies, such as listening and speaking, are important goals of English/language arts instruction, the primary focus of this chapter is on what needs to happen in classrooms for all students to achieve high standards in written language. First, literacy is defined according to standards documents and current research, and four core literacy standards are presented. Next, this chapter describes how to implement standards in classrooms. This is accomplished by synthesizing research on classroom practices for reading and writing, the two areas of literacy most often addressed in standards documents and state assessments.

In the area of reading, findings from two major national reports are reviewed. The first report is *Preventing Reading Difficulties in Young Children,* produced by the National Research Council (NRC) (Snow, Burns, & Griffin, 1998). The authors of this NRC report represent a diverse group of experts in reading research and reading instruction. Snow et al. describe how early reading develops and provide guidance on how early reading instruction should proceed in preschool through third grade based on a convergence of results from experimental and quasi-experimental research. The second report is a research synthesis using meta-analysis: the *Report of the National Reading Panel: Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction* (NRP, 2000). The Congressional charge given to the National Reading Panel (NRP) was to "assess the status of research-based knowledge, including the effectiveness of various approaches to teaching children to read" (p. 1). The NRP report extends Snow et al.'s report to include a synthesis of results from studies on instruction beyond third grade. The NRP report includes reports from each of the panel's six subgroups: alphabetics, comprehension, fluency, methodology, teacher education, and technology/next steps.

In this chapter, findings from Snow et al. (1998) and the NRP (2000) are supplemented with additional research. For example, the comprehension subgroup meta-analysis of the effects of comprehension strategy instruction on students' ability to read with understanding led to the

subgroup's conclusion that multiple strategy instruction is more effective than instruction in any single strategy. The meta-analytic results, however, did not offer information about how to effectively incorporate multiple strategy instruction into a comprehensive reading program. Nor was it possible to learn how to meet the individual needs of students in a classroom. To address such issues, multi-method and case study research is reviewed. For example, findings from a study of home and school influences on the literacy development of low-income children (Snow et al., 1991) and from a study of exemplary middle school teachers (Langer, 1999) are presented to describe classroom practices associated with either variance in reading performance (as did Snow et al. through correlational analysis) or high reading performance (as did both Langer and Snow et al.). Other reading research that informed the conceptualization and writing of this chapter included related developmental and cognitive research (e.g., Adams, 1994; Chall, 1996; Kintsch, 1998) and a recent review of vocabulary instruction (Blachowicz & Fisher, 2000).

In the area of writing, Hillocks's (1986) findings from a meta-analysis of the effects of different approaches to writing instruction on student writing are presented and related to reports in a recent volume published by the International Reading Association called *Perspectives on Writing: Research, Theory, and Practice* (Indrisano & Squire, 2000). Finally, recent research on the impact of state writing assessments and accountability systems on writing instruction (e.g., Ketter & Pool, 2001) is summarized.

ASPECTS OF LITERACY

Literacy is the ability to read and write meaningfully and with understanding. As noted in a publication by New Standards Primary Literacy Committee (1999), "the ultimate goal of reading is getting the meaning" (p. 19). A literate person perceives the meaning, the significance of a phenomenon, the substance, the main ideas, and the relevant details in a book, article, technical manual, poem, or Web page. Literacy also encompasses the ability to follow written directions, to write complete and accurate directions, and to communicate in writing the essence of a scene, emotion, experience, or idea so that a particular person or multiple audiences can read it and see and understand the point.

Intellectually Engaging and Challenging

Some researchers identify *thoughtful literacy* as the target for schooling, explaining that thoughtful literacy is the ability to "read, write, and think in the complex and critical ways needed in a post-industrial democratic society" (Allington & Johnston, 2000, p. 1). The cognitive challenge to reading is constructing meaning through a reciprocal interchange of ideas between one's prior knowledge and the message in a particular text (Harris & Hodges, 1995). The intellectual challenge to writing is not just to tell, but also to transform knowledge (Hillocks, 1995). In more general terms, becoming literate means doing authentic, intellectual work (Newmann, Bryk, & Nagaoka, 2001). Newmann et al. state that

> students should be expected to interpret and synthesize information, show relationships between various kinds of information, explain why some answers are better than others, and solve unfamiliar problems that might have more than one

plausible solution. Moreover, students should be expected to formulate problems, organize their knowledge and experiences in new ways to solve them, test their ideas with other students, express themselves using elaborated statements, both orally and in writing, and produce reasoning or justification for answers. (pp. 10–11)

Serves Multiple Purposes in School and Life

Reading and writing are tools of language for developing academic and enduring knowledge and skills that enable students to attend and succeed in further education as well as to enter and participate successfully in the job market. Multiple purposes for becoming literate are evident in the following statements from standards documents: students should be able to "use language to understand themselves and others and to make sense of their world (Lloyd-Jones & Lunsford, 1989, p. 3) as well as "to get things done" (New Standards Primary Literacy Committee, 1999, p. 70). Langer and Flihan (2000) remind us that "language is a tool" (p. 115). The ultimate purposes for which students use reading and writing as tools, however, are not specified by content standards. We want students to be able "to participate with increasing effectiveness in an increasingly wide array of culturally significant domains of conversation" (Applebee, 2000, p. 106).

Generative and Adaptive

According to the New Standards Primary Literacy Committee (1999), "people get smarter when they read; they learn the words, references and concepts that are the foundation for the next ideas they will encounter and learn. The more you know, the more you can learn" (p. 23). Similarly, writing is generative. As the New Standards Primary Literacy Committee notes, "Writing seems to unlock the mind, to organize and synthesize thinking, to excite the intelligence. By weaving together bits of information that may never have been joined before, writers discover new meaning" (p. 31).

People also need the ability to adapt their knowledge and skills to new situations. According to Bereiter and Scardamalia (1987), *high literacy,* as a primary goal of K–12 education, is akin to the expectations of the learned professions in which participants are expected to continually go beyond where they are, becoming more knowledgeable and skillful. Meeting this goal would enable students to apply their core knowledge to a variety of unpredictable tasks and situations. Similarly, reading comprehension theorists note that active reading for understanding can result in changes in prior knowledge "so that it can support comprehension and problem solving in new situations" (Kintsch, 1998, p. 290).

Applebee's (2000) discussion of undergraduate and graduate students' writing provides another perspective on the disposition to learn continually as an aspect of literacy. Summarizing research on advanced writers in post-secondary settings, Applebee points out that continual learning is critical to success:

> What each of these studies makes clear is that in order to write well in these new contexts, these already-accomplished writers have to learn a great deal about the particular demands of their new situations. In each case, they serve a kind of apprenticeship during which they come to understand not only the appropriate

rhetorical forms, but also the underlying issues that make writing interesting and arguments effective. (p. 105)

Requires Metacognitive and Metalinguistic Learning

Metacognition and metalinguistic awareness involve the ability to monitor and direct one's thinking and one's language. The metacognitive goal of literacy is developing productive habits of mind. According to the English Coalition (Lloyd-Jones & Lunsford, 1989), one aspect of productive habits of mind is becoming a language theorist. Children are naturally curious, hypothesizing rules and principles for how the world is ordered. They are helped in these inquiries when adults expect and support them to be curious, whether their curiosities are about language or any other phenomenon. Students also need to study how people use oral and written language, learn how to describe these uses in terms of grammar, syntax, rhetoric, discourse theory and semantics, and take responsibility for how well they communicate and learn (Lloyd-Jones & Lunsford, 1989). Specifically, the English Coalition expects students to learn to

- use language effectively to create knowledge, meaning and community in their lives
- reflect on and evaluate their own language use
- recognize and evaluate the ways in which others use language to affect them. (p. 19)

Thus, literacy involves more than reading and writing to complete assignments for school. A literate person is someone who reads thoughtfully and actively, analyzing and comparing and synthesizing information. A literate person is someone who writes to "discover new meaning" and adapts his or her knowledge to new situations, and is aware of how language is used to create meaning and to affect others. Four core literacy standards represent these aspects of literacy:

1. Read with understanding a variety of texts for a variety of purposes.
2. Write effectively for a variety of purposes and audiences.
3. Understand and know how to use language structure, features, conventions and vocabulary.
4. Use productive habits of mind.

These four standards are common across three national standards documents in English language arts:

1. *Standards for the English Language Arts*, by the National Council of Teachers of English (NCTE) and the International Reading Association (IRA) (1996)
2. *English Coalition Conference: Democracy through Language* (Lloyd-Jones & Lunsford, 1989)
3. *Reading and Writing Grade by Grade: Primary Literacy Standards for Kindergarten Through Third Grade* (New Standards Primary Literacy Committee, 1999).

The four core literacy standards adhere to quality criteria for standards; that is, they clearly convey the important knowledge and skills of literacy in broad enough terms to allow for multiple

approaches to curriculum, instruction, and assessment (Council of Chief State School Officers, 1998). The four core standards can help educators focus their efforts on improving learning and teaching in areas of skills and knowledge that are essential for success in school and life.

Standards as learning targets for all students, however, do not provide guidance on the classroom practices and experiences that students need to achieve these targets. The next sections of this chapter provide a synthesis of research-based knowledge regarding classroom practices for reading and writing. The Reading section is organized around topics used by the members of the National Reading Panel and the reading experts who wrote the National Research Council report on preventing reading difficulties (Snow et al., 1998). The Writing section is organized around topics identified in the literature and standards documents reviewed. The Reading and Writing topics are as follows:

Reading
- Unlocking the Code
- Phonics and Word Identification
- Fluency
- Vocabulary
- Comprehension

Writing
- Reading-Writing Connection
- Spelling
- Composition
- Productive Dispositions and Habits

READING

Although the five topics in this section are addressed separately, in apparent isolation, none alone is sufficient for becoming a good reader. Similarly, although these topics are addressed in a particular order matching the sequence of developmental milestones that chart progress along the pathway of becoming a good reader, effective classroom practices always reflect appropriately distributed attention to all five topics. In other words, although the topics and research-based practices are presented in a developmental fashion, they are not intended to be followed in a lock-step fashion. Individual and situational needs determine the focus of practices employed by teachers and are never divorced from the ultimate purposes of becoming literate.

When ease of word reading is not accomplished, the reader's ability to understand increasingly complex text is compromised (Adams, 1994). For this reason, the first two topics, unlocking the code, and phonics and word identification, are devoted primarily, but not exclusively, to research-based practices and learning environments for early on in the K–12 grade span. These two subsections describe classroom practices for the primary grades (K–2). The third topic, fluency, is devoted primarily, but not exclusively, to research-based practices and learning environments for grade two as well as its prior and subsequent grades of one and three. The task for beginning readers

during this period of their development is to integrate the mechanics of reading (e.g., word identification) into a unified, complex system for reading (Adams, 1994; Chall, 1996). Finally, the fourth and last sections on vocabulary and comprehension deal with the semantic and knowledge-building aspects of reading and are devoted to research-based practices and learning environments for all grade levels: primary, intermediate, middle, and secondary. The focus of these two sections is on developing the ability to use the reading system to learn.

Unlocking the Code

When explaining the importance of the K–3 reading standard, *understand and know how to use the print-sound code*, the New Standards Primary Literacy Committee (1999) writes:

> The ultimate goal of reading is getting the meaning. On the path toward that goal, learning the "code" that relates printed words to spoken language is a critical first step. English, like other languages that use alphabets, provides a systematic code that allows readers to recognize words efficiently. (p. 19)

Learning or "unlocking" an alphabetic code is facilitated by phonemic awareness. Phonemic awareness, as pointed out by curriculum developers Adams, Foorman, Lundberg, and Beeler (1998), "helps make the logic of the print-sound code self-evident" (p. 11). The fact of the matter, however, is that children as competent users of spoken language have no need to develop phonemic awareness until they start learning to read and spell (Adams, 1994). Although some children develop phonemic awareness incidentally while interacting with adults around nursery rhymes or letters of the alphabet, while being read to, or through their own attempts at figuring out how to read, other children rely on their experiences in school to develop phonemic awareness. Adams writes, "Developmentally, this awareness seems to depend upon the child's inclination or encouragement to lend conscious attention to the sounds (as distinct from the meanings) of words" (p. 65).

Using meta-analytic techniques, the National Reading Panel (NRP) (2000) alphabetics subgroup evaluated evidence of the effectiveness of phonemic awareness training for helping children develop phonemic awareness. In addition, this subgroup assessed the evidence of the effectiveness of phonemic awareness training for helping children transfer this awareness to beginning reading and spelling. The results of their meta-analysis are summarized briefly and their significance for classroom practices explained.

Research-Based Classroom Practices for Developing Phonemic Awareness

In the NRP's meta-analysis of phonemic awareness training effects, 66 effects were included from 52 research reports published in refereed journals. The vast majority of children participating in this research were kindergartners and first graders, although the grade range for the participants was from preschool to sixth grade.

Overall, the panel (2000) found that phonemic awareness instruction had a moderate but significant and positive effect on children's phonemic awareness, reading, and spelling. The largest to smallest effect sizes for children's performance on different tests are presented in Table 1. As indicated in the

first row of Table 1, the greatest impact of phonemic awareness training for children shows up on tests of phonemic awareness. Children successfully learned what they were taught and maintained their skills over the long term. For example, children learned to listen to words and segment or analyze them orally into constituent phonemes (e.g., "If you delete the initial sound from the word "lip," what remains? "ip") and blend segmented words (e.g., "What word does "mmmmmm" "aaaa" "ttttt" say? "Mat").

As Table 1 indicates, the transfer effects of phonemic awareness to reading and spelling were largest for spelling. As indicated by the third row of Table 1, the spelling effects were largest when spelling was assessed by a specially designed, experimenter-test. As indicated in the last row of Table 1, phonemic awareness training had virtually no impact on children's mathematics achievement. Thus, the meta-analytic results show that the training effects are not simply Hawthorne effects, raising achievement spuriously on any measure.

Table 1. Effect Sizes for Different Outcomes Measured as the Result of Phonemic Awareness Training

Type of Outcome Measured as the Result of Phonemic Awareness Training	Average Effect Size	Number of Effect Sizes
Phonemic awareness tests		
Immediate	.86	72
Follow-up	.73	14
Experimenter-designed spelling tests	.75	24
Experimenter-designed word reading tests	.61	58
Standardized spelling tests	.41	20
Standardized word reading tests	.33	39
Tests of reading comprehension	.32	18
Tests of mathematics achievement	.03	15

Note: Based on results reported in *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction* (Chapter 2, Part I, Tables 3 and 4, pp. 2-63 and 2-69), by the National Reading Panel, 2000, Washington, DC: Author.

Specifically, to understand the magnitude of the effects displayed in Table 1, consider a hypothetical example. Effect sizes are standard deviation units. An effect size of 1.00 is equivalent to one standard deviation gain above the average score of a comparison or control group. Thus, consider an effect size of .33. As can be seen in the second to last row of Table 1, this was the average effect size for the effects of phonemic awareness training on standardized tests of word reading. This finding indicates that on average, children receiving phonemic awareness training scored about one-third of a standard deviation above children who did not receive phonemic awareness training. If, for example, a standardized test of word reading had an average standard score of 100 and a standard deviation of 15, and, hypothetically, a child *not* given the phonemic awareness training scored 100, then a child who *was* given the phonemic awareness training would likely score 105, one-third of a standard deviation higher.

The results displayed in Table 1 show that phonemic awareness training has particular benefit for beginning reading and spelling. The relative magnitude of the different effects, however, indicates the least benefit for reading. The significance of this for classroom practices is that phonemic awareness training alone, as a single strategy or approach to teaching beginning reading, will yield very disappointing results. The 2000 NRP meta-analysis, while confirming that there is some benefit to phonemic awareness training, provides little guidance about what else needs to happen in classrooms to help children learn to read. The NRP concludes:

> There is obviously much more that children need to be taught to acquire reading and writing competence. Phonemic awareness instruction is intended only as a foundational piece. It helps children grasp how the alphabetic system works. (p. 2-43)

Phonemic awareness training ought to have certain characteristics to be most effective. Analyses of variables conducted in the NRP's (2000) meta-analysis, besides analysis by type of outcome measure, led to the following conclusions:

- Manipulating phonemes with hands-on letters (e.g., plastic letters, letter disks) yields larger effects than without letters.
- Focusing on only one or two phonemic processing skills (e.g., word analysis and word blending by subsyllable units) is more effective than focusing on three or more skills.
- Being explicit about the connection between phonemic awareness skills and reading strengthens training effects.
- Effects are largest when phonemic activities are brief (30 minutes or less) and have a total duration, across weeks, of 5 to 18 hours.

Curriculum and Instruction Ideas for Developing Letter Knowledge

Curriculum developers Adams et al. (1998) suggest that the use of letters in phonemic awareness activities should specifically support the goal of making the logic of the print-sound code self-evident. Furthermore, since the purpose of phonemic awareness instruction is making the logic of the code self-evident, not all 26 letters or the 44 phonemes of English need to be covered. To illustrate, Adams et al. suggest focusing only on a subset of consonants and the short vowels (*s*, *m*, *d*, *p*, *t*, *n*, *g*, *b*, *r*, *f*, *l* and *a*, *o*, *i*, *u*, *e*).

To interest and engage youngsters, Adams et al. (1998) suggest that the activities be game-like with a lot of child appeal. Examples include (1) singing chants that rhyme; (2) sorting pictures by initial sound, that is, naming pictures of objects, identifying their initial sounds, and then selecting the odd-one-out on the basis of initial sounds (e.g., a picture of a mitten would be the odd-one-out in a set with a picture of a fox, a foot, a fish, and a mitten); and (3) making words (i.e., using letter cards to spell, for example the word "ill," then the words "bill," "fill," "pill," and "will"). According to the NRP's (2000) findings, using two of the above sample activities would be more effective for children's learning than using all three at once.

To address the diversity of learning needs typically present in kindergarten classes, Adams et al. (1998) suggest that the phonemic activities be multi-leveled and responsive to different developmental accomplishments. New games should be introduced even as familiar ones or their variations are revisited to ensure a productive mix of new and review materials. Extra time should be created to work with children who need more practice. For example, some children may need concrete unit counters, such as fingers, felt pads, and syllable blanks (Bodrova, Leong, & Paynter, 1999). The complexity of the materials used can be varied by including items that vary in

- abstractability of the unit of analysis (an example, some children may need to begin by counting words in sentences to develop an understanding of the process of analyzing language, then move to counting syllables in words, then move to counting phonemes in words; likewise, words with no consonant blends are easier to analyze than words with consonant blends);
- familiarity/novelty and meaningfulness (e.g., use of children's and others' names); and/or
- the extent to which representation is symbolic (e.g., some children say and count phonemes; some children use letters to spell phonetically, others use letters to spell conventionally).

For children who need systematic, direct instruction to learn letter identities and letter-sound associations, an approach with features similar to Jolly Phonics might be promising. Jolly Phonics, developed in the United Kingdom, was highlighted by the National Reading Panel's (2000) alphabetics subgroup. Central to its program is the "use of meaningful stories, pictures, and actions to reinforce and recall letter-sound relationships and precise articulation of phonemes" (NRP, p. 2-124). Jolly Phonics uses alliteration and pantomime to help children learn letter identities and sounds that are otherwise arbitrary, meaningless associations between letter shapes, names, and sounds (e.g., children make their fingers crawl up their arms portraying an ant as they chant the initial sound of "ant" associated with the letter *a*). As reported by the NRP, the effect size for the Jolly Phonics group of children compared to a Big Books group of children was .73 averaged across measures of reading and writing words and pseudowords (nonsense words). A year later in first grade, the Jolly Phonics group still outperformed the control group in reading and spelling.

Features of a Comprehensive Pre-reading or Beginning Reading Program

Both Snow et al.'s (1998) NRC report and the NRP (2000) conclusions consistently and clearly state that phonemic awareness activities need to be part of a comprehensive, beginning reading program. When phonemic awareness is part of a comprehensive pre-reading or beginning reading program, such classrooms provide learning environments where the uses of written language are obvious, natural, and functional (Adams, 1994; Snow et al., 1998). Children can read real letters; they can also create a classroom post office that delivers letters and notes between class members. Creating a language-rich environment gives students some sense of where written language comes from. Dictating a set of "Rules for Taking Care of Our Hamster" is an example of this kind of participation (Goodman & Goodman, 1979, as cited by Adams, 1994).

A range of opportunities to capture talk in writing is characteristic of language-rich environments in kindergarten classrooms. Traditionally, this has been referred to as the language experience approach and "consists of writing down what children say and then leading them to appreciate that what has been written is what they have said" (Snow et al., 1998, p. 183). Capturing talk in writing gives children and teachers a shared, spoken-written experience to examine. Given the experience, teachers can make explicit, or children can notice, the alphabetic principle. For example, a child might notice that "each letter of the alphabet stands for one or more sounds that I make when I talk" (Snow et al., p. 183, quoting from Allen, 1976).

Student Diversity

Leading reading educators advocate for opportunities in the preschool and primary grade classrooms for children to practice alternate ways to read and spell with different learning functions. Alternatives to real reading include "pretend reading," as Fountas and Pinnell (1996) call it, and "finger-point reading." Pretend reading is reading that relies on picture cues or on memory of prior experience with a particular text. Pretend reading is fun for children who have not yet developed the knowledge and ability to use the print-sound code and reinforces knowledge of story structure and story elements. Finger-point reading, although it slows down more knowledgeable and skilled readers, is useful for focusing children on how the print-sound code works by literally pointing to the letter(s) while saying or hearing the sound(s) (Snow et al., 1991).

Likewise, "sound-spelling" provides an alternative to conventional spelling. "Sound-spelling," or invented spelling, is spelling phonetically, which reinforces knowledge of letter-sound relations (NRP, 2000). Beginning readers and spellers need teachers who recognize the knowledge about language that is evident in children's inventions and play. They need teachers who, for example, recognize the knowledge a child has gained about the past tense marker *ed* when he or she spells "watched" as *woched* after initially spelling it as *wocht* (Mason & Sinha, 1992). They need teachers who know that pretend reading helps to confirm for children their knowledge of story structure and story elements; but more important, they need teachers who know when a child is pretend reading, where that child has been, where he or she is going, and what instruction is needed to bring him or her forward (Chall, 1996).

Similarly, instruction in letter-sound associations should be tailored to meet the individual needs of students learning English as a second language. Instruction depends on the extent of students' literacy in their first language and the similarities between their first language and English. For example, for Spanish-speaking students learning English, the elements of the English print-sound code that need to be taught explicitly depends on whether or not the student is Spanish literate (Peregoy & Boyle, 2000). For Spanish-literate students learning to read English, the grapheme-phoneme associations for the consonants are similar enough in both English and Spanish that prior knowledge about the consonants may transfer readily to English reading for many students. In contrast, the vowel letters look the same in Spanish and English but represent sounds very differently. Therefore, for Spanish-literate students, explicit instruction in English vowel spelling patterns, but not necessarily in consonants, is often useful, preferably in the context of reading simple texts (Peregoy & Boyle, 2000).

Conclusions and Implications for Practice

Both the National Reading Panel (2000) and Snow et al. (1998) agree about the necessity and efficacy of phonemic awareness activities for young children who are beginning to learn to read. Snow et al. clearly state that "enhancing children's letter knowledge and phonemic awareness should be a priority goal in kindergarten classrooms" (p. 188). Phonemic awareness activities help children attend to the sounds of words and letters and begin to use the logic of the print-sound code to read and spell. This metalinguistic insight and letter knowledge are necessary but not sufficient for becoming literate. To help children develop these foundational abilities, evidence suggests that teachers should use the following classroom practices:

- Embed activities in comprehensive pre-reading and/or beginning reading instructional programs and language-rich environments where the uses of written language are obvious, natural, and functional.
- Select a subset of consonants and vowels to illustrate the logic of the print-sound code rather than covering all 44 phonemes and 26 letters of the alphabet.
- Use game-like, multi-leveled phonemic awareness activities with a lot of child appeal including both letter and non-letter manipulatives as appropriate.
- Identify and build on what children know about words, names, letter identities and letter-sound associations; support children's learning of letter identities and letter-sound associations with engaging rehearsal (e.g., alliteration, pantomime, chanting).

Phonics and Word Identification

For beginning readers, the important problem is how to identify printed words. According to Chall's (1996) scheme for understanding reading development, children who solve word identification problems drop their earliest attempts at pretend reading as their preferred approach (i.e., relying heavily on pictures and/or memory to "read"). They begin to pay more and more attention to alphabetic cues, that is, recognizing the letters and words as written and "matching" them with spoken words and sounds. At this time, "most of the words and letter-sounds have to be learned from those who know them — teachers, parents, siblings, classmates. There is much asking and telling, practicing "orally" and being confirmed" (Chall, p. 44).

Many children enter kindergarten knowing all their letters and sounds. These same children and others often enter first grade already reading. Other children have very little letter knowledge. Children who solve word identification problems early read considerably more than their peers who are still struggling to decode (Juel & Minden-Cupp, 1999). The advantages and consequences of solving or not solving word identification problems early have been described by Stanovich (1986) as "Matthew" effects: the rich get richer and the poor get poorer. As Juel and Minden-Cupp suggest, children who learn to decode early are children who have acquired knowledge that allows them to read on their own; and through reading a lot, they gain both general knowledge and familiarity with words in print.

Research-Based Classroom Practices for Developing Students' Decoding and Word Identification Skills

Assuming that learning to decode with print-sound knowledge is important to learning how to read, members of the NRP's (2000) alphabetics subgroup sought to answer the following research question: Does systematic phonics instruction help children learn to read more effectively than nonsystematic phonics instruction or instruction teaching no phonics? The panel noted that systematic phonics instruction "typically involves explicitly teaching students a prespecified set of letter-sound relations and having students read text that provides practice using these relations to decode words" (p. 2-92).

To answer this question, the group conducted a meta-analysis of 38 studies with 66 treatment-control group comparisons. Children participating in the studies were in grades K–6. The comparisons involved contrasting the effects of systematic phonics instruction with the effects of unsystematic or no phonics instruction on children's reading and spelling. Descriptions of different instructional approaches categorized for the purposes of the meta-analysis are provided in Table 2.

Overall, the effects of systematic phonics instruction on reading and spelling measures yielded an average effect size of .44, significantly different from zero and judged to be moderate in magnitude. The NRP's (2000) alphabetics subgroup concludes that "systematic phonics instruction makes a bigger contribution to children's growth in reading than alternative programs providing unsystematic or no phonics instruction" (p. 2-92).

Effective features. When analyzed by program type, synthetic phonics (the first type of systematic phonics instructional program listed in the left-hand column of Table 2) yielded the largest effect on reading and spelling. The onset/rime programs (the second type listed in Table 2, left-hand column) yielded the second largest effect on reading and spelling. The miscellaneous programs (the last program listed in Table 2, left-hand column) yielded the smallest effects on reading and spelling. (Combination programs were not numerous enough to be included in this analysis.) The three relative effect sizes of .45, .34, and .27 for synthetic, onset/rime, and miscellaneous programs, respectively, were all significantly greater than zero but "did not differ statistically from each other" (NRP, 2000, p. 2-119).

Seven systematic phonics programs (e.g., Direct Instruction, Orton Gillingham, Lippincott Basic Reading Series) were specifically evaluated in the studies included in this meta-analysis. The effect sizes for these programs on reading measures, and some spelling measures, ranged from a low of .23 to a high of .68. The lowest effect size was for the Orton Gillingham approach. Although student groups involved in these studies were older, mainly third through sixth grade, which may have made it harder for the treatment to produce results, the Orton Gillingham approach includes a heavy emphasis on learning letter-sound associations and less emphasis on how to use this code knowledge. These features are in direct contrast to program features of the Lippincott Basic Reading Series, which was associated with the highest effect size (i.e., .68). The NRP's (2000) report notes that the Lippincott program "teaches in a systematic manner how to use the alphabetic code to move from printed words to oral language. . . . Although the primary instructional focus is on decoding, another goal of this method is the instant recognition of words" (p. 2-166).

Table 2. Descriptions of Different Instructional Programs Categorized by the NRP (2000) Alphabetics Subgroup for Meta-analysis Reported in Chapter 2, Part II

Systematic Phonics Instruction	Unsystematic or No Phonics Instruction
Synthetic phonics programs (i.e., when all or most of the alphabetic representations for the 44 phonemes in English are taught) Onset/rime programs (i.e., when onsets and rimes are taught, such as *st* as in *stop*, and *and* as in *band*, respectively) Combinations of the above two Miscellaneous programs that explicitly and systematically teach children a set of prespecified print-sound associations and how to use them, typically to read texts with controlled vocabulary	Programs that teach whole word identification (e.g., basal programs typically used in the 1960s) Basal programs used in the 1970s to early 1990s Whole language programs (i.e., approaches with an emphasis on language experience [capturing children's talk in writing] or use of Big Books [shared reading of books with visually large enough print for teachers to demonstrate print-sound relations while children observe and participate])

Note: Information compiled from *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction* (pp. 2-103–2-105, p. 2-121, p. 2-124), by the National Reading Panel, 2000, Washington, DC: Author.

Although not without confounding variables (e.g., different student populations), the contrasting program features of the strongest and weakest phonics programs according to this NRP (2000) meta-analysis support one of the predictions and recommendations of the alphabetics subgroup:

> Programs that focus too much on teaching of letter-sound relations and not enough on putting them to use are not likely to be very effective. In implementing systematic phonics instruction, educators must keep the *end* in mind and insure that children understand the purpose of learning letter-sounds and are able to apply their skills in their daily reading and writing activities. (p. 2-96)

Differential effects on reading and spelling. Effect sizes reported by the NRP (2000) estimating the effectiveness of systematic phonics instruction on different measures are presented in Table 3. All effect sizes included in Table 3 were significantly greater than zero. As Table 3 shows, the largest effects were for identification of regularly spelled words. Knowledge of phonics can be successfully applied to this type of word. As can be inferred from the last row of Table 3, other information, such as context cues, can help students read.

Phonics serving reading comprehension. The NRP's (2000) documented effectiveness of systematic phonics for reading comprehension (see Table 3), although of less magnitude than that for word identification, is consistent with the tight correlation between word reading and comprehension during the early grades (Juel, 1988). No significant effects of systematic phonics instruction on comprehension were found by the NRP meta-analysis for students in second grade and beyond. The effect size for comprehension when only kindergarten and first-grade children were included in the analysis was .51. This was significantly different from zero and serves "to dispel any

belief that teaching phonics interferes with children's ability to read and comprehend text; quite the opposite is the case" (NRP, 2000, p. 2-113).

Table 3. Effect Sizes for Different Outcomes Measured as the Result of Systematic Phonics Instruction

Type of Outcome Measured as a Result of Systematic Phonics Instruction	Average Effect Size	Number of Effect Sizes
Identification of regularly spelled words	.67	30
Identification of nonwords	.60	40
Identification of a miscellaneous set of words	.40	59
Spelling	.35	37
Reading comprehension	.27	35
Reading text orally	.25	16

Note: Based on results reported in *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction* (Chapter 2, Part II, Table 3, p. 2-159), by the National Reading Panel, 2000, Washington, DC: Author.

Phonics serving reading vocabulary. A common criticism of systematic phonics instruction is that when so many of the high-frequency words in beginning reading texts are irregularly spelled (that is, exception or sight words), it is a waste of precious time to teach children knowledge about the print-sound code. Ehri (1998) suggests that although alphabetic knowledge is not helpful for decoding sight words, it does help children establish important networks of orthographic and semantic information, which aid recognition of these words from memory (for example, knowing the first letter-sound association in the word *is* and the final letter-sound association in the word *some* can help make these words more familiar and meaningful). Even high-frequency sight words have some regular letter-sound associations to help readers remember their identity (e.g., *is* and *some* are high-frequency sight words found in beginning readers; see Bodrova, Leong, & Semenov, 1999). The NRP (2000) meta-analytic finding of significant effects for systematic phonics instruction on sets of miscellaneous words, including sight words (see Table 3), is consistent with Ehri's research and theoretical perspective.

Phonics serving reading fluency. The smallest effect of systematic phonics instruction on reading was found for reading text orally (see Table 3). The fact that this effect size for reading text orally was significantly greater than zero suggests that phonics instruction does not interfere with developing fluency. Although phonics instruction does not appear to interfere with fluency, it does not appear to make much of a positive impact. Research on instruction that serves fluency with greater impact than phonics is the topic of a subsequent section of this chapter.

Student Diversity

With regard to different groups of children, especially students with high needs, the NRP's (2000) meta-analysis showed that systematic phonics instruction had significant, positive effects on reading for kindergarten and first-grade children identified as at risk for developing future reading problems. Moreover, significant effects were found for disabled readers (identified in the NRP meta-analysis as children with average intelligence but poor reading skills). In all cases, the effect sizes were

significantly greater than zero. For at-risk children, however, the timing of the systematic phonics instruction appears critical. When provided in second grade and later, effectiveness declines.

The NRP's (2000) meta-analysis revealed that low-achieving readers in second through sixth grade did *not* show significant benefit from systematic phonics instruction. Low-achieving readers were identified as children with reading difficulties and possibly other cognitive difficulties explaining their low achievement. Reasons given for the nonsignificant effects for this group included (1) the instruction may not have been sufficiently intense, (2) the reading difficulties of these children were not treated by phonics instruction, or (3) there were too few cases.

Significant effects were found for children at all socioeconomic (SES) levels. The effect size for low-SES students was .66; for middle class students it was .44. The NRP notes that "both were statistically greater than zero and did not differ from each other. The conclusion drawn is that systematic phonics instruction is beneficial to students regardless of their SES" (p. 2-95). It is also noted in the NRP report, however, that preferably, systematic phonics instruction should be suited to meet children's assessed needs. Since students arrive in school with varying degrees of knowledge about phonics and proficiency in using phonics to read and spell, tailoring phonics instruction to meet individual needs would seem to be the best use of everyone's time.

Meeting individual needs. Examination of the NRP's (2000) effect sizes reveals that one particular phonics program in the panel's meta-analysis appeared to be a promising program for helping at-risk first graders. The program, a modified Reading Recovery© program, yielded the largest effect size in this meta-analysis. This effect size, averaged across measures of word identification, spelling, nonword identification, and oral reading, was 3.71.

Tunmer and Hoover (1993) characterize their modified Reading Recovery© (RR) program as a metacognitive rather than a skill-and-drill approach. According to Tunmer and Hoover, metacognitive approaches to phonics instruction emphasize developing beginning readers' awareness of effective learning strategies *and* an overall understanding of how the alphabetic system works. In contrast, skill-and-drill approaches emphasize individual grapheme-phoneme relations taught in an isolated, piecemeal fashion. Tunmer and Hoover's (1993) modified RR program emphasizes connections between skills and knowledge and applications to daily reading and writing. This emphasis and other characteristics of the modified RR program delivered in a one-to-one setting are listed below:

- Selection of phonics elements for the focus of instruction is purposeful rather than exhaustive, that is
  - more abstractable units are followed by less abstractable units (e.g., phonograms [such as *-and* and *-ill*] are followed by single consonant- and vowel-letter sound associations), and
  - only elements appearing in one or more words in high-frequency word lists or from children's readers are taught.
- Teacher modeling is followed by gradually passing control over to the child for task completion.

- Children are required to use their newly gained knowledge of phonics and strategies to help them identify unfamiliar words in reading and spell unfamiliar words in writing.
- Pull-out teachers and classroom teachers examine evidence to arrive at a joint decision about individual children exiting the modified RR program.

The tremendous magnitude of the modified RR program's estimated effectiveness, however, may be compromised by threats to the study's validity, including possible regression to the mean and Hawthorne effects. Given these confounds related to regression to the mean and Hawthorne effects, proposals about the efficacy of the particular program characteristics or qualities should be treated as tentative explanations for student gain, not causal conclusions. Convergence of results from Tunmer and Hoover (1993) and exemplary literacy teacher research, however, support the adoption of the modified RR practices in classrooms. Process-oriented teaching and evidence of its utility in classrooms are discussed further in the exemplary literacy teacher section of this chapter.

Conclusions and Implications for Practice

The National Reading Panel's (2000) meta-analytic review of the effects of systematic phonics instruction on children's reading shows that such instruction improves children's ability to identify printed words, including both sight and easily sounded-out words. Moreover, this meta-analysis shows that for kindergarten and first-grade children, systematic phonics instruction appears to facilitate rather than interfere with reading comprehension and fluency. Importantly for at-risk kindergarten and first-grade children, the effectiveness of explicit phonics instruction is significant and strong for their reading performance, but its effectiveness appears to decline if this instruction is not provided before second grade. Thus, when to provide systematic phonics instruction is critical. At least for children at risk for developing reading difficulties, the key is to begin providing phonics instruction prior to second grade.

Still, there are other important complexities about systematic phonics instruction that the NRP (2000) meta-analysis did not address. None of the outcomes analyzed were measures of attitudes toward reading. Research cited by Snow et al. (e.g., Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998) suggests that when attitude toward reading is measured, at-risk children taught with whole language approaches, in spite of lower reading performance, have more positive attitudes toward reading. Snow et al. (1998) suggest that systematic phonics instruction may have positive effects that children don't realize for a long time.

The NRP (2000) concludes its meta-analysis on phonics instruction with some recommendations for classroom practices and cautions teachers should keep in mind. Panel members point out the importance of reading aloud to children, attending to children's interest in books, and using systematic phonics instruction only as part of a comprehensive program:

> Phonics instruction is never a total reading program. In first grade, teachers can provide controlled vocabulary texts that allow students to practice decoding, and they can also read quality literature to students to build a sense of story and to develop vocabulary and comprehension. Phonics should not become the dominant component

> in a reading program, neither in the amount of time devoted to it nor in the significance attached. It is important to evaluate children's reading in many ways, not only by their phonics but also in their interest in books and their ability to understand information that is read to them. By emphasizing all the processes that contribute to growth in reading, teachers will have the best chance of making every child a reader. (p. 2-136)

When teaching phonics per se, the NRP (2000) meta-analytic findings suggest that the following characteristics of practices should be present:

- A process-oriented emphasis so that students learn the value of phonics knowledge for reading and spelling
- Systematic coverage of, rather than incidental exposure to, phonics elements

Fluency

Fluency is the bottleneck (Perfetti & Roth, 1977) or gateway to reading for understanding. It frees and supports mental capacity for strategic processing of content and reconstruction of prior knowledge in lieu of the content (LaBerge & Samuels, 1974). Traditionally, fluency has been defined as a combination of word identification speed and accuracy. More recently, however, fluency has come to be understood as also including speed and accuracy of recognizing the meaning of phrases and sentences (NRP, 2000).

To develop fluency, reading experts recommend that teachers provide students with frequent opportunities to practice reading continuous text. Frequent, successful practice reading continuous text allows confirmation and consolidation of the beginner's knowledge of the print-sound code (Chall, 1996; Ehri, 1994). Frequent, successful practice in reading also builds a child's confidence in his or her sight vocabulary (Hiebert, Pearson, Taylor, Richardson, & Paris, 1998). Honig (1996) estimates that children need four to five successful exposures to a word to rapidly recognize it, although for some students, the number of exposures needed may be as high as 50 to 100. Correlational evidence confirms a relationship between lots of reading of continuous text and reading competence. Results from a survey of students taking the 2000 NAEP fourth-grade reading assessment, and relationships between the survey results and performance on the reading test indicated that students who read more pages daily in school and for homework scored higher than students who reported reading fewer pages daily (Donahue et al., 2000).

Research-Based Classroom Practices for Developing Fluency

The NRP (2000) fluency subgroup examined evidence of the effectiveness of two classroom approaches to improving fluency. These two approaches are silent reading and oral reading practice. Both types of practice are intended to give students more time to read and greater exposure to print in order to help them confirm and consolidate their print-sound knowledge.

Silent reading. The NRP (2000) fluency subgroup identified a set of 14 studies examining the effectiveness of increasing student silent reading time for improving reading performance. In these

studies, students read books silently to themselves. A typical classroom example of this type of approach is Silent Sustained Reading, in which students read daily in the classroom for 20 minutes. Another example of this approach is Accelerated Reader, a commonly purchased, commercial program adopted by schools. Accelerated Reader is a computerized system allowing teachers and/or students to select reading texts from a set of appropriately leveled texts. Students read the texts and then assess their comprehension and chart their progress through levels of increasing difficulty.

None of the silent reading studies reviewed, however, included measures of reading fluency. Thus, NRP's (2000) major conclusion was that there is "not adequate evidence" to draw a conclusion about the effectiveness of silent reading practice for improving fluency:

> Despite widespread acceptance of the idea that schools can successfully encourage students to read more and that these increases in reading practice will be translated into better fluency and higher reading achievement, there is not adequate evidence to sustain this claim. (p. 3-28)

On the other hand, the NRP (2000) cites evidence from a 1984 study by Manning and Manning of Silent Sustained Reading suggesting that when silent reading practice is accompanied by active, thoughtful responses to reading, students' vocabulary and reading comprehension do improve. In the Manning and Manning study, students responded actively and thoughtfully to their reading through writing (e.g., 20 minutes of silent sustained writing) or discussion with teachers or peers. As will be presented in subsequent sections of this chapter, the benefits of active, thoughtful processing of information in texts, through conversations and written responses, have been confirmed in other research with regard to vocabulary (Blachowitz & Fisher, 2000) and reading comprehension (Dole, 2000; Raphael, 1998; Rosenshine & Meister, 1994). Thus, although there is no evidence about the effectiveness of silent reading practice for improving reading fluency, there is evidence (discussed in subsequent sections of this chapter) suggesting that silent reading practice, when accompanied by active thoughtful response, facilitates reading competence.

Oral reading. The NRP (2000) fluency subgroup located 14 studies that examined the effectiveness of oral reading practice for improving reading performance. Students who participated in the 14 studies ranged in grade level from second to ninth. In the studies, students practiced reading text orally for 15 to 30 minutes per lesson. The text was read either for a set number of times (as few as one and as many as seven) or to a fluency criteria with or without different types of feedback from a parent, peer, or teacher or with different forms of guidance (i.e., listening to the text being read, listening to the text while reading it, or receiving particular types of feedback during oral reading).

Ninety-nine effect sizes were derived from the 14 studies. On average, findings indicated moderate positive effects of oral reading practice on various reading measures (average effect size was .41). The effect sizes ranged from near zero (.05) to more than one (1.48), but varied little with type of reading measure. As can be seen in Table 4, average effect sizes ranged from a high of .55 for word identification to a low of .35 for comprehension. All were significantly greater than zero. Based on these findings across multiple reading measures, the NRP (2000) concludes that oral reading practice had "a clear impact on the reading ability of non-impaired readers at least through grade 4" (p. 3-17).

"It is advisable," the fluency subgroup wrote, "that teachers include such activities in their regular instructional routines at least during the elementary grades, and certainly with struggling readers" (p. 3-20). Based on its findings, the NRP (2000) suggests that oral reading practice be brief (15 to 30 minutes per lesson). Furthermore, the fluency subgroup noted that the benefits gained from oral reading practices appear to occur "in the context of an overall reading program, not as stand-alone interventions" (p. 3-20).

Table 4. NRP (2000) Effect Sizes for Estimating the Effectiveness of Oral Reading Practice on Different Measures of Reading

Type of Reading Measure used as Outcome in Study of Oral Reading Practice	Effect Size
Word recognition	.55
Reading composite	.50
Fluency	.44
Comprehension	.35

Note: Information obtained from *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction* (p. 3-18), by the National Reading Panel, 2000, Washington, DC: Author.

Student Diversity

According to the NRP (2000), oral reading practice provides poor readers with opportunities to learn more about words while such practice provides good readers with opportunities to develop a stronger command of the prosody of the passages" (p. 3-17, citing a study by Faulkner & Levy, 1999). This is consistent with Chall's (1996) developmental perspective and Honig's (1996) individual difference perspective. Poor readers are meeting their need for greater numbers of exposures to words to develop word recognition automaticity, while average or good readers are moving beyond mechanical fluency to integration of all the mechanical operations for a smoothly operating system. We do not know from this research, however, how to help poor readers enter and progress through the integration stage.

Two factors need to be considered when increasing time for poor readers to practice reading orally. One factor is the source of guidance and feedback. The other factor is passage selection. For students with learning problems (e.g., learning disabilities or below-grade-level reading achievement), the NRP (2000) reported that neither peer-mediated nor parent-mediated oral reading practice led to benefits, however "repeated practice with tape recorders led to marked improvements" (p. 3-19). Research cited by Allington (2001) suggests that for peer-mediated practice to be effective, special training for peers is necessary to help them become skillful at giving appropriate and useful feedback.

When selecting passages for oral reading practice, the possible advantages and consequences of different types of text should be evaluated. The NRP's (2000) report indicates that when children with learning disabilities practice reading passages that share many words in common with passages used at post-test, performance improves. When these same children practice reading passages

without vocabulary controlled to match post-test passages, practice does not improve (Rashotte & Torgeson, 1985, as cited in NRP, 2000). These findings suggest that practicing only on passages with a lot of words in common builds fluency for only the restricted set of common words. Although this may be productive for readers who need to confirm their knowledge of particular letter-sound associations or other print-sound regularities, it may not be productive for readers who, in Chall's (1996) terms, need to become "unglued" from the print (p. 46). As Chall notes, "Too analytic an approach for too long may hold up silent reading comprehension" (p. 47). At some point, readers need to build "confidence in trying new strategies" that rely on more numerous sources of information, such as "knowledge of language, of ideas, and of facts to anticipate meanings as well as new words" (Chall, p. 47).

Comprehensive Classroom Reading Programs

The National Reading Panel (2000) recommends that oral reading practice for students occur as part of an overall reading program. The results of two studies on comprehensive reading programs in elementary school classrooms are pertinent to describing what we know about how such programs are implemented and to what extent they are effective for helping all children achieve reading standards.

In a two-year project by Stahl, Heubach, and Cramond (1997), reading programs in 14 second-grade classrooms were reorganized in an attempt to promote fluency and automatic word recognition. Children entered these classrooms with a wide range of reading levels. Some were virtual nonreaders; others could successfully handle fourth-grade material. In the Stahl et al. classroom reading program, work was organized around, and extended from, use of the basal. The teacher introduced each new basal section to the whole class by reading it aloud. Vocabulary work and discussion followed with both teacher- and student-generated questions. Additional comprehension activities included creating story maps, plot charts, and Venn diagrams.

In response to the diversity of students in the Stahl et al. classrooms, children who needed additional help were pulled aside for "echo reading," which involved teachers first reading a paragraph and then students reading the same paragraph. Students then read the selection again at home, preferably aloud to a parent. Further oral reading practice was made available from time to time, such as having each child practice reading one part of the selection for performance or having children reread the selection at home.

In addition, children were given daily opportunities to read books of their own choice and asked to read at home. Leslie and Caldwell's (1988) Qualitative Reading Inventory (QRI), a test consisting of graded passages for oral reading, each accompanied by comprehension questions, were used to assess reading growth. About 1.8 grade levels of growth were documented on average across the 14 second-grade classrooms in this study, almost twice as much as would be expected through maturation and traditional classroom practices alone. Although these outcomes are impressive, the 1997 Stahl et al. results also showed that students who began the program as nonreaders did not post significant gains in fluency. Their oral reading fluency with the grade-level basal continued to be slow and error prone. All but one of these 20 students could read at least at the primer level (i.e.,

beginning first grade), but 10 of them were still performing below grade level as measured by QRI oral reading and comprehension performance at the end of this one-year study.

Another example of a comprehensive reading program is the Four Block, multi-leveled approach, developed and studied by Cunningham, Hall, and Defee (1998), who reorganized elementary classroom reading programs using this approach. Three features of the Four Block method are similar to the features of Stahl's et al. (1997) program: (1) echo reading practices and rereading to improve word recognition and reading fluency, (2) student reading of self-selected books, and (3) student engagement in active comprehension work, for example, question and answering, discussions, story mapping. Other oral reading practices in the Four Block method are choral reading and reading books with predictable language and choral reading.

When the Four Block method is used, 2 1/4 to 2 1/2 hours daily is allotted to language arts; 30–40 minutes are devoted to each of four blocks: Guided Reading, Self-Selected Reading, Writing, and Working with Words (Cunningham et al., 1998). Comprehension is promoted through discussion about shared and self-selected reading and role-playing. Phonics, decoding, and sound-spelling are taught through phonemic analyses of words, "making words" with sets of letter cards (i.e., spelling and then switching letters around to make other words), and a writers' workshop that includes independent writing, as well as conferences and teacher-led mini-lessons.

To help struggling readers, small-group extra reading is provided daily for 45 minutes. Each small group includes one of the strongest readers in the classroom, one of the weakest readers, and two or three other children (Cunningham et al., 1998). The 45-minute session involves different activities: 10 minutes when students talk about their own self-selected books, shared reading and working through a book that they stay with for a week, word study involving making words, and then writing a sentence in response to the shared reading. Other schools using the Four Block method, according to Cunningham et al. (1998), use Reading Recovery to support struggling readers.

Cunningham et al. (1998) report that in a large suburban district in which the Four Block method was implemented across the elementary grades, of the 10–15 percent of children who were not reading at grade level at the end of first grade, one half were reading at or above grade level by second grade. By third, fourth, and fifth grade, each year, 90 percent of these same initially low-achieving students performed in the top 50th percentile. Cunningham et al. also described pilot study results from a site in a rural school district where 84 percent of students qualified for free and reduced lunch. After one year, 46 percent of first graders and 40 percent of second graders in classrooms using the Four Block method performed at or above grade level. In classrooms where the Four Block method was *not* being used, only 30 percent and 38 percent of first and second graders, respectively, performed at or above grade level.

Both Stahl et al. (1997) and Cunningham et al. (1998) found that when oral reading practice, including repeated reading to perfect fluency and accuracy, is used as part of an overall reading program, most elementary children are able to read at or above grade level. A critical feature of successful, comprehensive classroom reading programs is monitoring of reading fluency on an individual basis in order to identify and help struggling readers. Extra small-group reading time was provided to these readers as well as encouragement to engage in repeated oral reading at home. Some

individual children, however, 10 percent or less of a given cohort, develop at rates that do not allow them to reach grade-level benchmarks on time.

Conclusions and Implications for Practice

As the bottleneck (Perfetti & Roth, 1977) or gateway to reading for understanding, fluency has the potential to free and support mental capacity for strategic reading and sense making (LaBerge & Samuels, 1974). Oral reading practice, including repeated reading to perfect fluency and speed word recognition, is effective for helping elementary school children develop reading fluency. Research-based knowledge about classroom practices that improve student fluency suggests the following:

- Oral reading practice should be provided in brief sessions (15 to 30 minutes) and as part of a comprehensive classroom reading program.
- Extra oral reading practice should be provided to students who need greater numbers of exposures to words to gain familiarity and automaticity.
- Monitoring of student oral reading practice should be sensitive enough to identify developmental and individual needs (e.g., to confirm and consolidate print-sound knowledge or become "unglued" from print and integrate mechanics into a smoothly operating reading system that relies on multiple sources of information).

Vocabulary

Vocabulary is semantic knowledge about words and relationships used to understand, create meaning, and communicate. "Vocabulary is one of the most important areas within comprehension and should not be neglected" (NRP, 2000, p. 4-9). According to many authorities, the importance of vocabulary in reading for understanding has been recognized for more than a half century. The National Reading Panel subgroup on comprehension (2000) begins its synthesis of research on vocabulary instruction with the following quote from the 1925 edition of the National Society for Studies in Education Yearbook:

> Growth in reading power means, therefore, continuous enriching and enlarging of the reading vocabulary and increasing clarity of discrimination in appreciation of word values. (p. 4-15, quoting Whipple, 1925, p. 76)

The major conclusion of the NRP's (2000) review of experimental research on the efficacy of vocabulary instruction was that no single method would result in optimal learning. Similarly, Blachowicz and Fisher's (2000) recent review of research in the *Handbook of Reading Research III* concludes that vocabulary instruction should help students "build on *multiple* sources of information to learn words through *repeated* exposures" (p. 504). The remainder of this section provides a synthesis of the NRP and Blachowicz and Fisher findings organized around three principles derived from these two research reviews:

- Multiple methods and contexts ensure repeated exposure and aid learning.
- Personal and guided imagery and verbalization engage students in deep processing.
- Flexible vocabulary instruction respects students' diversity and thus promotes learning.

Multiple Methods and Contexts

According to meta-analytic results, providing students with multiple sources of information results in superior word learning (Blachowicz & Fisher, 2000, citing Stahl & Fairbanks, 1986). The NRP (2000) found that "extended, rich instruction of vocabulary (applying words to multiple contexts, etc.) was superior to less comprehensive methods" (p. 4-22). Comprehensive methods include combinations of direct and indirect methods of teaching and learning (NRP, 2000), studying definitions followed by sample sentences (Scott & Nagy, 1997), and immersing students in rich language environments where their attention is drawn to the learning of words (Blachowicz & Fisher, 2000). To illustrate a comprehensive approach, Blachowicz and Fisher cite McKeown, Beck, Omanson and Pople (1984). These researchers found that providing students with repeated exposures to new words and arranging activities beyond the classroom for students to use new words made a significant impact on tests of vocabulary. According to Blachowicz and Fisher, peer assistance also can provide multiple exposure to and explanations for key words and result in vocabulary gains. Peer assistance can be provided through reading in pairs and reciprocal peer-tutoring. To build vocabulary as a by-product of reading, Marzano, Seger, LaRock, and Barton (2000) recommend

- reading many books from a variety of genres, about a variety of topics, and at increasing or high levels of difficulty;
- keeping track of new words in a vocabulary notebook that organizes entries by meaningful categories (e.g., occupation, feelings/emotions, machines/tools);
- learning words on high-frequency word lists; and
- learning new terms through multiple exposures and uses.

Active Learning and Frequent Use

A number of research studies show that active learning by meaningfully analyzing, translating, and using new words facilitates vocabulary growth. For example, research (Daniels, 1994) found that in pre-kindergarten classrooms where American Sign Language was taught and used, hearing children were active participants in communication activities, and scored higher on tests of vocabulary than children in classrooms where only spoken English was taught and used. Other research noted by the National Reading Panel (2000) shows that in the upper grades, engaging students in multi-step, active processing and learning strategies (e.g., TOAST: test, organize, anchor, say, test) leads to greater vocabulary growth. Analyzing words in a particular category by distinguishing features (e.g., the distinguishing features of various types of rocks) also encourages active learning and vocabulary development (Blachowicz & Fisher, 2000). Teacher monitoring of students' performance and attention to the task, however, is key. Based on this feedback, teachers may need to redirect students, use alternate strategies or materials, or provide additional time for learning.

Flexible and Responsive Instruction

It is estimated that with over a year of wide reading, school children can learn 750 to 1,500 new vocabulary words incidentally (Marzano et al., 2000). Poor readers, however, do not learn vocabulary at rapid rates from incidental exposure while reading (Blachowicz & Fisher, 2000). For this reason and others, alternative vocabulary instruction methods should be made available to address particular instructional needs. Generally, however, instruction that works for good readers works for poor readers, for example aligning the depth of word knowledge with the requirements of current and future tasks, and helping students become increasingly more independent word learners. For poor readers, teachers should assist with decoding difficulties. Teachers should invite requests for definitions, provide speech prompts for pronunciation, and provide direct instruction in decoding strategies. For English second language learners, students benefit from instruction in the keyword method and other mnemonic devices (e.g., writing, repetition, contextual associations, use in a sentence, talking with others, imagery). Moreover, teachers and students should focus time and learning on words needed to build a vocabulary aligned with (1) the highest frequency words in English and (2) the core vocabulary of their academic subjects (Blachowicz & Fisher, 2000).

Blachowicz and Fisher (2000) note that the particular task demands of content-area reading, comprehension, and learning place vocabulary development in a key role. Previously learned words and their meanings, for example, may have to be modified to appropriately reflect the concepts and relationships denoted by the words in a particular discipline. Teachers can identify possible misconceptions or naive notions and help students unlearn them or develop them into more sophisticated understanding and knowledge. Strategies particularly appropriate to content-area reading and identified in Blachowicz and Fisher's review of research on vocabulary instruction include the following:

- Select or revise text for *considerateness* (proximity of vocabulary to defining terms, clarity of conceptions, explicitness).
- Pre-teach academic words (e.g., *unsubstantiated, meager, repertoire*).
- Use advanced organizers to provide a conceptual framework.
- Provide sample sentences using new terms to illustrate relationships.
- When a text marks the main points with surface cues (e.g., repetition of key terms; boldface), teach struggling readers how to use such cues to identify relevant words and main points.

Blachowicz and Fisher (2000) conclude their review of the research on vocabulary instruction by suggesting that

> teachers need to be knowledgeable about what they want students to know with respect to both the depth and breadth of learning and the kinds of connections to be made. Also, they must take into account the students' starting points. What do they already know that can help make the connection to new learning? What might conflict or confuse them? Teaching vocabulary becomes not a simple process of teaching words but one of teaching particular words to particular students for a particular purpose. (p. 517)

Conclusions and Implications for Practice

Growth in reading power means "continuous enriching and enlarging of the reading vocabulary and increasing clarity of discrimination in appreciation of word values" (Whipple, 1925, as quoted by the NRP, 2000, p. 4-15). To help students build vocabulary, according to both the NRP and Blachowicz and Fisher (2000), vocabulary instruction should include *both explicit and indirect methods* in a flexible manner that is responsive to individual learning needs. Specifically, evidence supports the following recommendations for vocabulary instruction:

- Assign, encourage and support wide reading and direct students' attention to the learning of new words from their reading through repeated use and exposure in multiple contexts.
- Ensure meaningful, repeated use of and exposure to new words in multiple contexts.
- Monitor and provide scaffolding and assistance to meet individual needs.
- Teach learning strategies.

Comprehension

To read with understanding a variety of texts for a variety of purposes is a core literacy standard. What does this mean? Read with understanding, or in more common terms, reading comprehension, is both superficial memory of text as well as deep understanding of the substance of text. According to Kintsch (1998), deeper understanding of text is *learning* from text. Although both involve construction of a mental representation, superficial memory is not integrated with the reader's prior knowledge and thus does not become part of it. Kintsch explains:

> In the extreme case, one can learn to recite a text by rote without understanding it at all. Learning from text, on the other hand, requires deeper understanding. I define learning from text as the ability to use the information acquired from the text productively in novel environments. This requires that the text information be integrated with the reader's prior knowledge and become a part of it, so that it can support comprehension and problem solving in new situations. (p. 290)

Developmental research suggests that not all young readers receive the instruction and experiences they need in and out of school to develop the abilities and knowledge required to read with understanding. In this section, this developmental research is followed by a synthesis of the work of Snow et al. (1998) for the NRC report and the NRP (2000) report. More recent and case study research is related to the Snow et al. and NRP findings, including research on content-area reading and students' attitudes toward reading.

Developmental Research

In the early 1980s, Juel (1988) followed 54 children to study their literacy development from first to fourth grade. Juel notes that the 54 children "attended one large, neighborhood elementary school

and lived in a low socioeconomic status area of small houses, duplexes, and apartments in Austin, Texas" (p. 439). Forty-three percent of the children were Hispanic, 31 percent Black, and 26 percent white. At the end of first grade, 29 children in the study scored in the lowest quartile on a norm-referenced test of reading comprehension, yielding an average grade equivalent of K–6. In grade-equivalent scores, this indicates that this group performed at levels expected of children who had attended only the first six months of kindergarten. Juel followed these children for the next three years assessing their reading and writing in second, third, and fourth grades.

Juel (1988) found that the probability that a poor reader at the end of first grade would become an average reader by fourth grade was about a one-in-eight. On average, the first-grade poor readers exhibited the same gap in performance at fourth grade that they did in first grade. At fourth grade their average grade equivalent was 3.5. It appeared that the school and classroom practices in Juel's study site were not effectively reducing the gap between measured performance and grade-level benchmarks for beginning poor readers.

Juel's (1988) research suggests that the continuing gaps between grade completion and expected achievement for these end-of-first-grade poor readers were due to inadequate early *and* beginning literacy and language instruction and experience. These inadequacies in instruction and experience consisted of (1) inadequate learning opportunities for beginning poor readers (i.e., there was no assessment of developing phonemic awareness nor appropriate instructional response, insufficient opportunities early on to learn how use print-sound knowledge, and not enough practice reading continuous text); (2) a strong dislike for reading among the poor readers; and (3) continuing, unidentified, and unaddressed language delays (e.g., despite the fact that listening comprehension scores were equivalent for good and poor readers in first grade, by fourth grade, poor readers performed at a mean grade equivalent of 2.6, whereas good readers performed at a mean grade equivalent of 5.2).

Juel (1988) and other researchers (e.g., Allington, 2001) believe that limited reading experiences is a major reason for continuing achievement gaps. Juel concludes her study by acknowledging that her findings were correlational and that intervention studies were needed to test hypotheses suggested in her research. Juel recommends that

> every effort must be made both to keep them [poor readers] motivated to read and to keep up their listening comprehension so they do not fall so far behind in vocabulary, concepts, and so on. The age-old technique of reading to children often seems to fit the requirement nicely and should not be forgotten in the elementary grades. (p. 448)

As noted in previous sections of this chapter on classroom practices for developing phonemic and the mechanics of reading, attention to these particular aspects of literacy development should never be treated as stand-alone interventions. Instead, these interventions need to be part of comprehensive classroom reading programs, including as recommended by the NRP (2000), reading aloud "quality literature to students to build a sense of story and to develop vocabulary and comprehension" (p. 2-136).

Research-Based Classroom Practices for Fostering Comprehension

Research shows that teachers can successfully teach active, strategic reading. The NRP's (2000) review of research found that instruction in comprehension monitoring was associated with positive effects on students' performance on standardized tests of reading comprehension. According to the NRP report, teachers used think-aloud demonstrations to model awareness of difficulties and strategies for addressing the difficulties, including articulating what is causing the difficulty, looking back or forward in the text to try to solve the problem, and restating or paraphrasing the text. Across grades three through six, significant positive effects were found for such modeling of comprehension monitoring strategies on student awareness of their own comprehension difficulties and to a lesser extent on student reading test performance. The subgroup concludes that "there is evidence that this training has specific and general transfer benefits" (NRP, 2000, p. 4-71).

Other strategies that the NRP (2000) comprehension subgroup's research review revealed to be effective and most promising for classroom practice were

- cooperative learning,
- graphic and semantic organizers (including story maps),
- question answering,
- question generating, and
- summarization.

Most promising of all for classroom practice were approaches to strategy instruction that focused on multiple strategies, rather than a single strategy, and utilized teacher modeling with guided and independent practice and opportunities to discuss the substance of texts.

Literate conversations. Citing Palincsar, Brown, and Campione (1993), Snow et al. (1998) explain how classroom teachers can successfully improve non-readers' or poor readers' listening comprehension. The research of Palincsar et al. involved teachers in first- and second-grade classrooms using reciprocal teaching dialogues about texts read with children or by children silently or orally depending on children's decoding abilities. Snow et al. reported that with such an approach, children's listening comprehension improves significantly. In addition,

> teachers reported that, as a result of their experiences in reciprocal teaching dialogues, their expectations regarding these children were raised. In other words, children who appeared to have a disability on the basis of their participation in the conventional classroom dynamic appeared quite able in the context of reciprocal teaching dialogues. (p. 222)

Reciprocal Teaching, developed by Brown and Palincsar (1989), is an approach to developing comprehension that relies on small-group instruction and dialogues. The teacher models active strategic reading, specifically four strategies: generating questions, summarizing, clarification of word meanings, and activating prior knowledge through making and investigating predictions (Rosenshine & Meister, 1994). In small groups, students watch and practice the strategies on a passage of expository material, paragraph by paragraph, first with teacher feedback, then among

themselves, providing instructional support for one another. The practice becomes a dialogue. For example, according to Rosenshine and Meister (1994), one student in the group generates and states a question and another student answers it. A third student comments on the answer. One student provides a summary of the passage and another student comments on the summary or helps to improve it.

In a meta-analysis of 16 studies evaluating Reciprocal Teaching used with individuals ranging in age from seven years old to adulthood, Rosenshine and Meister (1994) found significant effects on reading comprehension as measured by accuracy in summaries of main ideas or responses to short-answer questions about passages read (i.e., an average effect size of .88 for 10 effect sizes). When analyzed by grade level, Rosenshine and Meister found that the significant impact on comprehension associated with Reciprocal Teaching occurred only at the middle school grade levels and with adults. Moreover, the measured effectiveness was less impressive when standardized reading comprehension tests were used (e.g., the Gates-MacGinitie Reading Test). Rosenshine and Meister found an average effect size for standardized comprehension tests of .32 for nine effect sizes.

A number of other researchers (e.g., Allington, 2001; Keene & Zimmerman, 1997; Hiebert et al., 1998; Raphael, 1998; Newmann et al., 2001) have suggested additional strategic, conversational approaches to developing reading comprehension:

- K-W-L (what do you know, what do you want to learn, and what have you learned)
- Conversations about text-to-self, text-to-texts, and text-to-world connections
- Experience-Text-Relationship (ETR) developed by teachers working in low-income schools as a way to engage students in discussions about their reading
- Literacy circles or discussion groups called book clubs that replace the traditional classroom talk pattern dominated by teacher control (i.e., initiation-response-evaluation [I-R-E] with classroom talk comprised of a balance of teacher- and student-initiated exchanges
- Debates

According to Hiebert et al. (1998), teachers who use ETR have found that it helps students discover that "texts can be used as 'evidence' to support their own conclusions about big ideas like themes and characters" (Topic 5, p. 3). According to Raphael (1998), talk among and by students about what they're reading (1) contributes greatly to their ability to work through complex issues and (2) provides teachers with data on student understanding that can lead to spontaneous instruction within teachable moments. Teachers in high-performing, high-needs schools expect their "students to not merely work together, but to sharpen their understanding with, against, and from each other" (Langer, 1999, p. 35). "In comparison," Langer found, "teachers in more typical classes focused on individual thinking" (p. 35).

Classroom time and space. To become an active, skilled reader and participate in thoughtful conversations takes time spent in a literate community. It is not easy for teachers or students to develop conceptions about what it means to be an active skilled reader (NRP, 2000). Modeling and encouraging use of active, strategic approaches to reading for understanding has been shown to

positively impact student reading performance (NRP, 2000; Snow et al., 1998, citing Haller, Child, & Walberg's [1998] meta-analysis of the effects of meta-cognitive strategy instruction on reading). Snow et al. point out, however, that the effectiveness of such instruction lies in the "intermingling of two pedagogic processes" (p. 220), namely, instruction in relevant background knowledge about the content of texts and instruction in particular active learning strategies.

To create literate communities in classrooms in which strategic reading is modeled and thoughtful conversations practiced, Allington (2001) recommends

- large blocks of uninterrupted time;
- regular time allocated to simply reading (e.g., 15–30 minutes or 11+ pages 3–5 days/week);
- opportunity to explore ideas and themes in depth;
- students seated at tables, rather than desks;
- a large supply of enticing reading material (e.g., books, magazines, series books, junk reading) across a range of difficulty at least as wide as the range of reading achievement levels of students in the class; and
- access to school book rooms and libraries and public libraries.

Structured reading practice. Conversational approaches alone are not the only practices used by exemplary teachers to engage students thoughtfully in reading and writing. Research shows that student growth in literacy depends on classroom time for reading and writing narratives, stories, and other extended texts plus use of traditional workbook-type exercises (Briggs & Thomas, 1997; Knapp, 1995; Snow et al., 1991). Snow et al. (1991) studied family and school factors related to literacy in racially and ethnically mixed neighborhoods including financially secure working-class as well as poor families. Their study involved following three cohorts of children, students originally in grades two, four, and six, for two years; thus, their data collection extended into grades three, five, and seven. Individual case follow-up was also done in ninth grade.

With regard to students' reading comprehension, quantitative analyses showed that classroom practices that significantly related to gains were

- practice with structured materials (such as workbook homework),
- direct teaching (the amount of time allocated for reading instruction, the quality of instruction ratings, the presence of explicit teaching of comprehension strategies), and
- wide exposure to literacy materials (visits to the library, use of varied materials in reading instruction, use of more difficult texts). (Snow et al., 1991, pp. 143–144)

One of the fifth-grade teachers in Snow et al.'s (1991) study exemplifies these findings; and one of her students, Charles, illustrates the positive impact she had on students' achievement. While in her class, Charles' reading comprehension test scores increased 2.2 years. His teacher, Ms. Pasquale, had assembled more than 600 titles in her classroom library plus masses of comics, magazines, and newspapers. She included conventional skills workbooks and traditional texts in lessons and

conducted small-group instruction in phonics and comprehension. "On 3 days a week, 30 minutes was allocated to simply reading" (Snow et al., p. 149). Ms. Pasquale emphasized math and science; her classroom was well stocked with math and science tools (e.g., Cuisenaire rods, magnets, microscopes). Every Thursday, she walked the class to a well-stocked branch library to select a book to read at home. At the ninth-grade follow-up, however, four years later, Charles "was reading at a third grade level, even lower than his fifth grade scores" (p. 187). Although Charles' story is a single, perhaps dated and extreme case, his story as documented and told by Snow et al. indicates that there are still some puzzles about individual differences and challenges that need to be addressed for all students to meet standards in literacy.

Content-area reading. Recent reviews of classroom-based research and about the role of prior knowledge in content-area reading reveal that prior knowledge needs to be discussed and made explicit in order to detect prior misconceptions or unsophisticated knowledge (Dole, 2000). The quality of readers' prior knowledge and beliefs influences the extent to which readers learn from text. Prior knowledge that is inconsistent with information in a passage can interfere with learning. When prior knowledge consists of misconceptions or naive knowledge, many readers hold onto their misconceptions and naivete "despite reading contradictory information in text" (Dole, p. 101). Dole's research and that of others (e.g., Swafford & Bryan, 2000) indicates that simply making explicit the readers' common misconceptions as well as clearly making refutational statements available helps students change their understanding and acquire more sophisticated knowledge.

In science classes, Dole (2000) found that when texts directly stated and then refuted students' naive conceptions, students demonstrated more sophisticated understanding of science concepts. Based on her research, Dole recommends that teachers teach students to use metacognitive strategies to monitor their existing and changing conceptions. For example, writing, through learning logs, think sheets, and collaborative reports, can be used with middle school students to make their thinking public or explicit and thus more easily monitored and likely to be refined (Swafford & Bryan, 2000). Finally, Dole recommends that for students who struggle with the mechanics of reading and writing, alternative ways to learn concepts must be made available, such as supplementary books, team work, individual tutoring, and audio cassettes.

Student Diversity

Dole's (2000) and Swafford and Bryan's (2000) research support recommendations made by Allington (2001). In his book *What Really Matters for Struggling Readers: Designing Research-Based Programs,* Allington writes, "It is important that students develop the habit of reflecting on what they already know about a text or the topic of a text before they begin reading" (p. 99). In addition, teachers need to be aware of, and respond productively to, students' attitudes, beliefs, and interpretations of expectations (Dole, 2000). For example, Dole observed that some students, when taught how to paraphrase text while reading, copied what their neighbors wrote or copied from the textbook instead of recording their own ideas. Students' work avoidance is consistent with some recent research on reading motivation, which notes that students report not "liking reading when there are too many people, vocabulary questions, complicated stories to follow or when the words are too difficult" (Baker & Wigfield, 1999, p. 476).

Baker and Wigfield (1999) found that among fifth- and sixth-grade students in an urban school district, the factors that motivated different groups of students to read and achieve were both similar and different. In terms of similarities between students by ethnicity, the reading achievement of both African American and white students (as measured by the Comprehensive Test of Basic Skills [CTBS]) was influenced by three factors. Both African American and white students who reported little interest in reading complicated stories and other difficult passages scored lower on the reading test. African American and white students who reported that they liked to read difficult material and that they experienced enjoyment from reading scored higher on the reading test. In addition, white students who reported being motivated by self-efficacy, curiosity, recognition, grades, and compliance (reading to meet the expectations of others) had higher reading scores — a correlation that was not found for African American students.

In terms of gender, both boys and girls who reported avoiding difficult reading material scored lower on the CTBS. Girls who reported that they gained satisfaction from reading scored higher on the reading test — this statistically significant correlation was not found for boys (Baker & Wigfield, 1999). Finally, one relationship between socioeconomic status and reading motivation was found. Middle-income family children were more found to be more motivated to avoid work related to reading than low-income children. "Thus, it is clearly not the case that students who may lack material resources and opportunity because of low income are less motivated with respect to reading" (Baker & Wigfield, p. 473).

Baker and Wigfield's (1999) research shows that students vary in their reasons for reading and that it may be important for teachers to distinguish among these reasons. To make the most of the attitudes, beliefs, and emotions that influence the processes of reading for understanding, Marzano et al. (2000) recommend the following practices:

- Identify and build upon individual student interests.
- Help students generate interest (e.g., "How can I use this information or experience to accomplish a goal that is important to me?").
- Help students replace negative self-talk with positive self-talk (e.g., replace, "This isn't interesting" with "I'm going to find something of interest to me").
- Provide students with strategies for recognizing and understanding emotional responses to reading (e.g., surprise, puzzlement, frustration, sadness). (pp. 8.4–8.8)

Conclusions and Implications for Practice

To read with understanding, or more commonly, reading comprehension, involves both superficial memory of text as well as deep understanding of the substance of text. Learning from text "requires that text information be integrated with the readers' prior knowledge and become part of it, so that it can support comprehension and problem solving in new situations" (Kintsch, 1998, p. 290). Good readers are active strategic readers (Pressley, 1998).

To help students develop conceptions about what it means to be a strategic reader and to apply this understanding productively in school, daily life, and on the job, evidence supports the following recommendations for classroom practices:

- Model key strategies using think-aloud demonstrations, followed by student practice that includes teacher feedback.
- Create classroom learning environments for literate, thoughtful conversations about both strategy applications (metacognitive dialogue) and the content of texts (substantive dialogue)
- Develop language comprehension skills in general while developing proficiency in the print-specific mechanics of reading for understanding.
- Provide both direct and indirect methods of teaching and learning in ample amounts (e.g., practice with structured materials [such as workbook homework] and wide exposure to literacy materials [visits to the library, use of varied materials in reading instruction, use of more difficult texts]).

WRITING

> Learning to write assists children in their reading; in learning to read, children also gain insights that help them as writers. But writing is more than an aid to learning to read; it is an important curricular goal. Through writing children express themselves, clarify their thinking, communicate ideas, and integrate new information into their knowledge base. (Hiebert et al., 1998, Topic 6, p. 1)

Unlike the two major reviews of research on reading instruction (NRP, 2000; Snow et al., 1998), reviews of research on writing instruction are less recent. One noteworthy early study is the NCTE-commissioned Braddock Report, which noted that there was only a rudimentary awareness of the teaching of writing: "Some terms are being defined usefully, a number of other procedures are being refined, but the field as a whole is laced with dreams, prejudices, and makeshift operations" (as quoted in Smith, 2000, p. 1). About 20 years later, Hillocks's (1984) meta-analysis of the effectiveness of different approaches to writing instruction revealed that teaching grammar had little positive benefit for students in terms of their ability to write effectively, but that teaching procedures for learning about the substance of what one is going to write about had much benefit. Hillocks's meta-analysis confirmed the efficacy of process approaches to writing instruction.

In this section, research findings about the effectiveness of different classroom practices are reviewed. These findings are organized around the following topics critical to learning to write, namely, the reading-writing connection, spelling, composing, and productive dispositions and habits. This section also examines the research about the connections between accountability assessment and writing instruction.

The Reading-Writing Connection

In many respects, reading and writing are both problem-solving tasks. Beginners problem solve to decode and spell words. Skilled readers problem solve to make sense of what they read when it is

confusing or contradicts or challenges prior knowledge (Pressley & Afflerbach, 1995). Similarly, writing requires problem solving, involving, for example, planning how to reach goals, making decisions about sequence, emphasis, and mode of presentation of ideas, and determining how to compose text that is appropriate for the audience (Hayes, 2000; Rosebery et al., 1989; Scardamalia & Bereiter, 1985). In both spelling and composing, knowledge gained from reading informs one's facility with writing (Langer, 1999). When approached as similar, related problem-solving tasks, knowledge is transferred between reading and writing. Successful instruction in both reading and writing can begin in the earliest grades, but instruction in one cannot replace the other; it is best to focus on both (Langer, 1999).

In science courses, writing to learn significantly and positively influences students' conceptual understanding. When middle school students write to explore their own ideas, share ideas with peers, and reflect on those ideas, in combination with teacher-led discussions, they examine and re-examine their knowledge as they encounter new information in lessons and in reading (Swafford & Bryan, 2000). Learning logs, when used in conjunction with hands-on activities, can be used like dialogue journals as a means for students to communicate what they know and understand to a teacher and receive feedback. As described by Swafford and Bryan, "Writing not only helps students organize their observations, but also gives the teacher an opportunity to intervene and invite students to consider alternative evidence" (p. 156). Writing is also used to actively engage students in making sense of text when reading; for example, before reading a science text, students write what they know, share their entries with partners, read the text, and write what they learned (K-W-L) (Swafford & Bryan, 2000).

Spelling

In the earliest grades, beginning writers develop phonemic awareness and knowledge of print-sound associations as they compose messages (Hiebert et al., 1998). Hiebert et al. cite research by Clarke (1988) demonstrating that when first-grade children were encouraged to use sound-spelling (invented spelling), they wrote longer compositions and performed better on spelling and word analysis tasks than children who were encouraged to use conventional spelling. The most positive effects were found for children who were struggling the most in reading at the beginning of first grade, perhaps giving these children "the confidence that they can attempt words they have not seen or written before" (Hiebert et al., Topic 6, p. 6). Effective teachers also use information in students' invented spellings and other aspects of students' writing to identify gaps in children's knowledge about language structure and conventions and direct their instruction accordingly to address those needs (Heistad, 1997).

To teach conventional spelling, Hiebert et al. (1998) suggest that in addition to a formal spelling program, teachers should expect children to be responsible for correctly spelling words used in their writing and that they should provide time, reminders, and editing/proofreading checklists for this purpose.

Composing

Hillocks (1984) conducted a meta-analysis of 73 studies that assessed the effect of four different instructional modes and six different focus areas for writing instruction on students' writing performance. Findings about the effectiveness of the different modes are summarized first, followed by findings about the effectiveness of the different focus areas.

The first instructional mode was termed presentational. In this mode, the teacher dominates the classroom by lecturing and presenting material from the textbook, assigns predetermined assignments, and establishes criteria for writing. Hillocks describes this mode as "teaching is telling." The second mode of instruction is the natural process. Here the teacher gives the students more autonomy by encouraging them to pick their own writing topic, engage in peer feedback, revise their writing, and participate in small, student-led discussion groups. The third mode of instruction is individualized writing conferences between the teacher and student. The fourth mode of instruction is environmental, which "places student, materials, activities, teacher, and learning task in balance" (Hillocks, 1995, p. 221). In the environmental mode of writing instruction, teachers organize "student-led small-group discussions focused on solving problems" (Hillocks, 1995, p. 221) that involve making and justifying judgments about writing and revisions. The student-led, small-group discussions focus on "specifically stated dimensions, such as judging pieces of writing according to specific criteria and revising some or all of them according to suggestions generated through use of the criteria" (Hillocks, 1995, p. 221). Hillocks's (1984) meta-analysis revealed that students in the environmental group outperformed students in the other three groups. This indicates that students improve their writing when teachers make explicit for them the criteria against which their writing will be judged, allow and encourage them to work together using that criteria to judge writing, and expect them to justify their reasoning to one another.

In addition, the meta-analysis identified six different focus areas for writing instruction investigated by researchers. These included grammar study, the study of model pieces of writing, sentence-combining practice, use of scales to judge and revise writing, inquiry instruction and practice, and free-writing practice. The most effective treatments were process oriented, namely, in order of greatest effectiveness: learning and practicing inquiry (e.g., through observation, drafting interpretations), practicing sentence combining, and judging and revising writing with the guidance of rubrics. Grammar study produced no positive benefit for students in terms of their ability to write effectively. Thus, Hillocks's (1984) research shows that teaching students how to write leads to students learning how to write.

In elementary school, students need much time and opportunities to practice learning how to write. According to Hiebert et al. (1998), learning to write in elementary school occurs through frequent, often daily, writing from kindergarten through third grade. In his chapter on understanding cognition and affect in writing, Hayes (2000) stated that "extensive writing experience is widely assumed to be essential for development of high levels of writing skill; for example, with increased experience, writers may acquire more effective writing strategies, more refined standards for evaluating text, more facility with specific genre, and so on" (p. 39). He noted that research suggests that many years of practice, a decade was reported in some studies, may be required to attain expert performance in any genre of writing.

In addition, students who have teachers who talk with them always or sometimes about their writing perform higher on the NAEP writing assessment (Greenwald, Persky, Campbell, & Mazzeo, 1999). Talk that is conversational rather than primarily "teacher talk" is more effective for students learning to write.

Children need to learn the writing process, including planning (i.e., generating ideas, organizing, and setting goals), composing, revising (reading and editing), and, throughout the process, monitoring (Hayes, 2000). In some cases state policy encourages these types of processes. For example, in Kentucky, the state writing assessment in 1997–1998 included both an on-demand written response to a prompt as well as a portfolio of original, genre-varied compositions collected over one year. Teachers studied by Wolf, Borko, Elliott, and McIver (2000) found that the portfolio requirement changed their writing instruction dramatically from teaching grammar to using a workshop approach. Teachers modeled writerly habits, such as being "in love with the pencil," not for making "corrections by the millions," but "to demonstrate their own fascination with writing" (Wolf et al., pp. 378–379). Writers from the communities came to speak about writing. Students were taught how to reflect on their writing through both self- and peer-critiques, and to "fire-up" a piece to make it more readable and engaging. In this case study, it was evident that the state writing assessments and professional development provided in writing instruction gave teachers opportunities to think and talk more deeply about writing and to experiment with new approaches in their classrooms. The portfolio requirement had allowed them to teach students productive habits of mind, such as revising to improve readability and listening to a story twice to figure out what their peers were talking about in their pieces.

Since a key to writing is learning how to recall content without prompts from conversational partners, Hillocks (1995) advocates explicitly teaching inquiry as part of writing instruction. Basic strategies for inquiry include observing, questioning, constructing representations and interpretations, and testing hypotheses. Other planning strategies for recalling content include mapping, listing, brainstorming, analyzing data to develop claims for arguments, and paying close attention to sensory perceptions for generating detail. For students to learn process writing, they need modeling, explanations, and guiding practice with coaching and a gradual reduction of support. Hillocks is adamantly opposed to teaching as "telling and testing." He writes, "Explicit teaching is not worth a dead cow in a dairy farm if it is removed from actually using the procedure or concepts at some level of sophistication" (p. 123).

Productive Dispositions and Habits

Learning to write for a variety of audiences and purposes occurs through participation in literate communities that provide modeling and encouragement of, and resources supporting, writerly habits and dispositions (Freedman, 1998). Assignments need to be designed to reinforce the belief that writing and reading are purposeful, meaningful acts and tools of communication (Rosebery et al., 1989). Providing students with choice in what they read and write, for example, positively affects their attitude toward learning (Langer, 1999). Writing to learn is another example of writing purposefully. Research has found that essay writing, for example to defend a position or explain a cause-and-effect relationship, is more beneficial than answering questions or taking notes regardless of students' prior knowledge (Newell, 1984, as cited by Langer, 1999).

One example of how a teacher created a language-rich environment was reported by Freedman (1998). In a California classroom of low-tracked, multiethnic, inner-city, grade nine, formerly low-achieving students, students exchanged their writing and served as audiences with classrooms in Britain. Over the course of a year, Bridget, their teacher in the U.S. classroom, along with a team of researchers and the British students, created a language-rich social environment in which it was "cool" to write. She also carefully attended to the needs of each developing individual student. Freedman notes that "Bridget used the writing that came from England to help her students analyze, talk about, and then practice what makes a piece successful and what appeals to a distant audience" (p. 192).

Maintaining a language-rich social environment for high-needs students such as the classroom described by Freedman (1998) has implications for instructional time. When one of the students was asked if he could apply what he learned about writing to school next year, he reflected:

> I was writing to some friends, and so then I cared, about what I was writing, and . . . then you know that slowed it down, and you know I took my time, and you know I got it all. Finished and, that would be, a way I would write to a teacher, I would make sure everything's, you know . . . best as it could be. (Freedman, 1998, p. 203)

This student's reflection suggests that in order to succeed with "school writing" next year, he will need sufficient time to slow it down and make sure everything's the best it can be. Extending academic time in literacy for students who need it is recommended by Allington (2001) and others (e.g., Education Trust, 1999) in the form of double reading or language arts instructional periods. An extra writing course for students who fail the state assessment in Maryland has also proved effective for helping students demonstrate proficiency in literacy (Ketter & Pool, 2001).

Accountability, Assessments and Writing Instruction

Some preliminary research examining relationships between accountability, assessments, and writing instruction suggests that the relationships are complex and both advantageous and detrimental to the quality of writing instruction. In order to help students pass state writing exams, educators have designed and implemented special courses for students who fail such exams. Ketter and Pool (2001) studied writing instruction and student writing in a class for students who had either failed the state writing test prior to ninth grade and/or had high instructional needs (e.g., 14 of the 23 students were identified for special education). Teachers of the class frequently used the Topic, Audience, Purpose, Form (TAPF) algorithm, an instructional routine developed for practicing test-like prompts. Their students wrote using TAPF and successfully addressed and met criteria on the scoring guides used to evaluate their writing. After class participation, all but one student passed the state writing assessment (and one more student dropped out just before the assessment). Nonetheless, Ketter and Pool's observations, interviews with students, and analyses of writing samples, led them to conclude that the instruction in this class narrowed conceptions of writing and narrowed the range of skill, strategy, and genre exposure. Ketter and Pool conclude that the students learned to become test-takers, not writers or authors.

Similarly, Strickland et al. (2001) reported both positive and negative effects of state assessment and accountability pressures on writing instruction. On the positive side, teachers began thinking and talking more about writing with the potential of unifying school staffs around consistent goals across grade levels. Second, the increased use of well-conceived rubrics promoted the learning of teachers with little background in writing and served as tools for student self-monitoring and assessment. Some teachers reported that the standards-based reforms in writing had caused them to expand their writing programs to include more writing forms.

On the other hand, teachers complained about a lack of sufficient time to teach writing and the fragmented curriculum that results given the pressure to cover a multitude of standards (Strickland et al., 2001). A narrowing of writing instruction to focus on only test-taking was also a complaint. Strickland et al. expressed dissatisfaction with the current impact of standards-based reform:

> All writers need time to experiment, to think outside the box. They need opportunities to select their own topics and to work in a wide variety of genres, well beyond those that will be tested. Ironically, it would be more honest to simply spend a portion of time teaching to the writing test as its own genre. (p. 396)

Research suggests there is variation in how educators respond to accountability in writing. Langer (1999) studied "beat-the-odds" middle school and high schools serving high-needs student populations in ways that resulted in outstanding performance on state tests. Langer found that faculty and staff analyzed the state writing tests for key skills and knowledge and then revised their curriculum and instruction to include explicit opportunities for students to develop these particular skills and knowledge. The teachers integrated test preparation into their ongoing curriculum and instruction and spent only a small amount of time teaching to the writing test as its own genre. Therefore, unlike the special writing test-preparation course studied in the Ketter and Pool (2001) research, test preparation in the Langer study sites occurred as part of ongoing, regular classroom instruction. More research is needed that examines alternate ways of providing writing test preparation to students with high needs. The relationships between accountability, individual student needs, instruction, and literacy are complex and deserving of further attention.

Conclusions and Implications for Practice

Research and experience tell us that students learn to write by participating in literate communities. Recommended classroom practices to help develop literate communities include the following:

- Immerse students in reading and writing of whole, personally meaningful texts (e.g., students writing to and from each other in British and American classrooms).
- Help students transfer knowledge between reading and writing.
- Teach the whole writing process as a reiterative, cyclical process.
- Expect students to apply skills and knowledge learned in isolation to reading and writing stories, articles, and other extended texts.
- Allow for student choice in reading and writing.

- Engage students in thoughtful conversations about both the process of strategy application (metacognitive dialogue) and the content of their writing (substantive dialogue).
- Prepare students for upcoming high-stakes tests with instruction specially designed to help them meet the particular demands of upcoming writing tests.
- Provide sufficient time for thoughtful conversations and practice of the writing process and particular strategies, for example double or extra periods of instruction.

EXEMPLARY LITERACY TEACHERS AND THEIR SCHOOLS

In recent years, a number of researchers have studied literacy practices in classrooms and schools. These studies are situated in and inform the complicated arena of good teaching for literacy development (Allington & Johnston, 2000). Unlike many of the researchers cited in the previous sections who more typically have a cognitive-componential view of reading and learning, these researchers more typically have a social-constructivist view of reading and learning. However, each view complements the other and helps to build a fuller understanding of what needs to happen in classrooms for all students to become literate.

Most of the research reviewed in this section was conducted in elementary schools (Allington & Johnston, 2000; Briggs & Thomas, 1997; Education Trust, 1999; Heistad, 1997; Pressley et al., 2001; Taylor, Pearson, Clark, & Walpole, 1999), but not all (Langer, 1999). Researchers sought nominations of exemplary teachers and schools or identified them on the basis of students' high performance on state or other assessments in reading and writing. Researchers observed, surveyed, and interviewed teachers extensively to gather data and made sense of the data through a reiterative process of using conceptual frameworks to formulate and test working hypotheses and in turn revise hypotheses and the frameworks.

Findings from the exemplary teacher and schools research are clustered around four headings:

- Sophisticated Pedagogical Content Knowledge
- Tailoring Instruction
- Metacognitive Modeling and Coaching
- Complexity and Interactions

Sophisticated Pedagogical Content Knowledge

The predominant finding from exemplary literacy teacher research is that exemplary teachers teach to children's assessed needs. They base these needs assessments on sophisticated knowledge about literacy and literacy development. In their classrooms and interactions with students, teachers represent literacy as actual reading and writing and frequent participation in substantive discussions about what and how students read and write. These classroom structures and interactions demonstrate pedagogical content knowledge in action. Shulman (1986) and Darling-Hammond (1999) define pedagogical content knowledge (see Chapter 3 of this synthesis) as

- knowing how to represent the core ideas of a content area to students,
- understanding the common mistakes students make, and
- considering how to build on students' prior experiences and knowledge.

According to Stahl (1998), sophisticated pedagogical content knowledge for beginning literacy has the following dimensions:

> First, it involves "kidwatching," or close analysis of children's writing and invented spelling, and the observation of children's miscues during reading. This involves a teacher's knowing (and carrying around in his or her head) a scope and sequence of phonics skills and a knowledge of where every child is in relation to that scope and sequence. It involves targeting instruction to a child's level so that a child gets instruction in short *a*, for example, when she or he is ready for it, not at a point in the year when the guidebook says it should be taught. This involves fairly expert teaching. (p. 58)

With their sophisticated knowledge base, exemplary literacy teachers are selective about the practices they use in their classrooms rather than adopting an allegiance to one or another ideology or orientation. Pressley et al. (2001) suggests that exemplary teachers' selectivity and professional judgment are illustrative of the idea of *conceptual selectivity,* which according to Duffy (1991) should be a core component of teacher education. In their study of 30 first-grade teachers, Pressley et al. found that exemplary teachers selected and combined practices that worked for them and their students without regard for the purity of one approach or orientation. Pressley et al. conclude:

> This study provides support for neither any hypothesis that effective literacy instruction boils down to one or two critical components nor the particular package of components favored either by skills advocates or whole-language-oriented educators. Rather, there was support for the position that effective literacy instruction is a complex interaction of components. That does not mean, however, that we observed a little of this and a little of that in the classrooms of the most effective teachers. Rather, in the most-effective-for-locale classrooms, we observed a lot of skills instruction intelligently integrated with voluminous reading and writing. (pp. 49–50)

In an urban district, Heistad (1997) found evidence consistent with the idea of conceptual selectivity as a distinctive quality of exceptional teachers. Heistad surveyed 102 second-grade teachers about their specific reading practices for one randomly selected struggling student (identified by performing at the 50th percentile or lower on a standardized test of reading comprehension). "Beat-the-odds" teachers were then identified by classrooms of students who exhibited the greatest value-added gains in reading comprehension. Value-added gains represented increased comprehension performance from the beginning to the end of the second-grade year. The practices reported by these 17 "beat-the-odds" or exceptional teachers (16% of total sample) were compared to practices reported by all other teachers.

Heistad (1997) found that the "beat-the-odds" teachers demonstrated greater expertise in literacy instruction through their beliefs and practices. They were less likely than all other teachers to believe that literacy developed naturally like speaking without guidance and planned opportunities from adults. They reported less allegiance to the whole language approach. They engaged students more frequently in independent reading and journal writing and gave students incentives to read. Students in their classrooms made greater gains in reading than students in all other classrooms.

Langer (1999) described sophisticated pedagogical content knowledge in the words of one exemplary middle school teacher who called herself the "Grammar Queen." She used "literature the students read as models for targeted conventions, language choices, literary concepts, and stylistic devices" (Langer, 1999, p. 17). The "Grammar Queen" was masterful at making reverberating connections across and during activities by commenting through direct statements and offering reminders and instruction about literary devices and other linguistic features without interfering with students' efforts at interpretation.

Tailoring Instruction

Exemplary literacy teachers understand common mistakes students make as they learn to read and write. These teachers teach opportunistically and responsively. They observe students read and write whole texts and conduct mini-lessons at teachable moments and/or small instructional groups regularly on a daily basis. What impressed the researchers on the CELA project was the exemplary fourth-grade teachers' knowledge applied in practice:

> Indeed, part of what we found impressive is this very ability to know when to be explicit, which entails knowing roughly what students know, what they need to know at a particular point, and what they can figure out for themselves. (p. 17)

Several researchers found that use of small, flexible instructional groups characterized exemplary literacy learning and teaching in elementary-level classrooms and schools (Briggs & Thomas, 1997; Heistad, 1997; Taylor et al., 1999). Consistent with recommendations from the Center for Early Instruction and Achievement in Reading (CIERA), grouping is used to individualize and intensify learning of skills and applications (Hiebert et al., 1998). Grouping structures and decisions are responsive to students' needs and varied across days. For example, one of Heistad's "beat-the-odds" teachers reported using whole-class instruction some days and small-group instruction on other days.

Instructional leaders in exemplary schools change group assignments mid-year and mid-semester based on students' need as shown in Briggs and Thomas' (1997) report on a study of four exemplary elementary schools in Texas. At a large school with a 1,100-student enrollment, Briggs and Thomas found that grade-level chairs assumed most of the responsibility for assigning students in classrooms. The principal at this school reported:

> Students are grouped so that no teacher has more than three groups of students in a class. . . . Grouping is based upon an individual placement test through Reading Mastery and each student reading [aloud] to a teacher. No student is locked into a group or class. . . . The key is to reach them where they are and to move them

> forward. We will move students around during the day. For example, a new fourth-grade student couldn't read, so we put her in the third grade (for four months) for reading instruction and in fourth-grade class for everything else. When she improved, we moved her into the fourth-grade class for the whole day. (p. 15)

Taylor et al. (1999) studied first- through third-grade teachers in 14 elementary schools where the percentage of students eligible for free and reduced lunch ranged from 28 to 92. Consistent with Heistad's (1997) finding, the most effective teachers in the most effective schools used more small-group instruction. Teachers explained that small-group instruction and the focus of that instruction was one of the most important factors for helping struggling readers. One teacher was quoted as saying, "They need to be coached at their instructional levels" (Taylor et al., 1999, p. 32). Grouping allows teachers to differentiate instruction and experiences so that individual students learn and practice what they need to develop greater independence in reading. Differentiated instruction is illustrated by one of Heistad's "beat-the-odds" teacher's descriptions of his or her second-grade classroom:

> I meet with 7 independent readers for brief periods of time to set up independent lessons. This could be 5–10 minutes. Because they are motivated and reading at 4th grade level and above.
>
> A group of 7 other students were non-readers. I meet with them to do specific lessons every day using guided reading practice. This group has made progress. Two have moved up to another group. One special education student has been absent a lot. The other four will need continued special help through the year. (p. 15)

Grouping can help teachers to tailor instruction to specific learning needs, but teachers also need multi-sourced and multi-leveled curricula and materials (Allington & Johnston, 2000). Several researchers reported providing a double dose of reading practice to some students either with grade-level or below-level texts as typifying effective programs, schools, and teachers of literacy (Cunningham, Hall, & Defee, 1998; Education Trust, 1999; Knapp et al., 1995). Appropriate resource allocation within a school and its larger system at the district, state, and/or federal level, however, is necessary to supply teachers with sufficient numbers of multi-leveled curricula and materials (Allington, 2001).

Exemplary teachers also tailor their instruction to accommodate and encourage biliteracy. Knapp et al. (1995) found that teaching-for-meaning teachers were more apt to acknowledge and use multiple languages. Biliteracy is encouraged and expected. In a classroom studied and described to illustrate the qualities and outcomes of a biliterate third-grade classroom, Moll, Saez, and Dworin (2001) reported that students could use either one or both Spanish and English "to do their academic work and to obtain support to develop their biliteracy" (p. 444). In addition, Moll et al. wrote:

> The transfer of literate competencies from one language to the other may occur most readily within genre, we speculate, because a genre defines, for the reader or writer, the context as similar across languages. (p. 444)

Moll et al.'s (2001) speculation is consistent with claims made by other biliteracy experts. Zentella (2001) suggests that for Spanish-speaking English language learners, completing homework in Spanish contributes positively to their preparation for and performance on tests in English. These students, presumably, learn the genre exemplified in their homework and the tests and can apply that knowledge to meet the demands of any text that belongs, regardless of whether it is written in Spanish or English.

Metacognitive Modeling and Coaching

When skills are taught, whether in large or small instructional groups, whether in mini-lessons at teachable moments or systematically over time, effective teachers coach students about how to apply the skills to reading connected text. Skills are not taught in isolation. Coaching as a style of interacting with students is preferred over telling by the most effective teachers and may be an interactive style that is the norm in the most effective schools (Taylor et al., 1999). The most effective teachers in the most effective schools were observed using a more varied repertoire of practices. They tended to use a combination of sight-word practice and explicit phonics instruction in isolation and in combination with coaching to support the use of word-solving strategies in everyday reading (Taylor et al., 1999). At grade three, in the most effective schools, classroom or resource room teachers provided struggling readers with coaching in reading that draws students' attention to word families or how words are broken into syllables.

When asked about reasons for their success, teachers at the most effective schools reported teaching metacognitive strategies and providing demonstrations, such as think-aloud demonstrations (Taylor et al., 1999). One teacher was quoted as saying, "I am process oriented so kids become independent rather than reliant on the teacher" (Taylor et al., 1999, p. 35). Emphasis on developing self-regulation was evident across the exemplary teacher research. Exemplary literacy teachers provide students with models, lists, and self-evaluation rubrics to guide and monitor their own thinking during reading and writing; for example, one teacher in the Langer (1999) study had students ask themselves, "Did you keep going until you learned enough to write?" (p. 29).

Allington and Johnston (2000) reported that when teachers teach predominately from the role of a facilitator, a leader, not an authority on every topic, but a person with special interests, literate thinking, including self-correction and strategy refinement, tends to be made available as models and for discussion:

> The teachers admitted their limited knowledge of various topics, especially those raised by their students, their mistakes, and their own interests. These practices simultaneously seemed to have the effect of making the teachers "real," making personal interests acceptable and thus distributing authority, making error a source of learning about self-correction and strategy refinement, and making space for real dialogue. . . . The routine demonstrations of how literate people think and read and write — including errors and self-corrections — made their own and their student thinking available as models and for discussion. (pp. 14–15)

Complexity and Interactions

Knapp et al. (1995) studied teaching for meaning in literacy and mathematics instruction in first- through sixth-grade classrooms in large, urban city schools. Schools were selected for the study if 50 percent or more of their student populations were eligible for free and reduced lunch and performed better than average on tests compared to schools with similar demographic characteristics. Classroom practices for literacy instruction were examined in relation to student performance on a test of reading comprehension and a test of writing composition using a single prompt. Knapp et al. found two classroom practices that were associated with student performance on these literacy measures: explicit teaching of comprehension strategies and complexity/length of writing assignments. These and other practices characterized teaching-for-meaning practices.

Consistent with the experimental and quasi-experimental research reviewed by the NRP (2000), explicit teaching of strategies, in this case, predicting, summarizing and use of context cues through think-aloud demonstrations and applications to reading, was associated with the highest performance on the reading comprehension tests. Moreover, students who scored highest on the writing assessments tended to be in classrooms where opportunities for extended writing were provided. In other words, the teachers of the highest performing writers assigned composed-extended assignments of no predetermined length (e.g., journals, book reports, poems). Teachers of the lowest performing writers assigned noncomposed assignments (e.g., copying, dictation, single-word responses) (Knapp et al., 1995).

In teaching-for-meaning classrooms, teachers who responded actively and constructively to students' differences were those who held high expectations for all their students and built on students' backgrounds. Knapp et al. describe these teachers as people who "communicate explicitly to students that their cultural background was not a 'problem' to be overcome but rather a strength to be acknowledged and exploited in schooling" (p. 38).

In exemplary literacy teachers' classrooms, there is complexity and multiplicity in both the medium and substance of activities. Exemplary teachers assemble and use curriculum that is multi-sourced and multi-leveled (Allington & Johnston, 2000; Moll et al., 2001). Their students are engaged in higher order thinking and "mind-to-mind discussions" with the expectation that they will not merely work together, but sharpen their understanding with, against, and from each other (Langer, 1999, p. 34). There is a lot of discussion of the meaning of what was read, not just about facts. Language arts lessons integrate standards across the curriculum, emphasizing social studies and science vocabulary and concept development and expose students to well-stocked libraries with a variety of materials (Snow et al., 1991). Students collaborate on joint projects and productions. Classrooms are organized into centers and groups for a variety of small-group, large-group, and individual work.

The complexity and interactive climate of these exemplary classrooms, nonetheless, is not chaotic. Behavioral expectations are clear. Students are brought back to task by the teachers and teachers teach students how to do the tasks (Snow et al., 1991). For instance, an exemplary middle school teacher who used literacy circles to help students develop productive habits and strategies for reading to learn taught students the roles and responsibilities of each participant in a literacy circle.

Throughout the year, students practiced each role; these roles included discussion director, literary illuminator, vocabulary enricher, summarizer, and connector (Langer, 1999).

Also, perhaps contributing to the orderliness in these exemplary classrooms and high-performing, high-needs schools is focus. Evidence suggests that teachers focus their expertise by content area and focus classroom instruction according to developmental needs. In Knapp et al.'s (1995) study, teachers appeared to develop specialization in either literacy or mathematics, but not in both. Moreover, shifting emphases across the grades may have contributed to a focus on and orderly management of literacy standards. Knapp et al. found that instructional emphases changed as children moved through grades, acquiring and solidifying reading skills. "Primary grade teachers spent more time on teaching discrete reading skills but were still observed as not being disproportionately low or moderate in meaning orientation compared to 3rd, 4th, 5th and 6th grade teachers" (Knapp et al., 1995, p. 83). Shifting emphases from the development of word identification and fluency in primary grades to the development of comprehension in intermediate and upper grade levels may contribute to teachers' capacity to successfully help all students become literate without sacrificing any particular component or strand of literacy development.

Conclusions and Implications for Practice

In conclusion, the exemplary teacher research shows that these expert teachers possess and use sophisticated pedagogical content knowledge in the area of literacy. They tailor instruction and use multiple materials to meet individual and developmental needs. They practice biliteracy and model and coach metacognitive strategies for word identification, self-monitoring, and self-correcting. Classroom tasks are complex and interactive. Their classrooms are language-rich learning environments in which higher order thinking is expected and encouraged through extended reading and writing of whole texts and mind-to-mind discussions.

These findings suggest that the following classroom practices and conditions need to be supported in schools in order to create and maintain language-rich learning environments:

- Opportunities for teachers to develop sophisticated pedagogical content knowledge in literacy
- Well-stocked libraries with a variety of reading materials at a variety of readability levels
- Ample time for students and teachers to engage in a variety of reading and writing tasks for multiple purposes and in multiple languages
- Ample time for students and teachers to engage in metacognitive and substantive, mind-to-mind discussions

Summary and Conclusions

National Assessment of Educational Progress trends indicate that achievement gaps in fourth-grade reading continue to exist (Phillips, 2001). Other evidence suggests that one reason for the achievement gaps may be the nature of the classroom practices and material resources provided to high-needs students (Duke, 2000; Snow et al., 1991; Valdes, 1998).

A literate person is one who is intellectually engaged in reading and writing, effectively uses reading and writing knowledge and skills in school and in life, continually learns, and is awareness of how language is used to communicate and to influence others. To become literate, children need classroom-based learning opportunities to develop foundational skills and knowledge as well as opportunities to integrate skills and knowledge in order to successfully complete complex tasks.

Learning to read with understanding requires opportunities early in every student's schooling to figure out how to unlock the print-sound code and to develop both phonemic awareness and knowledge of phonics. Among other strategies, systematic phonics instruction should be integrated into a comprehensive reading program for kindergarten and first-grade children.

Learning to read with understanding also requires, through both direct instruction and discovery, opportunities to learn how print-sound relations can be used to read and spell words for meaningful communication. Beginning readers also need frequent opportunities to practice oral reading to help (1) confirm and consolidate their knowledge about the print-sound code as well as (2) "unglue" themselves from print and try new strategies that use multiple sources of information to recognize words and construct meaning. Like other aspects of reading and writing instruction, oral reading practice should be part of a comprehensive reading program delivered in a language-rich learning environment.

Beginning readers need opportunities to read a lot and to find value in reading. While developing print-specific skills, such as the mechanics of decoding and increasing automaticity in word recognition, beginning readers need opportunities to simultaneously build vocabulary and general competencies in receptive and expressive language. Students also need opportunities to engage in thoughtful conversations about strategies for reading and understanding as well as substantive discussions about the significance and relevance of the information in texts they are reading.

Learning to write effectively for a variety of audiences requires opportunities to connect reading and writing to confirm the logic of the print-sound code, to make explicit and reflect on relevant prior knowledge and changing conceptions associated with reading, and to notice and learn from models of language use. Learning to write effectively for a variety of audiences requires writing extended compositions with support and guidance on how to improve the readability of one's writing, including the provision of long, uninterrupted periods of time. Moreover, to learn to write effectively, students need opportunities to discuss writing problems and solutions with peers and teachers (Hillocks, 1995).

Research indicates that to effectively provide students with the learning opportunities just identified, teachers should incorporate the following classroom practices.

Purposefully Draw from a Repertoire of Methods

- Assess what individual students know about language, the print-sound code, and reading and writing.

- Determine what individual students need to be taught explicitly and what they can discover for themselves (for example, knowledge of phonic elements and understanding of core vocabulary terms).
- Help students connect language skills and concepts to applications reading and writing stories, informational reports and other texts.
- Select illustrative and generative phonic elements for lessons, rather than all elements from an exhaustive list.
- Coach students in word identification strategies.
- Assign workbook homework exercises and rereading of texts to increase text exposure and support fluency development.
- Engage students in active learning supported by manipulatives and other forms of analysis and synthesis (e.g., spelling and transforming words with plastic letters; constructing story maps and semantic maps; Test, Organize, Anchor, Say, & Test (TOAST); sorting new vocabulary terms into meaningful categories).
- Model strategies followed by guided and independent practice.
- Prepare students for upcoming state writing tests by focusing on developing the particular skills and knowledge required to meet the task demands of the test.

Represent Out-of-School Literacy as In-School Literacy

- Provide multi-leveled, multi-source reading material to match the interests, background knowledge, and abilities of all students in a classroom.
- Integrate texts from across the curriculum.
- Build on individual students' background knowledge and experiences.
- Encourage transfer of knowledge from one language to another.
- Use routine think-alouds to model strategic reading, including self-correction, summarizing, and other meaning-making strategies.
- Engage in obvious, natural, and functional uses of writing.
- Provide extended periods of time to simply read, talk about what was read, write, and problem solve to improve the readability of written products (e.g., discussion groups and writers workshops).
- Teach multiple roles for discussion groups, including discussion director, literary illuminator, vocabulary enricher, summarizer, and connector.

Clearly, research literature suggests that effective classroom practice requires much of teachers. Exemplary teachers demonstrate sophisticated pedagogical content knowledge. They recognize and respond to what individual students know, where they have progressed from, what they need to be taught explicitly, and what they can discover themselves. They select and combine practices and materials as needed to meet children's changing learning needs. In order to effectively draw on this knowledge and set of skills, teachers need the kinds of professional development and organizational supports discussed in Chapters 3 and 4.

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CHAPTER 2
MATHEMATICS STANDARDS IN CLASSROOM PRACTICE

by
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How well do U.S. students learn mathematics? Results of national and international assessments over the past 30 years suggest that the answer is "not very well." In *Adding it Up*, a recent report of the National Research Council (Kilpatrick, Swafford, & Findell, 2001), the authors describe the research evidence about the shortcomings of U.S. students' mathematics performance as "consistent and compelling." For example, the most recent National Assessment of Educational Progress (NAEP) examination found that only 21 percent of fourth graders, 24 percent of eighth graders, and 16 percent of 12th graders performed at or above the proficient level (Dossey, 2000). Additional evidence is provided by the results of the Third International Mathematics and Science Study (TIMSS). U.S. 12th graders, including those taking the most advanced high school mathematics courses, had among the lowest scores in mathematics. Results of these and other studies indicate that U.S. students have a limited understanding of basic mathematical concepts and limited ability to use their mathematics skills to solve problems, even simple ones (Kilpatrick et al., 2001).

Although the mathematics achievement of U.S. students overall does not currently meet national and international expectations, students in some schools and states perform as well as the best students in the world. There are many reasons that some students perform better than others. In this chapter, we focus on several of the reasons that relate to factors that schools and teachers can influence. These include high student learning goals and appropriate curricula and instructional practices.

This chapter begins by summarizing the strands of mathematics knowledge and skills described in standards documents developed by various national, professional organizations. These standards set high student learning goals that exceed the goals of instruction in most U.S. classrooms. The vision of mathematics outlined by these standards emphasizes the importance of both conceptual understanding and procedural fluency. Research on teaching for these two aspects is included in the second section of this chapter. A discussion of the research-based characteristics of effective standards-based instruction and recommendations for practice follows. Also included are characteristics of mathematics programs that have been successfully implemented with diverse student populations. The last section of the chapter offers conclusions that can be drawn from research. Recommendations for practice drawn from research are included throughout the chapter.

MATHEMATICS STANDARDS: SETTING THE BAR HIGH

In 1989, the National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics*, the landmark standards document that represented a shift toward teaching mathematics that is meaningful and contextual. That document was revised and released in 2000 as *Principles and Standards for School Mathematics*. To support the use of

standards in the classroom, the NCTM also published *Professional Standards for Teaching Mathematics* (1991) and *Assessment Standards for School Mathematics* (1995).

Principles and Standards for School Mathematics describes curriculum and evaluation standards for mathematics education that define a comprehensive and ambitious vision for school mathematics. This vision assumes that students engage in complex learning tasks that draw on knowledge from a wide variety of mathematics topics; represent mathematics in a variety of ways; develop, refine, and test conjectures on the basis of evidence; develop flexible and resourceful problem-solving skills; work productively and reflectively alone or in groups, using the latest technology; and effectively communicate their ideas and results in a variety of ways.

The NCTM is not alone in its efforts to define mathematics standards. The list that follows includes the NCTM document as well as other primary sources of descriptions of key knowledge and skills students should learn in mathematics:

1. *Principles and Standards for School Mathematics* (NCTM, 2000)
2. *Mathematics Framework for the 1996 and 2000 National Assessment of Educational Progress* (NAEP, 1996)
3. The Third International Mathematics and Science Study's (TIMSS) *Curriculum Frameworks for Mathematics and Science* (Robitaille, Schmidt, Raizen, McKnight, Britton, & Nicol, 1993)
4. *Mathematics: Report of the Project 2061 Phase I Mathematics Panel* (American Association for the Advancement of Science [AAAS], 1989)
5. *Adding it Up: Helping Children Learn Mathematics*, published by the National Research Council's Mathematics Learning Study Committee (Kilpatrick et al., 2001)

An analysis of these documents reveals common strands of mathematics knowledge and skills, referred to in this report as content and process standards. NCTM's (2000) *Principles and Standards for School Mathematics* defines content standards as standards that describe knowledge that students are expected to know in specific areas of mathematics, for example algebra and number theory. Process standards refer to the mathematics skills and processes needed to use the content to solve problems in school and real-world settings.

A third type of standard addresses students' motivations and dispositions toward mathematics. *Adding it Up* (Kilpatrick et al., 2001) calls this attribute "productive disposition," which it defines as seeing mathematics as sensible, useful, and worthwhile and believing in diligence and one's own efficacy. This type of standard is addressed indirectly in this chapter in the discussion of effective standards-based curricula and instructional practices.

Content Standards

Five content standards appear in three or more of the documents listed above:

1. Numbers and operations (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)
2. Algebra (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)
3. Geometry (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)
4. Measurement (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993)
5. Data analysis and probability (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)

Other content standards described in one or two of these documents include proportionality (Robitaille et al., 1993), validation and structure (Robitaille et al., 1993), analysis and/or calculus (Robitaille et al., 1993; AAAS, 1989), discrete mathematics (AAAS, 1989), and logic and set theory (AAAS, 1989). These topics are subsumed under one or a combination of the five standards listed above in the remaining documents. For example, discrete mathematics can be integrated into statistics (NCTM, 2000), and proportionality fits within the scope of numbers and operations.

The various documents specify learning expectations for particular grade levels in different ways. For example, *Principles and Standards for School Mathematics* (NCTM, 2000) specifies expectations for learning within four grade-level bands: pre-kindergarten through second grade, grades three to five, grades six to eight, and grades nine to twelve. Regardless of the specific grade-level bands identified, however, there is agreement across these documents that standards apply to all grade levels, but that the amount of attention devoted to individual standards and the extent to which they are emphasized at different grade levels should vary.

The various standards documents emphasize the importance of developing students' knowledge of mathematics content across all grades to build a foundation for more complex materials in later grades. For example, students' knowledge of algebra begins in the elementary grades with an awareness and understanding of patterns, relations, equality, and change (e.g., growth over a period of time). These topics form the foundation of an understanding of functions. At the secondary level, algebra includes the ability to model quantitative relationships and draw conclusions from those models. Students' algebra knowledge also includes familiarity with classes of functions that can be used to represent quantitative information, such as exponential, polynomial, logarithmic, and periodic functions.

Similarly, knowledge of geometry begins in the primary grades with a familiarity with and ability to reason about two- and three-dimensional geometric shapes and their properties. By the upper elementary grades, students are expected to understand and use transformations, symmetry, and geometric modeling to solve problems. In middle school, students learn to develop mathematics arguments about geometric situations, use coordinate geometry to represent and examine geometric properties, and use geometric models to represent and explain numerical and algebraic relationships. In high school, geometry includes constructing proofs of geometric theorems and conjectures, the

use of trigonometry to determine angles and lengths, and the use of more complex coordinate systems such as polar and spherical systems to understand geometric situations.

These examples highlight another important emphasis in the standards documents — the interrelationships between the various content areas of mathematics. For example, geometric representations are used to describe algebraic and numeric phenomena, and algebraic functions can be used to describe translations, reflections, and rotations of objects.

Process Standards

Four process standards are found in four or more of the five documents listed above:

1. Problem solving (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989; Kilpatrick et al., 2001)
2. Reasoning (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)
3. Communication (NCTM, 2000; NAEP, 1996; Robitaille et al., 1993; AAAS, 1989)
4. Procedural fluency (NAEP, 1996; Robitaille et al., 1993; AAAS, 1989; Kilpatrick et al., 2001)

Each of the standards documents also describes the ability to use various mathematics representations as an important skill for students to acquire. How this skill is categorized in the different documents, however, varies. NCTM's *Principles and Standards for School Mathematics* (2000) identifies the ability to represent as a separate process standard. NAEP's (1996) *Mathematics Framework* describes this skill under the content strand "number sense, properties, and operations." TIMSS's *Curriculum Frameworks for Mathematics and Science* (Robitaille et al., 1993) identifies "representing" as a subcategory of the "performance expectation" category of "knowing." The National Research Council (NRC) (Kilpatrick et al., 2001) describes the ability to represent under a problem-solving strand called "strategic competence."

The different ways in which the skill of representation is treated in various standards documents highlight the highly integrated nature of the content and processes of mathematics. Similarly, although content standards generally refer to mathematics *knowledge* and process standards refer to mathematics *skills*, these categories — like the teaching of mathematics — overlap. For example, the skill of computational fluency is identified in NCTM's *Principles and Standards for School Mathematics* and in NAEP's *Mathematics Framework* under content strands that deal with numbers and operations.

Like content standards, process standards should be addressed at all grade levels. The standards documents analyzed for this report emphasize that the process standards require years of nurturing in the classroom. For example, problem solving refers to the ability to formulate problems in a mathematical way, represent problems in mathematical terms (e.g., numerically, geometrically), and solve these problems (Kilpatrick et al., 2001). Problem solving includes the ability to formulate problems in mathematics terms by identifying assumptions, identifying what is known, and determining what sort of answer is needed. Such skills are not developed without a great deal of

practice. If students are to move beyond solving simple problems and develop confidence in their problem-solving ability, they need many opportunities to reason about novel and complex problems.

Although standards developers emphasize the importance of problem solving throughout the school years, some teachers question the ability of young students to solve problems before they master basic skills. Research demonstrates, however, that mastering basic skills is not essential to the ability to think about, represent, and solve problems (Means & Knapp, 1991). Research suggests that teachers begin problem solving in kindergarten by encouraging students to use the problem-solving strategies that they bring with them from their experiences at home. Teachers can build on these skills as well as the understandings that students already have about mathematics phenomena (e.g., numbers and simple operations).

The process standard of communicating mathematics ideas in written and oral forms also requires development from the early grades. To meet the communication standard, students need to be able to adaptively use multiple representations and approaches — or perhaps different arguments — to support an idea, depending on their audience. In order to communicate a mathematics argument, students need to organize the argument, articulate assumptions and reasoning, and justify their conclusions. Students also need to develop mathematics-specific listening and reading skills to understand and evaluate the communications of others. In later grades, students will be expected to construct mathematical proofs that thoroughly communicate deductive arguments.

Teachers should begin to develop students' communication skills as early as kindergarten not only because it takes time to develop these skills but also because developing these skills helps students learn from one another. In addition, research suggests that communicating mathematics ideas in written or oral forms has other benefits. It enhances students' abilities to reason with and understand mathematics (NCTM, 2000).

The Status of Mathematics Standards Across the States

Most states have developed and adopted their own mathematics standards, but the quality and content of these standards vary (see, e.g., American Federation of Teachers, 1999). In some states, standards are too vague and broad. In other states, standards omit more challenging academic content.

Quality Counts also reports that instruction is often more influenced by state assessment and accountability systems than by standards. Many educators are more focused on teaching what is covered by state assessments than on students' learning the knowledge and skills identified in state- and national-level standards, primarily because state and district accountability systems tend to include sanctions, rewards, and public reporting of assessment results.

The variation in quality of state mathematics standards documents and the tendency to focus teaching on the narrow range of content covered by state mathematics assessments jeopardize students' learning. Under these circumstances, it is likely that students will not have the opportunity to learn the array or complexity of knowledge and skills described by mathematics standards in national

documents and their mathematics performance will suffer as a result. The remaining sections of this chapter describe curriculum and instructional practices that can help teachers address shortcomings in state standards documents and state assessments.

MATHEMATICS STANDARDS IN CLASSROOMS: DEVELOPING UNDERSTANDING *AND* FLUENCY

Teaching for Understanding

Part of the motivation behind the NCTM's development of curriculum, teaching, assessment, and content standards was to raise expectations about mathematics learning from low-level, rote computation and routine use of formulas to higher order understanding and application of concepts. Research discussed in this chapter focuses on standards-based mathematics classroom practices that address this central focus of mathematics standards — that students will *understand* the mathematics concepts described in content standards.

Teaching for understanding is a complex endeavor. In order to teach for understanding, teachers themselves must have a deep understanding of mathematics concepts and know how to promote and assess students' understanding. The task of teaching for understanding is further complicated by the nature of understanding. As Carpenter and Lehrer (1999) write:

> Understanding is not an all-or-none phenomenon. Virtually all complex ideas or processes can be understood at a number of levels and in quite different ways. Therefore, it is more appropriate to think of understanding as emerging or developing rather than presuming that someone either does or does not understand a given topic, idea, or process. (p. 20)

Instruction that promotes student understanding focuses on the meaning of material rather than the development of rote, procedural skills. Knapp, Shields, and Turnbull (1995) describe teaching for meaning as follows:

- Helping students perceive the relationship of "parts" (e.g., discrete skills) to "wholes" (e.g., the application of skills to communicate, comprehend, or reason);
- Providing students with the tools to construct meaning in their encounters with academic tasks and in the world in which they live; and
- Making explicit connections between one subject area and the next and between what is learned in school and children's home lives. (see p. 771)

McLaughlin and Talbert (1993) conclude that teaching for understanding requires a great deal of teachers in terms of what they know and are able to do:

> Teaching for understanding assumes substantial new learning on teachers' part; it requires change not only in what is taught but in how it is taught. Learning how to involve students actively in the construction of knowledge, how to move beyond fact-

> based concepts of knowledge and learning outcomes, and how to fashion new classroom roles and relationships involves more than simply sharpening up teaching skills or teachers' professional knowledge base as conventionally conceived. Teaching for understanding requires teachers to have comprehensive and in-depth knowledge of subject matter, competence in representation and manipulation of this knowledge in instructional activities, and skill in managing classroom processes in a way that enables active student learning. (p. 2)

Given the complexity of teaching for understanding, it's not surprising that research about standards-based reform suggests that getting teachers to teach for understanding is a difficult change to implement. For example, Spillane and Zeuli (1999) conducted a study of mathematics teachers who reported teaching in ways that were consistent with state and national efforts to reform mathematics education. Based on systematic observations of teachers' instructional practice, Spillane and Zeuli found that only a small minority (16%) of teachers (1) used tasks in ways that were likely to engage students in understanding and grappling with key mathematics concepts and (2) created classroom discourse norms that encouraged students to make and revise conjectures, reason mathematically, and justify positions. Another 40 percent used tasks almost as effectively as teachers in the first group, but infrequently tried to tease out students' mathematical thinking through classroom discourse. The instruction of the remaining 44 percent of teachers focused primarily on reinforcing mathematics facts and procedures, rather than helping students understand key mathematics concepts or principles. Spillane and Zeuli conclude that their findings reinforce that changing instruction is fundamentally difficult, particularly since all of the teachers they studied reported that they were implementing reform-oriented classroom practices.

In addition to the fact that it's difficult for teachers to fundamentally change their instructional practices, there are no doubt other reasons that teachers don't teach for understanding. A study by Knapp, Adelman, et al. (1995), for example, found that teachers who emphasized arithmetic and the learning of discrete skills tended to see mathematics as rigidly hierarchical and had limited expectations of their students.

Despite the challenges, teaching for understanding is worth the effort. Students who understand mathematics are able to generate new mathematics knowledge, remember and reconstruct material, and apply their knowledge to novel situations (Hiebert & Carpenter, 1992). Further, as shown in a recent analysis of 1996 NAEP data (Wenglinsky, 2000; Grouws & Smith, 2000), there is evidence that teaching for understanding promotes higher achievement. The NAEP analysis indicated that eighth-grade students whose teachers emphasized higher order thinking skills and hands-on activities had higher overall achievement on NAEP assessment than students whose teachers did not emphasize these skills (Wenglinsky, 2000; Grouws & Smith, 2000).

Similarly, Knapp, Adelman, et al.'s (1995) study of high-poverty schools found that effective mathematics teachers focused on developing students' understanding. A finding from this study was that teaching for understanding resulted in greater gains for low-achieving students than for higher achieving students. This contradicts the notion that low-performing students are not ready or able to understand more advanced material. However, as Knapp, Adelman, et al. note, teachers who emphasized understanding did not abandon instruction of basic skills: "In meaning-oriented

mathematics classes, students encountered non-routine problems — puzzles and complex story problems — as well as the more routine story problems that, along with sheets of arithmetic practice problems, formed the mainstay of skills-oriented classrooms" (p. 187).

Teachers need support in order to learn how to teach for understanding. To acquire strategies for increasing students' understanding, teachers need opportunities to learn through professional development that has the research-based features described in Chapter 3 of this synthesis; they also need the organizational supports described in Chapter 4.

Balancing Conceptual Understanding and Procedural Fluency

Research indicates that classroom instruction should address both conceptual understanding and procedural fluency. Procedural fluency is the ability to compute, calculate, and use rules and formulas correctly, quickly, and with assurance. It also encompasses the ability to apply procedures flexibly since, as the NRC's *Adding it Up* report (Kilpatrick et al., 2001) notes, "not all computational situations are alike" (p. 4-8). Procedural fluency is as important to mathematics as the ability to identify letters based on their sounds is to reading. *Adding it Up* stresses the importance of procedural fluency when it notes that "without procedural fluency, students have trouble deepening their understanding of mathematical ideas or solving mathematics problems" (p. 4-9).

Although a balance between conceptual understanding and procedural fluency is recommended, studies of practice indicate that U.S. teachers currently emphasize computational fluency to the extent that it frequently preempts teaching for understanding. For example, the TIMSS video study of eighth-grade instruction (Stigler & Hiebert, 1999) revealed that 90 percent of class time in the U.S. is spent practicing procedures. In contrast, teachers in Japan, where students outperform U.S. students, spend only 40 percent of class time practicing procedures. Similarly, the 1996 NAEP teacher survey found that U.S. mathematics teachers spent more time teaching facts, concepts, and the skills and procedures needed to solve routine problems than they did teaching process standards such as reasoning, analytic abilities, and communication (Grouws & Smith, 2000). In particular, although a majority of teachers had students complete textbook problems on a daily basis, fewer than 10 percent of fourth- and eighth-grade teachers had their students *write* about how they solved those problems.

Adding it Up (Kilpatrick et al., 2001) makes explicit the importance of addressing conceptual understanding as well as computational and procedural skills: "More than just a means to produce answers, computation is increasingly seen as a window on the deep structure of the number system" (p. 6-1). As students learn computational procedures and algorithms (such as a step-by-step procedure for multiplying three-digit numbers), they gain conceptual understanding of the organization that underlies mathematics procedures, which helps them know when to appropriately apply these procedures. *Adding it Up* stresses the interrelationship between procedural fluency and conceptual understanding of mathematics concepts:

> The two [procedural fluency and conceptual understanding] are interwoven. Understanding makes learning skills easier, less susceptible to common errors, and less prone to forgetting. By the same token, a certain level of skill is required to learn

many mathematical concepts with understanding, and using procedures can help strengthen and develop that understanding. (p. 4-8)

Other research findings reinforce the conclusion that the relationship between conceptual understanding and procedural fluency is not a simple sequence in which one type of knowledge is acquired before the other. A recent study (Rittle-Johnson, Siegler, & Alibali, 2001) concludes that one type of knowledge leads to increases in the other type, which then causes increases in the first type. Rittle-Johnson et al.'s study, which examined fifth and sixth graders' learning of decimal fractions (numbers between 0 and 1), found an iterative relationship between students' understanding of decimal fraction concepts (e.g., the relative magnitude of decimal fractions and that zero is a place holder) and their ability to complete procedures involving decimal fractions (e.g., placing these fractions on number lines). From this and other research, we know that enhanced procedural skill can lead to better conceptual knowledge, and that conceptual knowledge can contribute to improved procedural skill. Rittle-Johnson et al.'s study also found that when learning a specific topic, these two types of knowledge contribute to gains in the other type of knowledge.

As demonstrated by Knapp, Adelman, et al.'s (1995) study of classrooms in high-poverty schools, teachers' use of a balanced curriculum that focuses on developing students' conceptual understanding of mathematics and procedural skills can help such students perform above average on state mathematics assessments. A similar finding was reported by Reyes, Scribner, and Paredes Scribner (1999), who studied Texas schools serving largely Hispanic populations. These schools were high poverty (64–95 percent of students were from economically disadvantaged families) and high performing (they exhibited above-average performance on the Texas Assessment of Academic Skills and received state or national recognition). Reyes et al. report that these schools regularly incorporated practice into lessons at all grade levels — even though their emphasis was on teaching for understanding.

Other studies of classrooms that addressed both conceptual understanding and procedural fluency provide additional evidence of the benefits of doing so. For example, studies of classrooms that included a problem-solving approach to mathematics instruction in which practice of computation was integrated into the solution methods of problems found that students' ability to perform computation and procedures did not decline and that their conceptual understanding was greatly enhanced (Kilpatrick et al., 2001; Carpenter, Fennema, & Franke, 1996).

Research suggests that when students are taught arithmetical procedures without understanding, their development of more advanced mathematics knowledge and skills is handicapped (Carpenter & Lehrer, 1999; Hiebert & Carpenter, 1992). Further, as Kilpatrick et al. (2001) note, "once students have learned procedures without understanding, it can be difficult to get them to engage in activities to help them understand the reasons underlying the procedure" (p. 4-8).

In summary, research supports a balance between teaching for understanding and teaching for procedural fluency. Research indicates that, at a minimum, balancing computational practice with the development of conceptual understanding will not detract from students' computational fluency. Further, across the research reviewed, it is clear that the development of procedural skills and conceptual understanding are interrelated — development in conceptual understanding promotes

procedural fluency and vice versa. Further, as summarized in *Adding it Up*, learning procedures in concert with developing conceptual understanding of those procedures is more effective for long-term development of students' mathematics skills and knowledge than is learning mathematics without such understanding.

The remainder of this chapter describes researched-based practices for curriculum and instruction that support students' achievement of high standards. Although these practices alone will not ensure that students' performance will improve, using them can increase the likelihood that all students will learn the mathematics described by standards.

CHARACTERISTICS OF AN EFFECTIVE STANDARDS-BASED CURRICULUM

Battista and Clements (2000) describe a curriculum as "a detailed instructional blueprint for guiding students' acquisition of certain culturally valued concepts, procedures, intellectual dispositions, and ways of reasoning" (p. 738). One of the intended purposes of the NCTM standards is to serve as a guide for educators as they develop such local detailed blueprints. However, the curriculum followed by many mathematics teachers is determined by the textbook they use rather than by NCTM or state standards. This hampers teachers' efforts to help their students achieve standards because, as a recent review of middle school mathematics textbooks found, most traditional textbooks do not contain many of the content recommendations found in standards documents (Kulm, Morris, & Grier, 1999).

As several studies have shown, one characteristic of an effective standards-based curriculum is that it is aligned with national and/or state standards. For example, a study by the Charles A. Dana Center (1999) of nine high-performing, high-poverty, urban elementary schools in seven states found that these schools used standards to align curriculum and instruction to ensure that students learned what they were expected to learn and what would be tested. Schools were considered high poverty if they enrolled a majority of students who met free or reduced-price lunch criteria, and high performing if they demonstrated above-average performance on state assessments for three consecutive years.

Similarly, an Education Trust (1999) survey of 366 high-performing, high-poverty elementary and secondary schools located in 21 states found that 80 percent of these schools reported using standards extensively to design curriculum and instruction. High-poverty schools were those with more than 50 percent of students living in poverty; high-performing schools were those that had the largest gains on state assessments in reading and/or mathematics or whose scores in mathematics and/or reading were among the top 10 for high-poverty schools in the state. Most of these schools operated in isolated rural or crowded urban locations.

As explained in the previous section, an effective standards-based curriculum balances conceptual understanding and procedural fluency. Closely related to the idea of balance is comprehensiveness. A comprehensive curriculum includes the breadth and complexity of content and process defined by NCTM standards and those of other national groups. NCTM (2000) describes its standards as "a comprehensive foundation recommended for all students, rather than a menu from which to make curricular choices" (p. 29). This means that if a district or school's mathematics curriculum focuses on only certain standards, learning will be compromised.

Knapp, Shields, et al.'s (1995) study of high-performing, high-poverty schools found that curricula used by teachers of students who exhibited high computational and problem-solving abilities focused on more than just arithmetic. These curricula integrated additional strands of mathematics defined by standards — such as measurement, algebra, geometry, and data analysis — into instruction. Effective instruction, these researchers conclude, emphasizes the development of knowledge and skills in *all* of the important areas of content and process.

A standards-based curriculum also needs to be *articulated* across the grades (NCTM, 2000). For example, the algebra and geometry standards identified earlier in this chapter should be covered at all grade levels, but the main learning goals within each grade should build on each other across grades. Such a curriculum gives teachers an idea of what students learned prior to their current grade level, what students need to learn at their current grade level, and what students need to be prepared to learn in future grades (NCTM, 2000). A well-articulated curriculum helps to prevent the repetition of instruction that occurs so often (Smith, Smith, & Bryk, 1998). A well-articulated curriculum also focuses the instructional goals for each grade level, thereby reducing the sheer number of standards and benchmarks that need to be addressed and encouraging depth in what is addressed.

Another characteristic of an effective standards-based curriculum is *coherence* within and across grades. NCTM (2000) describes a coherent curriculum as one that "effectively organizes and integrates important mathematical ideas so that students can see how the ideas build on, or connect with, other ideas, thus enabling them to develop new understandings and skills" (p. 15). As seen in the TIMSS video study (Stigler & Hiebert, 1999), coherence within a lesson is as important as coherence within and across grade levels. Typical U.S. mathematics lessons included several ideas or topics that were not related or well developed, but Japanese lessons were designed around one central big idea that was developed and extended throughout the lesson.

In summary, research describes a quality mathematics curriculum for all students as focused on students' learning of standards. This focus on standards should result in a curriculum with the following characteristics:

- Is aligned with standards
- Balances fluency in procedural skills and conceptual understanding
- Is comprehensive, addressing all of the content and process standards
- Articulates standards and expectations across and within grades
- Is coherent across and within grades and within lessons

A high-quality curriculum is not enough to ensure that students learn. Students need time to assimilate knowledge of mathematics concepts and skills that are nurtured by carefully selected appropriate tasks, meaningful discourse, and adequate practice rather than mere exposure to mathematics content. Different students need different experiences and amounts of instruction to achieve high standards. The next section focuses on instructional features that promote students' learning of standards.

Characteristics of Effective Standards-Based Mathematics Instruction

Curriculum plays a critical role in determining what students learn. But it is increasingly evident that instruction has a reciprocal relationship with curriculum in students' learning of mathematics (Boaler, 2001; Cohen & Ball, 1999; Cohen, Raudenbush, & Ball, 2000). The Mathematics Learning Study Committee of the NRC declares, "No instructional practice, commodity, or material exists independently of context and participants as a durable and reliable resource for developing mathematical proficiency" (Kilpatrick et al., 2001, p. 9-44).

Teachers' knowledge and beliefs about mathematics education play a vital role in instruction. Researchers propose that teachers need to have extensive knowledge in at least three areas: mathematics content, the students in their classroom, and instructional practice (Kilpatrick et al., 2001; NRC, 2001). For example, recent analyses of 1996 NAEP data show the importance of teachers' knowledge of mathematics content (Wenglinsky, 2000). Eighth-grade students of teachers who majored or minored in mathematics outperformed other students on the NAEP exam by about 40 percent.

Figuring out what individual students know is not an easy task (Ball, 1997). Ball argues that determining the knowledge base of students is difficult in part because students "do not present their thinking in ways that match adult forms. They use nonstandard terms, draw pictures, and make analogies" (p.735). She explains:

> Interpreting what students mean involves considerable skill at listening, watching, and studying written work. . . . Listening across chasms of age, culture, and class, teachers face a problem common to most forms of cross-cultural communication. The problem is one of trying to understand what students mean with their words, pictures, gestures, and tone. (p. 735)

Ball also argues that determining what students know "involves generosity, giving them the benefit of the doubt, and skepticism, not assuming too much about what they mean" (p. 735). In addition, teachers need to realize that students' understanding often depends on the context — "the particular task they are given . . . the adult who is asking them questions, and . . . the other students around them" (p.736). Ball suggests that teacher collaboration — teachers working together to evaluate curriculum materials, to analyze student written work, to review videotapes of classroom lessons, and to observe one another's instruction — is one strategy for gaining knowledge of what students know, understand, and are learning.

Developing teachers' knowledge of how students learn mathematics has benefits for teachers and students. For example, students of teachers participating in a professional development program known as Cognitively Guided Instruction (CGI) outperformed students in traditional classrooms on tests of problem solving and performed equally well as students from traditional classes on tests of basic skills. Cognitively Guided Instruction focuses on helping teachers better understand the development of students' mathematical thinking, which enhances teachers' ability to make better instructional decisions. (Carpenter, Fennema, Franke, Levi, & Empson, 2000). In addition to the

changes in student performance, teachers' beliefs about learning and about students' abilities changed toward an instructional approach that builds on students' prior knowledge and actively engages them in learning (Peterson, Fennema, Carpenter, & Loef, 1989; Carpenter, Fennema, & Franke, 1996).

In the remainder of this section, several effective mathematics instructional practices are described. Having deep understanding of content as well as knowledge about how students learn will support teachers' use of these practices. The practices include use of worthwhile mathematics tasks, hands-on experiences, appropriate assessments, supportive technology, and orchestration of productive classroom discourse.

Worthwhile Mathematics Tasks

Teachers' use of purposefully developed and selected mathematics tasks can be a powerful strategy for promoting students' higher order thinking skills within the discipline. As Hiebert et al. (1997) explain, they can also help students understand the true nature of mathematics:

> Students form their perceptions of what a subject is all about from the kinds of tasks they do. . . . If students are asked in mathematics class only to practice prescribed procedures by completing sets of exercises, they will think that mathematics is about following directions to move symbols around as quickly as possible. If we want students to think that doing mathematics means solving problems, they will need to spend most of their time solving problems. (pp. 17–18)

Characteristics of Good Mathematics Tasks

Mathematics tasks that require students to integrate their knowledge and skills in new ways promote their achievement of standards. The NCTM's (1991) *Professional Standards for Teaching Mathematics* highlights the importance of worthwhile mathematics tasks. According to this document, teachers' selection and development of tasks that provide students with opportunities to develop mathematics "understandings, competence, interests, and dispositions" (p. 24) is a vital part of mathematics instruction. These standards further state that tasks should

- engage students' intellect;
- develop students' mathematical understandings and skills;
- stimulate students to make connections and develop a coherent framework for mathematical ideas;
- call for problem formulation, problem solving, and mathematical reasoning;
- promote communication about mathematics;
- represent mathematics as an ongoing human activity;
- display sensitivity to, and draw on, students' diverse background experiences and dispositions; and
- promote the development of all students' dispositions to do mathematics. (p. 25)

It seems clear from the guidelines just presented that the number of worthwhile mathematics tasks that can be addressed in one class period is small. The results of a TIMSS teacher survey indicate that many teachers will need to change how they construct their lessons if they are to focus on worthwhile tasks. The TIMSS data indicated that a majority of eighth-grade mathematics teachers in the U.S. involve students in six or more activities during a typical class, whereas only 25 percent of German teachers reported doing so. Presenting fewer activities within a class period, and having those activities involve students in important mathematics work, is likely to be more effective than involving students in several, superficial activities, such as drill-and-practice worksheets (U.S. Department of Education, 1997).

Hiebert et al. (1997), in a study of four elementary-level mathematics curricula (Cognitively Guided Instruction, Conceptually Based Instruction, Problem Centered Learning, and Supporting Ten-Structured Thinking), make similar conclusions about worthwhile mathematics tasks. They suggest that such tasks should have the following properties:

- Tasks must allow the students to treat the situations as problematic.
- What is problematic about the task should be the mathematics rather than other aspects of the situation.
- Tasks must offer students the chance to use skills and knowledge that they already possess. (p. 18)

Hiebert et al. point out that it is important for tasks to be selected with the learning goals or standards in mind. They describe the following example of a worthwhile mathematics task that addresses the content standard of numbers and operations. In the fourth week of an urban school's first-grade classroom, students are asked to find pairs of numbers that add up to ten. After students work independently on this task, the teacher elicits answers from them and represents these pairs of numbers on the board. The teacher draws rows of ten circles and groups circles into two groups that represent the two numbers that add to ten until all possible pairs of numbers (i.e., 1 and 9, 2 and 8) are recorded. Next, a whole-class discussion ensues about the patterns that can be seen in these pairs of numbers that add up to ten. Students notice that 2 plus 8 is the same as 8 plus 2 (the property of commutativity); as one number in the pair increases in value, the other number decreases by the same value, and that any number plus zero equals that number.

These are impressive insights for a class of first graders. It is clear that the task itself, in conjunction with the teacher's ability to facilitate a productive discussion about the task, led to student learning about important mathematics concepts. However, to manage this level of discourse, teachers must understand the mathematics concepts in a task and be open to students' own discoveries and understanding about the ideas.

Hiebert et al. (1997) also stress that the mathematics learned through a task should connect with other knowledge that students have learned both within and across lessons so that students can develop and reflect on a coherent body of knowledge. Further, tasks need to be accessible to all the students in a classroom to maximize learning opportunities for everyone. For example, presenting a problem that requires students to determine how many passes a combine would have to make in

order to harvest a field of wheat might require a short lesson on what a combine is before the problem might be understood by some students.

The NRC (Kilpatrick et al., 2001) emphasizes that mathematics tasks should be solvable using the skills and knowledge that students already possess. Having students solve challenging problems that are within their capability develops their sense of efficacy as problem solvers. As necessary, and without simplifying the mathematics involved, teachers should provide scaffolding (information and/or questions that build on what students already know) to assist them in acquiring and applying concepts, skills, and abilities as they work on challenging tasks.

Effective mathematics tasks provide opportunities for students to practice basic skills and develop higher order thinking skills (NCTM, 1991). Fennema, Sowder, and Carpenter (1999) argue that mathematics should be presented in problem contexts that require students to create their own solutions. As students engage in solving these problems, they "concurrently learn basic skills, concepts, and ways to engage in mathematical activity" (p. 186). Thus, a classroom that emphasizes thoughtfully designed mathematics tasks develops students' achievement of multiple standards — for example, conceptual understanding, procedural fluency, and problem solving — whereas practicing computational procedures in isolation only develops students' computational skills.

Tasks that require students to represent mathematics information contribute to classroom discourse focused on meaning, especially when the precise representation (e.g., graph, table, drawing, equation) is determined by the student. In a recent analysis of the eighth-grade TIMSS video data of a random sample of classrooms in Japan, Germany, and the United States, Hardy (2001) found that tasks eliciting representations of mathematics information (e.g., "draw a square and label the parts corresponding to the parts of this binomial expression") were more likely to result in classroom dialogue about the meaning and connections between solution methods, symbolic systems, and mathematics concepts than did problems requiring applications of concepts or routine tasks. In addition, representational tasks that were open ended with respect to the kind of representation used (e.g., "prove the relationship between the length of a triangle side and its opposite angle") resulted in greater discourse about meaning than occurred when the representation was pre-specified (e.g., "sketch the function's graph on the axes provided"). Tasks that require students to represent information, and to select their own mode of representation, contribute to classroom dialogue that is focused on meaning and to student-constructed connections between solution methods, symbolic systems, or mathematics concepts.

Similarly, problems with multiple solution methods promote students' mathematics understanding. Knapp, Adelman, et al.'s (1995) research about high-poverty schools found that effective teachers maintained complex discussion around problems by using problems with more than one solution and by asking students for alternate solutions. The teachers did not emphasize typical solution strategies to problems or tout one strategy as more correct than another.

Selecting and Using Worthwhile Mathematics Tasks

Students' interests, understandings, and what they already know are all factors that should be considered when developing and selecting tasks (NCTM, 1991). Teachers also should consider

gender and diversity issues when selecting tasks to ensure that all students find problems equally accessible. Carpenter and Lehrer (1999) write, "The selection and sequencing of tasks and tools is critical. They should not be selected exclusively on mathematical structure. We must take into account children's thinking, the knowledge they bring to a situation, and the way their thinking typically develops" (p. 27).

Research by Stein and colleagues underscores the importance of teachers' knowledge about students, content, and how to use tasks effectively (Stein, Grover, & Henningsen, 1996; Henningsen & Stein, 1997; Stein, Smith, Henningsen, & Silver, 2000). The researchers found that mathematics tasks that are well designed and appropriately set up for students are often carried out in the classroom in ways that reduce their potential effectiveness on students' learning. This decreased effectiveness of tasks was associated with several different factors. First, teachers frequently were observed taking over the challenging aspects of problems by either performing them for students or telling students how to do them. Second, tasks were often inappropriate for students because students lacked the necessary prior knowledge, interest, or motivation. Third, teachers often emphasized the correctness of answers over the mathematical reasoning involved in solving a problem, which undermined students' engagement in complex thought. Fourth, teachers tended to provide too much or too little time to engage students in meaningful inquiry with a particular task. Fifth, when students were not held accountable for their work on a task, they were less likely to engage in that task in a meaningful way.

These researchers also identified factors that helped to maintain students' engagement in the complex thought required by well-designed tasks. The seven factors that promoted students' engagement in a problematic, meaningful task were the following:

- The task appropriately built on students' prior knowledge.
- Teachers provided the appropriate amount of time for thoughtful inquiry.
- Competent performance was modeled by the teacher or capable students.
- Teachers sustained pressure for explanations and justifications from students.
- Teachers provided scaffolding in such a manner that maintained the complexity of the task for students.
- Students were provided with means of monitoring their own progress.
- Teachers frequently drew connections among mathematical ideas and concepts. (Stein et al., 1996, p. 481)

The Importance of Context

There is growing enthusiasm for embedding mathematics in real-world, contextualized problems so that students can connect mathematics with their experiences outside of the classroom. For example, in 1990, the College Board initiated the Equity 2000 Project, an effort designed to close the gap between minority and disadvantaged youth and their nonminority, nondisadvantaged peers by ensuring that high school students have early experiences in algebra and geometry. A report about the results of the project after ten years of implementation (see Green, 2001) indicated that the use of contextualized learning, which places "the teaching and learning of mathematics in the context

of real-world application and modeling," is effective for helping students overcome math anxiety (p. 220).

Although some studies indicate that embedding mathematics in contextualized problems can reduce mathematics anxiety, research indicates that this strategy has not been as successful in terms of enhancing students' learning as intended (Zevenbergen, 2000). One frequently observed problem with contextualized tasks is that minority students are less likely to focus on the mathematical aspects of the problem than are middle-class, white students. For example, one study found that students from different socioeconomic backgrounds performed equally well on decontextualized tasks but differed when the tasks became contextualized (Zevenbergen, 2000). Another study observed that one curriculum's "real-world" math problems were more motivating for boys than girls because they addressed topics such as sports and cars (Boaler, 1997). Thus, the use of contextualized problems and tasks should be monitored by teachers to ensure that students are focusing on and thinking about the mathematics content of such problems.

In summary, although worthwhile mathematics tasks are an important part of instruction, using them effectively is a complex process. Not only must teachers select tasks that require mathematical reasoning, problem formulation and problem solving, they must also ensure that the tasks develop students' mathematics understanding and skills and are accessible to students in terms of their interests and prior knowledge. Teachers must also move from being a "dispenser of knowledge" to a "facilitator of learning," which Silver and Smith (1997) conclude is a considerable challenge "for teachers who have had limited experience in mathematics teaching and learning that is centered around the use of 'worthwhile' mathematical tasks" (p. 14).

Supportive Patterns of Classroom Discourse

Engaging students in conversations in the mathematics classroom provides important learning opportunities for students. Research about educational environments at Vanderbilt University (Bransford, Zech, Schwartz, Barron, Vye, & the Cognition and Technology Group, 2000) indicates that mathematics discourse promotes learning by providing students with the opportunity to present ideas, receive feedback, and revise and advance their understanding: "Discussions . . . are important because they can create interactive conditions that help people test their current levels of comprehension and revise their ideas" (p. 289).

Hiebert et al. (1997) write about the importance of discussions for learning by creating cognitive conflict. Cognitive conflict occurs when students encounter ideas that differ from their own in ways that cause them to rethink their understanding. Discussion becomes effective discourse when students are confronted with such contradictions, re-evaluate their methods and ideas, elaborate and clarify their thinking, and reorganize their understanding. Peer interaction is especially effective at promoting cognitive conflict because the differences in thinking are likely to be within a range that will generate genuine, fruitful conflict. In addition, when students are asked to orally justify their solution methods to their teachers and their peers, their own understanding deepens (NCTM, 2000).

The NRC's *Adding it Up* report (Kilpatrick et al., 2001) discusses the potential for higher order discourse to promote students' learning:

> The point of classroom discourse is to develop students' understanding of key ideas. But it also affords opportunities to emphasize and model mathematical reasoning and problem solving and to enhance students' disposition toward mathematics. Therefore, discourse needs to be planned with these goals in mind, not merely as a 'checking for understanding' form of recitation. (p. 9-32)

Effective classroom discourse contributes to students' learning the standards of communication, reasoning, conceptual understanding, and others. The NCTM *Professional Standards for Teaching Mathematics* (1991) recommends that students engage in discourse in the following ways:

> [Students should] listen to, respond to, and question the teacher and one another; use a variety of tools to reason, make connections, solve problems, and communicate; initiate problems and questions; make conjectures and present solutions; explore examples and counterexamples to investigate a conjecture; try to convince themselves and one another of the validity of particular representations, solutions, conjectures, and answers; and rely on mathematical evidence and argument to determine validity. (p. 45)

In addition, research suggests that students need assistance in learning how to communicate about mathematics because this type of interaction does not come naturally to them (NCTM, 2000).

The NCTM *Professional Standards for Teaching Mathematics* (1991) specify the teacher's role in discourse with the following activities:

> Posing questions and tasks that elicit, engage, and challenge each student's thinking; listening carefully to students' ideas; asking students to clarify and justify their ideas orally and in writing; deciding what to pursue in depth from among the ideas that students bring up during a discussion; deciding when and how to attach mathematical notation and language to students' ideas; deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty; and monitoring students' participation in discussions and deciding when and how to encourage each student to participate. (p. 35)

Professional Standards for Teaching Mathematics also includes a standard that addresses the use of tools for enhancing classroom discourse. For example, concrete representations, materials, invented symbols, and technology can all be used as tools for mathematics work that can then be focused and reflected on in classroom discussion.

More and more teachers create opportunities for students to engage in classroom discussions, but these discussions are not necessarily productive discourse. The 1996 NAEP teacher survey data show that teachers of more than two thirds of students in grades four and eight involve students in discussions at least once or twice a week using the following methods: solving problems in a group or with a partner, having students talk to the class about their math work, having students discuss problem solutions with other students, and having students solve problems that reflect real-life

situations (Grouws & Smith, 2000). However, other research suggests that the higher level and complex kind of discourse recommended in the research are infrequent in mathematics classrooms. Several studies reveal that on average, teachers' questions tend to elicit low-level responses from students rather than answers that require complex reasoning, explanation, or justification (Johnson, 2000; Koehler & Prior, 1993). *Adding it Up* (Kilpatrick et al., 2001) advises teachers to maintain complex and challenging discourse in the classroom, for example by having students with incorrect or undesirable solutions explain their reasoning because this promotes understanding and learning.

Characteristics of Effective Mathematics Discourse

Focusing classroom discussion on students' own problem-solving strategies and ideas greatly enhances students' learning. Hiebert et al. (1997) devote considerable space to describing social norms for successful mathematics classroom interactions. They conclude that the following are important social norms for the classroom:

- Discussions are about methods and ideas.
- Students choose their own methods and share them with others.
- Mistakes are sites for learning.
- Correctness is determined by the logic of mathematics. (pp. 46–49)

Other research similarly concludes that when students develop and discuss their own solution methods, they are better able to apply mathematics knowledge in new problem situations (Grouws & Cebulla, 1999).

Silver and Smith (1997) propose three important ingredients to creating successful discourse communities in the mathematics classroom:

- Conversation and communication need to be seen as central to the task of teaching and learning mathematics.
- Students need to be provided with worthwhile tasks that provide a basis for rich mathematical conversations.
- Teachers need to monitor students' mathematical discourse and to take appropriate action to facilitate discussions that can support students' learning of important mathematical ideas. (p. 5)

The first ingredient requires establishing a classroom environment in which students' thinking and speaking are valued and respected. The classroom norms need to permit and encourage students to ask about material they do not understand and to posit ideas and hypotheses that will be seriously considered. Students whose primary language is not English need help so that they can use their own language as a tool for mathematics and develop a shared mathematics vocabulary. Teachers need to be able and willing to challenge students' ideas and thinking within the classroom in a safe and encouraging manner.

The second ingredient is worthwhile mathematics tasks, described earlier in this chapter. The third ingredient refers to teachers facilitating discourse by providing appropriate time and interactions for

students to discuss problem solutions, and by communicating the norms for mathematics discourse in the classroom. Teachers might provide, for example, characteristics of good explanations or restrict the amount of commentary regarding one another's ideas.

Cobb, Boufi, McClain, and Whitenack (1997) write that "reflective discourse" is a discussion method that is particularly effective in developing the mathematics abilities that appear in the standards. They define reflective discourse as discussion "characterized by repeated shifts such that what the students and teacher do in action subsequently becomes an explicit object of discussion" (p. 258). An example provided by Cobb et al. illustrates this idea.

A first-grade teacher presented a picture of two trees on the overhead projector and asked the class to think about ways in which five monkeys could play in the two trees. Students responded with pairs of numbers with a sum of five (e.g., five in one tree, none in the other tree; two in one tree, three in the other tree). The teacher recorded the students' responses (i.e., the ways) in a table until she knew they had given all of the possible pairs for five. She then initiated the first shift in discourse by asking, *"Are there more ways?"* A student responded, *"I don't think there are more ways."* The teacher then asked why the student thought that there were no more ways. The student's response, *"That's all the ways that they can be,"* prompted the teacher to make another shift in the discourse by asking how they could know if they had thought of all the ways.

In this example, the mathematical activity was generating the pairs of numbers that have a sum of five. The result of that activity (i.e., the table of number pairs) then became the object of discussion through a shift in the discourse initiated by the teacher.

Two practices, in particular, were identified as useful in promoting reflective discourse in the classroom. First, the teacher changed the conversation to focus on what the students and teacher did mathematically (in this example, produced the pairs of numbers that sum to five), and acknowledged that students need to play an active role in such discourse if it is to influence their learning. If students had not been able to answer the question that the teacher asked to initiate the shift in the discussion, then the shift would not have occurred. Second, the teacher developed a symbolic record of students' contributions to the discussion. This symbolic record of the mathematics activity (in this case, a table), then became the focus of group or collective reflection.

Teachers need to listen to and understand the reasoning of the specific students in their classrooms, build on students' informal understanding, and challenge their misconceptions. Fennema, Sowder, and Carpenter (1999) write about the role of the mathematics teacher when interacting with students:

> The teacher must be active in establishing a classroom with norms that encourage a climate of understanding, in selecting tasks that incorporate important mathematics appropriate for each student and that will enable their understanding to grow, in assessing each student's growth, and in ensuring that all students are enabled to learn mathematics with understanding. However, sometimes a teacher must be passive and let students struggle either alone or with each other in the problem-solving process. It takes restraint . . . but the best role of the teacher [at times] may be to just listen to

what the student is doing and to ask questions that enable the student to find her or his own pathway to successful problem solving. (p. 190)

In order to use classroom discussion to develop students' understanding of mathematics, teachers must continue to learn more about mathematics content, pedagogy, and students' thinking. Carpenter and Lehrer (1999) write, "Teachers need to recognize that their own knowledge of mathematics and of students' thinking, as well as any student's understanding, is not static" (p. 31). Teachers should consciously use classroom discussions as opportunities to develop a better model of students' learning and thinking.

In summary, research indicates that managing meaningful discourse in the mathematics classroom requires a teacher who is knowledgeable about not only the mathematics of the lesson but also about how students learn in general, and about the particular students in the class (Kilpatrick et al., 2001). Discussion should be viewed as a central activity for learning mathematics and focus on worthwhile mathematics tasks. Both teachers and students should question, respond, and listen to mathematics ideas and methods for solving problems and rely on mathematics evidence to determine the validity of arguments and conclusions.

Appropriate Hands-on Experiences

Research supports the use of hands-on experiences — physical models as well as manipulatives and other concrete objects — to promote students' understanding of mathematics concepts and as tools for solving mathematics problems. For example, a recent analysis of 1996 NAEP data revealed that eighth graders who experienced some hands-on instruction demonstrated more learning than students in classrooms without these experiences (Wenglinsky, 2000). Another category of hands-on experiences includes activities such as physically collecting data (e.g., temperature or speed) to use for mathematics investigations. This section addresses the first type of hands-on experiences, namely, the use of concrete objects as mathematics tools.

The NCTM standards (2000) note the importance of using concrete objects for the development of students' representation abilities: "Primary school students might use objects to represent the number of wheels on four bicycles or the number of fireflies in a story. They may represent larger numbers of objects using place-value mats or base-ten blocks" (p. 68). As a result of using concrete objects to represent mathematics ideas, students learn to organize their thinking, and reflect on concrete representations.

The use of physical materials in the classroom can extend students' pre-existing experiences and knowledge of quantities. For example, teachers in the primary years can take advantage of students' experiences with physical quantities (such as pails of sand, numbers of cookies, and the weights of books) to promote students' understanding of mathematics concepts. Another benefit of the use of physical materials in the classroom is that they provide a shared representation of mathematics concepts, which, in turn, can become a common experience for classroom discussion.

The use of concrete objects allows students to experience and develop understanding of concepts before they are exposed to more conventional abstract notations (e.g., number sentences, formulas,

or equations) for these concepts. However, as the National Research Council (Kilpatrick et al., 2001) advises, teachers need to make explicit connections between concrete experiences, concepts, and symbols; when they don't, manipulatives become "just one more thing to learn rather than a process leading to a larger mathematical learning goal" (p. 9-41).

Hiebert et al. (1997) conclude that there are three guidelines for the effective use of tools, such as concrete objects, language, symbols, notation, or drawings, in mathematics instruction:

- Students must construct meaning for tools.
- Tools must be used for a purpose.
- Tools should be used to record, communicate, and think about mathematics. (pp. 168–169)

The first guideline indicates that students must understand the mathematical meaning of the materials they are working with if those materials are going to promote learning. For example, simply having students complete mathematics problems using base-ten blocks without drawing connections between the materials and the abstract numbers and operations will not advance students' understanding of these concepts. The second and third guidelines advise that tools be useful for conducting, communicating, or thinking about mathematics.

Research about high-performing, high-poverty schools supports the use of manipulatives in the classroom to increase students' achievement. Reyes et al. (1999) found that effective teachers in the Texas schools they studied used manipulatives and other hands-on materials in instruction. At the elementary level, manipulatives were used for teaching basic skills, introducing new mathematics concepts, involving students in critical thinking and problem solving, encouraging students to actively participate in the learning process, and fostering interest in and motivation for learning mathematics. Teachers in the middle schools also reported using hands-on materials and experiences to "provide students with visual representations of mathematical concepts and the procedural steps involved in problem solving." (p. 108). The use of concrete objects also gave students practical examples of how and why mathematics is important to learn.

The mere use of manipulatives, however, does not necessarily indicate that they are being used to teach for understanding in the mathematics classroom. Knapp, Adelman, et al. (1995) found that teachers who developed students' breadth of knowledge and conceptual understanding were more likely to use manipulatives effectively than were teachers who focused only on procedural skills. Knapp, Adelman, et al. observed ineffective uses of manipulatives in skill-based classrooms where teachers used manipulatives to capture students' interest and attention. Teachers who used manipulatives ineffectively did not see the mathematical properties of the objectives and therefore did not understand how to use them to foster students' understanding.

A recent study found that when teachers implement hands-on experiences, they commonly lose sight of the instructional goal for mathematics learning (Sowder, Philipp, Armstrong, & Schappelle, 1998). In activities that were intended to teach mathematics, such as having students plan an end-of-school picnic, much time was lost in non-mathematics conversation. Enhancing teachers' understanding of mathematics content is one way to promote their ability to have extended, in-depth,

conceptually rich and focused conversations in the classroom. Furthermore, teachers reported high levels of satisfaction with professional development that promoted their understanding of mathematics content. These results suggest that teachers' understanding of mathematics is related to their successful implementation of hands-on educational experiences.

In summary, hands-on experiences should build on experiences and knowledge of quantities and other mathematics concepts that students bring to school. Teachers should explicitly make connections between the mathematics of the hands-on experiences and the objects students use in hands-on experiences. These objects should have mathematical meaning for students and should be used for doing mathematics (i.e., thinking, representing, and/or problem solving).

Supportive Technology

Standards documents and curriculum frameworks recommend the use of calculators, computers, and other technologies in instruction (AAAS, 1989; Robitaille et al., 1993; NCTM, 2000) to promote students' learning. Specifically, calculators and computers can be used as tools in solving mathematics problems and promoting discourse about important concepts (NCTM, 1991). For example, graphing calculators permit students to more easily relate modifications of functions to changes in graphic representations of those functions (NCTM, 2000), which enhances students' knowledge of algebra and geometry.

Research on the effects of calculators on students' computational and problem-solving skills is generally positive. For example, a meta-analysis of 88 research studies by Hembree and Dessart (1992), found that "the preponderance of research evidence supports the fact that calculator use for instruction and testing enhances learning and the performance of arithmetical concepts and skills, problem solving, and attitudes of students" (p. 30). A study by Grouws and Cebulla (1999) notes that "teachers ask more high-level questions when calculators are present, and students become more actively involved through asking questions, conjecturing, and exploring when they use calculators" (p. 129).

Studies of students using graphing calculators report similar findings. These students have enhanced graphing abilities, representational skills, problem-solving abilities, mental flexibility, perseverance, and conceptual understanding when compared to students who do not use graphing calculators. In addition, most studies of graphing calculators have not found negative effects on basic skills, factual knowledge, or computational skills (Grouws & Cebulla, 1999).

On the other hand, an analysis of 1996 NAEP and 1994–95 TIMSS data of fourth graders' achievement conducted by the Brown Center for Education Policy (Loveless & Dipnera, 2000) found that students who reported using calculators every day in the class had the lowest test scores compared to students who reported using calculators "never," "once or twice a month," or "once or twice a week." But Loveless and Dipnera caution against drawing the conclusion that calculator use causes low achievement, noting, "Low student achievement may just as easily 'cause' calculator use as the other way around" (pp. 22–23). In fact, they note, the negative correlation between calculator use and NAEP scores was not found when *teachers* were asked how frequently their students use

calculators. Teachers who reported that their students used calculators every day had students with high test scores.

Research about computer use by students suggests that software that addresses higher order thinking skills, such as application and simulation, can promote learning, but that software emphasizing drill and practice of basic skills may actually detract from learning. The Education Trust (1998) reports that high achievement is associated with frequent exposure to computer simulations and other high-level applications. However, using computers for drill exercises was negatively correlated with achievement. These findings are particularly disturbing in light of other findings related to the types of computer use that various groups of students experience. Specifically, the Education Trust study found that the use of computers for drill and practice of computational skills is nearly twice as common for African American students as for white students, and software addressing higher order thinking about mathematics (e.g., application and simulation) is more than twice as likely to be experienced by white students as by African Americans in this country.

Reyes et al. (1999) found that high-performing, high-poverty Hispanic schools in Texas used computer programs to assess students' mastery of mathematics content, to re-teach or strengthen certain mathematics skills, and to diagnose weaknesses in a manner that could be used to develop individualized learning plans for students. Reyes et al. report that the most effective teachers selected instructional software for mathematics with the following three features:

- Emphasis was placed on meaning and understanding. . . .
- Mathematical skills were embedded in context. . . .
- Connections were made between subject areas and between school and life outside of school. (p. 125)

These researchers also report that computerized instruction in these schools was learner centered and interactive:

> Teachers and students collaborated and interchanged roles from learner to expert and vice versa. . . . In short, technology was used as a catalyst for change and as a tool for creating, implementing, managing, and communicating a new conception of teaching and learning mathematics and a system that supports it. . . . In the process, basic skills in mathematics were learned as well or better through these alternative instructional approaches. (p. 125)

Research suggests that special populations can benefit from instruction that integrates the use of computers and other technologies. Curriculum developers at Vanderbilt University constructed and researched a video-disc series intended for fifth- and sixth-graders titled "The Adventures of Jasper Woodbury" (Vye, Sharp, McCabe, & Bransford, 1991; Learning Technology Center, Vanderbilt University, 1996). Research about this series reveals that students learned more from the video-disc based materials than from a traditional curriculum, in both high-achieving and high-poverty populations of students. The researchers report that students' motivation was enhanced by the video-disc exercises and that the software provided extensive background information material for students.

A recent study examined the use of the Vanderbilt video-disc followed by a hands-on mathematics problem with a tenth-grade class of learning-disabled students (Bottge, 2001). Students first completed one of the video-disc's most difficult problems. Then they completed a similar, hands-on project. In post-tests, students who experienced the video-disc lesson exhibited better knowledge of the mathematics content than similar students who received traditional instruction. Bottge attributes these results to the fact that students were presented with interesting, challenging, and complex problems and that using video-based instruction bypassed students' difficulties with deciphering text-based problems.

Internet connections can also be resources for students and teachers, giving them opportunities to pursue activities and information that interest them and to access Web sites with well-designed activities on specific mathematics topics. For example, Reyes et al. (1999) report on a high-achieving, high-poverty elementary classroom that took students to the NASA space center. Later, students contacted NASA via the Internet for information about altitudes and the speed of rockets. NASA provided data and formulas for speed and velocity, which students studied with their teachers. Reyes et al. report that students were excited that they had received the information so quickly and "searched for other ways to 'surf the net' for information on topics of interest" (p. 101).

Although some kinds of computer software can enhance students' learning, teachers may encounter school- and district-level barriers to including these resources in instruction. This is particularly true for high poverty schools, which are more likely than others not to have access to the Internet and other advanced telecommunications or software that is aligned with the curriculum (Education Week, 2001b). Second, these schools lacked technical support and adequately trained staff for using technology in instruction.

The lack of training for using technology is not confined to high poverty schools. A recent national survey (National Center for Education Statistics, 2001) revealed that only 10 percent of teachers reported that they were "very well prepared" to use technology in the classroom; an additional 23 percent described themselves as "well prepared" to use technology in instruction. Most teachers (53%) rated themselves as only "somewhat prepared."

In summary, research suggests that the use of calculators and computers in the classroom as tools for thinking about and addressing mathematics with understanding can enhance students' achievement. Indeed, for some students, computers may be a more accessible medium than textbooks for learning mathematics. However, the use of computer programs that solely provide drill in basic skills should be avoided.

Aligned and Appropriate Student Assessment

Assessment is not a new concept for teachers. They currently use various types of assessments, including informal questioning, multiple-choice tests, oral assessments, essay questions, and other short constructed-response formats. Some may even use portfolios or projects as assessments. What may be different for many teachers is the idea that decisions about the type of assessment to use should be based on the type of knowledge or skill being assessed and individual students' needs and learning styles. One of the purposes of NCTM's *Assessment Standards for School Mathematics*

(1995) was to provide guidance for teachers about assessment of mathematics learning in a standards-based system:

1. Assessment should reflect the mathematics that all students need to know and be able to do.
2. Assessment should enhance mathematics learning.
3. Assessment should promote equity.
4. Assessment should be an open process.
5. Assessment should promote valid inferences about mathematics learning.
6. Assessment should be a coherent process. (pp. 11–21)

The vision for mathematics assessment described in this document includes having students solve complex and novel problems that require procedural and conceptual knowledge (rather than mastering concepts and procedures in isolation of problems). Further, it presents four important uses of assessment information: monitoring student progress, making instructional decisions, evaluating students' achievement, and evaluating programs. Research demonstrates that it is important to consider the type of assessment as well as the appropriate use of results since both of these influence students' learning.

Regardless of the type of assessment used, feedback from assessment can provide teachers and students with valuable information about students' progress, including their areas of understanding and misunderstanding (National Research Council, 1993). This information can then be used to adjust instruction. Such formative assessment practices are supported by research by Black and Wiliam (1998). In a meta-analysis of 43 studies of assessment innovations, they found that programs that strengthened teachers' practices of formative assessment produced significant and substantial gains in students' learning, especially for low-achieving students.

Further evidence for the usefulness of formative assessment comes from Reyes et al.'s (1999) study of high-performing, high-poverty, largely Hispanic schools in Texas that systematically measured and monitored students' progress in mathematics. Teachers at these schools tried to minimize standardized assessments but monitored students' progress using textbook or teacher-constructed tests at the end of every week. These assessments took a variety of forms, including one-on-one questioning of students by teachers, teacher monitoring of individual and group work during class, computer-based assessments aligned with state standards, student presentations of homework, and portfolios and projects. Assessments gave teachers important feedback about students' strengths and needs, which they could then use to adjust instruction and communicate student progress to students and their parents. One school involved students in daily testing of one or more of the state standards and re-taught concepts when necessary. The authors conclude that "formative assessments played a major role in generating best instructional practices and effective mathematics classrooms" (p. 124).

Other studies of effective schools show that they have assessment systems in place to identify and monitor students who are not achieving standards. For example, 81 percent of effective high-poverty schools studied by the Education Trust (1999) reported using a comprehensive system for monitoring student progress and providing early support to students in danger of falling behind. The regular

assessment of students' learning in these schools was used as a tool for identifying students in need of additional instructional assistance such as tutorial programs. As the Education Trust notes, "The push-pull of monitoring progress and providing extra support helps schools to stay on top of the development of each of their students. In this way, they can make sure that no student will fall through the cracks" (p. 9). Nearly all (94%) of the schools studied used standards to assess student progress; 77 percent offered regular mechanisms for teachers to analyze student work against the standards. These monitoring systems provided the opportunity for interventions, such as pull-out or added academic programs, but these types of interventions were reported more often for reading than for mathematics.

Research provides teachers with some guidance about when and how to use different assessment methods. For example, at the elementary level, teachers in the Reyes et al. (1999) study frequently used oral assessments, which were particularly effective when students were at the beginning levels of learning concepts and skills. The authors conclude that oral assessments at the elementary level removed pressure from students to perform on written tests and helped them "(1) focus more on understanding, (2) develop a mathematics vocabulary, (3) learn how to 'think out loud' as they solved problems . . . and (4) develop a firm foundation of language skills . . . for later critical-thinking and problem-solving use" (pp.101–102).

Teachers at these schools also assigned group or individual projects, but only after students demonstrated mastery of the requisite mathematics concepts or applications. When group projects were assigned, each student was held accountable for some part of the project; projects were completed before end-of-year assessments to ensure that material that students had not mastered could be re-taught. Teachers also used computer technology as an instructional and assessment aid in the classroom. Some computer programs were used to diagnose students' weaknesses and to provide them with practice in those areas, progressively increasing the difficulty of the activities.

Research supports some use of open-ended mathematics assessment tasks, especially for formative assessment purposes because these tasks provide teachers with a window to students' understanding. Senk, Beckmann, and Thompson (1997) note that high school teachers, in particular, tend to assess students' mathematics understanding using standardized or text-based tests, thereby receiving a very narrow glimpse of-students' understanding. Senk et al. conclude that high school teachers should learn to integrate open-ended assessment tasks into their evaluations of students because of the information these tasks can provide.

Teachers should not rely solely on open-ended assessment methods, however. A study of 1996 NAEP results by Wenglinsky (2000), indicated that eighth-grade students who took "point-in-time" tests, which can take a variety of formats (e.g., multiple choice, short answer, and extended written response) and are of short duration (a class period to several hours), outperformed those who were frequently assessed using "ongoing" methods, such as portfolios and projects, which tend to be comprised of open-ended tasks and extend over several days to months.

Performance assessment seems a logical way to determine whether students have acquired the desired level of mathematics understanding and procedural skill and a means to improve students' communication abilities. However, as studies have shown, teachers' beliefs about mathematics, for

example that there is one correct answer to a problem, serve as a barrier to the successful use of performance assessments in the classroom (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997; Saxe, Franke, Gearhart, Howard, & Crockett, 1997). Thus, teachers will require a great deal of support to use performance assessment to promote students' reasoning and problem-solving abilities and to effectively integrate it into instruction.

A study by Fuchs, Fuchs, Karns, Hamlett, and Katzaroff (1999) illustrates the positive outcomes that teachers can realize with performance assessment as well as the challenges they still face in using it successfully with all students. Fuchs et al. studied the influence of teachers' use of performance assessments on their classroom practice and knowledge, and on students' problem-solving abilities. After one year, most average- and high-performing students of teachers who incorporated performance assessment into classroom practice showed improvements in their problem-solving abilities, whereas some average and most below-average students did not demonstrate such improvement. Fuchs et al. note that teachers received substantial support for using this type of assessment in the form of professional development and collaboration time. However, the authors conclude that teachers need even more support in order to address the needs of low-performing students, in particular, extensive, long-term professional development.

External assessments, such as those conducted by districts and states, also influence students' learning. A study of the influence of New Jersey's Elementary School Proficiency Assessment on fourth-grade teaching practices revealed that including open-ended questions on the exam prompted teachers to ask students to explain their thinking and emphasize problem solving more often (Center for Educational Policy Analysis, 2001). On the negative side, teachers in high-poverty districts reported spending nearly twice as much time teaching test mechanics and using commercial test-preparation materials than did teachers in low-poverty districts.

Similarly, based on a decade of mathematics reform in Pittsburgh Public Schools, school administrators note that high-stakes assessments "either promote reform and lead to increased math learning by all students or they undermine reform and produce ill-prepared students who get high test scores. It all depends on the test that is selected and how it is used" (Briars, 1999, p. 32). By way of example, the author describes a district elementary school where 79 percent of fourth graders scored at or above the 51st percentile on the district's norm-referenced test. However, results from a later standards-based assessment revealed that less than five percent of these students had met the standard in skills, concepts, and problem solving. Teachers at the school had focused their instruction on preparing students to do well on the district's norm-referenced test, which unfortunately had led to huge gaps in the knowledge and skills of nearly all of the fourth-grade students.

A study of the impact on instruction of Maine's and Maryland's mathematics performance assessments revealed that teachers did not change their fundamental methods of instruction in response to the programs (Firestone, Mayrowetz, & Fairman, 1998). Although teachers changed the *order* in which they taught content areas in mathematics, they did not change their teaching practices very much. The teachers in this study maintained a procedural and rule-based perspective of mathematics; consequently, they continued to focus on telling students procedural solutions to problems followed by having students practice those procedures. Firestone et al. conclude that teachers "lack the deep understanding of mathematics to teach in ways that help students learn to

reason mathematically while calculating accurately. Teachers also need to better understand how students make sense of and learn from mathematical problems" (p. 112). These researchers conclude that high-stakes accountability systems are not effective mechanisms for changing the instruction received by students.

In conclusion, research suggests that assessment should be used formatively by teachers to gauge students' learning and adjust instruction to meet students' needs. An assessment system for monitoring students' learning should also be in place at the building level to identify students who are low achieving and to provide adequate instructional time and resources for these students. A variety of assessment methods, including open-ended, oral, and performance assessments, should be used to reveal information about students' understanding and misunderstanding and to improve instruction. In addition, research indicates that teachers should consider carefully their use of ongoing assessment methods and balance these with point-in-time assessments. Finally, research suggests that education systems will need to provide teachers with a great deal of support in the form of professional development and opportunities to collaborate with colleagues if teachers are to effectively implement performance assessment.

Diversity and Standards-Based Classroom Practices

Gaps in mathematics achievement between ethnic minority and majority populations on the NAEP have remained consistently large between 1990 and 1996 (Dossey, 2000). When NAEP data were examined by state, only a handful of states had reduced gaps between the performance of the top and bottom quartiles on the fourth- and eighth-grade mathematics test (Barton, 2001). Other analyses of these NAEP data, combined with teacher survey data, conclude that performance differences are correlated with differences in instruction received by populations of students (Strutchens & Silver, 2000; Education Trust, 1998). Classes with large populations of minority students are not only less likely to have well-qualified teachers, they are also more likely to lack other resources to support instruction. These differences in learning opportunities lead to differences in achievement.

Studies of high-performing, high-poverty schools suggest that a large component of success is putting in place high standards, a curriculum aligned with standards, extra assistance for students who need it, high-quality professional development for teachers, and supportive organizational structures (Haycock, 2001; Berman, Chambliss, & Wood, 2001). However, there is disagreement about the type of mathematics programs diverse student populations should receive.

Battista (1999) and Delpit (1995) state that some people think that traditionally underserved and underrepresented students may require a more structured environment than reform programs provide because these students are less prepared than middle-class students to receive a curriculum focused on understanding, that is, one that uses open-ended problems and higher order discourse. A study by Lubienski (2000) of seventh graders receiving a problem-based curriculum provides some support for this idea. Lubienski found that high-poverty students were more uncomfortable than middle class students with the open-ended nature and focus on understanding of the reform curriculum. Lubienski suggested that the structured environment of the "algorithmic mode of instruction" doesn't connect to middle class students' lives any better than to underserved and underrepresented students' lives.

It does, however, have clear roles for teachers and students. These two characteristics may "level the playing field" and make this mode more comfortable for diverse students. (Lubienski, p. 478).

Effective Elementary Programs for Diverse Populations

Reform-based mathematics programs can result in high achievement in minority and educationally disadvantaged students. For example, at the elementary level, Resnick, Bill, Lesgold, and Leer (1991) successfully developed and implemented an instructional program for use with ethnic minority and low-income student populations. The program, which Resnick et al. refer to as a "reasoning-based arithmetic program," was guided by the following six principles:

1. Develop children's trust in their own knowledge.
2. Draw children's informal knowledge, developed outside school, into the classroom.
3. Use formal notations (identify sentences and equations) as a public record of discussions and conclusions.
4. Introduce key mathematical structures as quickly as possible.
5. Encourage everyday problem finding.
6. Talk about mathematics; don't just do arithmetic. (pp. 35–43)

The reasoning-based arithmetic program included a large amount of small-group and teacher-led discussion. Based on its premise that all students come to school with reasoning and thinking abilities, the program recommends that instruction build on students' informal knowledge and skills. Resnick et al. indicate that educationally disadvantaged students require more explicit emphasis on reasoning and thinking because they are less likely to be exposed to such skills in their homes: "Such children often fail to learn the 'hidden curriculum' of thinking and reasoning that more favored children acquire without much explicit help from teachers" (p. 28).

Implementing the reasoning-based arithmetic program resulted in dramatic gains in California Achievement Test scores for first- and second-grade students experiencing the program. These gains were exhibited and sustained by students at all levels. Students also exhibited conceptual understanding and confidence in their mathematics abilities. The researchers conclude that a program focused on developing conceptual understanding and drawing on students' informal mathematics knowledge acquired outside of school can be effectively implemented with educationally disadvantaged students. Furthermore, this research indicates that instruction about conceptual understanding does not need to follow students' learning of arithmetic — the two can be developed simultaneously.

Other elementary curricula focused on developing students' understanding have been successfully implemented with high-poverty populations. For example, Peterson, Fennema, and Carpenter (1991) write of the implementation of Cognitively Guided Instruction (CGI) in first-grade classrooms in high-poverty, urban schools. At the end of the school year, students who attended CGI classrooms performed nearly four standard deviations above a comparison group of students on a test of conceptual understanding, and about five standard deviations better than the comparison students

on a test of basic skills. The following factors were found to be important for instructing educationally disadvantaged students:

1. Assessing students' mathematical knowledge and understanding;
2. Building on students' informal and formal mathematical knowledge; and
3. Constructing curricula and teaching in ways that encourage mathematical thinking and problem solving by all children. (pp. 92–93)

Knapp, Adelman, et al. (1995) also found that effective teachers of high-poverty students focused mathematics instruction on student understanding and made connections between the world that students knew outside of the classroom and the world they experienced in the classroom. These teachers worked to overcome student background factors that could have become barriers to students' success in mathematics. Effective teachers also reported being more familiar with the populations of students in their classes. They explicitly acknowledged the diversity in their classrooms, and recognized and valued the strengths and knowledge of all students.

Effective Secondary Programs for Diverse Populations

Research about mathematics instruction at the secondary level reveals that emphasizing understanding and discourse enhances the achievement of low-performing students. Boaler (1997) studied two high-poverty secondary schools in England with different instructional approaches: One provided an open-ended, problem-based program; the other, a traditional, tracked, procedural-based program. The problem-based program focused on problem solving, high expectations for all students, a broad array of mathematics topics and discussion and justification. Teachers in the problem-based program made a point of ensuring that material was accessible to students by introducing problems and working with students to ensure that they understood the mathematics of the problems. Students in this program received explicit instruction centered on how to productively engage in the processes that characterize mathematics (e.g., solving problems, conjecturing, reasoning). As part of this instruction, teachers held discussions with their students about what constitutes quality work in mathematics.

Boaler found that after three years, students attending the problem-based program had achievement levels on national exams that were significantly higher than the achievement levels of students in the traditional program. In addition, the correlation between social class (based on parents' occupations) and achievement decreased among students in the problem-based program to the point that as a group these students performed above the national average. In contrast, the achievement gap between social classes and genders significantly increased for students in the traditional program (Boaler, 2001). Boaler concludes that not only can an open-ended, problem-based mathematics program be implemented for educationally disadvantaged students, but that implementing any program that is less demanding, such as one emphasizing procedural skill, is a disservice to such students (Boaler, 2001).

Another study of middle-school mathematics for disadvantaged students was conducted by Silver and Stein (1996). These researchers developed and implemented in high-poverty urban settings a curriculum titled QUASAR (Quantitative Understanding: Amplifying Student Achievement and

Reasoning) in high poverty urban settings. The program, which was problem-based, included a broad range of mathematics content and balanced attention to basic skills with instruction in higher-order mathematical thinking. It also emphasized communication and collaboration and required students to provide explanations and justification for their work. Students who experienced the QUASAR program performed well on assessments of conceptual understanding and on NAEP exams when compared with other urban populations of students. These students also were more likely to successfully complete high school algebra. Silver and Stein conclude that the program's focus on teaching mathematics with meaning, along with its support for teachers' implementation of new instructional methods, contributed to its successful outcomes with disadvantaged students.

At the high school level, policies that require all students to take "gate-keeping" mathematics classes, such as algebra and geometry, are affecting the achievement gap. Equity 2000, a program developed by the College Board, (Green, 2001; College Board, 2000) includes such policies. In the Equity 2000 program all students must enroll in and pass both algebra and geometry in high school. Where the policy was implemented on a district-wide level, mathematics achievement gaps decreased.

Policy was not the sole reason for the success of the program. The program also included a safety-net feature for students who were not prepared to take the courses or who were struggling to make progress in them. These extended learning opportunities for students included Saturday academies, summer programs, Academic Enrichment Laboratories (a mentoring program), and other programs, events, and partnerships, often with local universities and colleges. Teachers helped to reduce students' mathematics anxiety and increase the likelihood of their success by contextualizing learning. They connected mathematics to students' lives and interests and incorporated strategies that addressed multiple intelligences and a diversity of learning styles. As a result of the program, passing rates rose from 40 percent to 60 percent on average in Algebra I, and from 36 percent to 59 percent in Geometry. Nonetheless, longitudinal research of the program sites reveals a persistent gap between minority and nonminority students on many measures (Green, 2001), suggesting that this program has not completely ameliorated the problems it was designed to address.

The Equity 2000 program was based on research indicating that all students benefit from taking algebra in high school. Recent research provides additional support for this practice. For example, an analysis of the National Educational Longitudinal Study data conducted by Gamoran and Hannigan (2000) combined high school transcript data with scores of eighth- and 10th-grade students on a 40-item multiple choice mathematics assessment. This study revealed that low-achieving students who enrolled in algebra while in high school had significantly better 10th-grade mathematics test scores than did students who did not take an algebra course. However, low-achieving students' gains were not as large as the gains of average- or high-achieving students who had completed algebra.

The researchers posit three possible reasons for this finding of disparate influences of algebra on learning: (1) low-achieving students may lack the capacity to benefit from algebra courses as much as other students, (2) algebra classes might not adequately meet the needs of the low-achieving students, or (3) low-achieving students might be tracked into classes that are watered-down versions of the algebra experienced by higher achieving students. The authors conclude that a policy requiring

algebra-for-all would benefit all students, though, as the Equity 2000 program demonstrated, some additional work on implementation of such a policy might further enhance its impact.

Ethnic Diversity and Mathematics Instruction

In their study of high-performing, high-poverty Hispanic elementary, middle, and high schools in Texas, Reyes et al. (1999) found that effective teachers focused on developing students' understanding of mathematics *and* their basic skills. These teachers believed that students and teachers together create new mathematics knowledge through goal-directed activities. They created a classroom environment that valued students and their cultures by drawing on students' backgrounds and knowledge to make mathematics more relevant for them and by using Spanish as a tool for inquiry, communication, and thinking.

Fashola, Slavin, Calderón, and Durán (2001) reviewed research on the effectiveness of instructional programs for elementary and middle school Latino students. In particular, they were interested in identifying programs that "have been shown to be effective in rigorous evaluations, that are replicable across a broad range of elementary and middle schools, and that have been successfully evaluated or at least frequently applied to schools serving many Latino students" (p. 5). Fashola et al. identified five mathematics programs that met these criteria: Comprehensive School Mathematics Program (CSMP), Cognitively Guided Instruction (CGI), Project SEED, Skills Reinforcement Project, and Maneuvers with Mathematics. Common to these programs are emphases on problem solving, abstract mathematics concepts, and a broad range of content. After reviewing these programs, the authors conclude:

> There is a broad range of replicable programs from which elementary and middle schools can choose to meet the needs of their Latino students. . . . Anyone who believes that the often dismal performance of many Latino students is inevitable must confront the data from these programs. . . . It would be foolish for schools to ignore the rich and varied set of alternatives available to them to enhance the learning of their Latino and non-Latino students. (p. 51)

Some research has addressed sociological differences between minority and majority populations that influence learning mathematics. When the social culture of the home and the language used in the home differ from those of the school, students are more likely to have difficulties learning mathematics (Zevenbergen, 2000). For example, students may find it difficult to benefit fully from instruction if their culture includes norms for social interaction that differ from those used in school because social interaction is rarely taught explicitly in mathematics classrooms. This places a burden on the student to learn the norms for social interaction through observation and participation. Research has found that providing educationally disadvantaged students with explicit instruction in how to learn mathematics has dramatic effects on students' learning. For example, Boaler (2001) observed that explicitly teaching study methods to students in high-poverty secondary school classrooms enhanced students' achievement.

In conclusion, mathematics programs that have been successful for minority and educationally disadvantaged populations are comprehensive, covering a broad range of topics and developing

mathematical understanding as well as basic skills. They focus on problem solving and explicitly teach students how to learn mathematics and use reasoning and thinking skills. Successful programs also promote communication and collaboration. They respect students' informal knowledge and culture by drawing on their experiences outside of school and encouraging the use of their native language when participating in mathematical activities (e.g., solving problems, formulating justifications, making conjectures).

SUMMARY AND CONCLUSIONS

The research described in this chapter addressed classroom practices that help students, particularly low-performing students, to successfully acquire the knowledge and skills articulated in standards developed by organizations at the national level. A common theme across these studies has been the importance of balance, not only in the content presented but also in assessment and instructional approaches. Balance in content means that it emphasizes both conceptual understanding and procedural skills. It also means that the curriculum addresses the range of mathematics topics and process skills defined by standards and that this content is addressed in a coherent way across the grade levels, emphasizing particular skills and concepts to different degrees at different grade levels.

In terms of assessment, balance means that teachers should use a variety of assessment approaches to determine the degree to which students' have acquired the targeted knowledge, including the conceptions and misconceptions they have formed. Studies indicate that, in addition, teachers should know how to use assessment for formative purposes — to make appropriate adjustments to instruction for individual or groups of students — not just for summative purposes — to make decisions about whether students have passed or failed at some particular point in their studies, such as the end of a course. Formative assessment in the classroom should be balanced with formative assessment at the school level. There should be a school-level assessment system that frequently monitors students' learning across all grades to provide early support to students who are struggling.

Balance in instructional approach means that teachers should use a variety of strategies to actively engage students. These strategies include using hands-on experiences, technology, and worthwhile tasks. Teachers must also be able to orchestrate classroom discourse in ways that challenge and engage students and cause them to question and revise their understanding. In addition, teachers should be skilled at respecting and incorporating students' cultures in instruction. This increases students' motivation and helps them make sense of what they are learning. Instruction is strengthened further when teachers build on what students' already know — knowledge acquired formally in previous grades as well as informal knowledge, such as problem-solving strategies and mathematical understanding, gained through out-of-school experiences.

Research cited in this chapter provides guidance for successful practice, but it also reveals issues still to be resolved. For example, teaching for understanding — a key goal of mathematics standards — requires substantial change in teacher practice. Implementing such change is extremely difficult for most teachers. One factor that inhibits the change is teachers' lack of deep understanding of mathematics. It is difficult for teachers to orchestrate discourse, select and use worthwhile mathematics tasks, connect manipulatives with the mathematics concepts they represent, and take

advantage of the power of technology for exploring mathematics topics without having an understanding of mathematics themselves.

Other issues still to be resolved include the role of contextualized problems with diverse populations. In some cases, such problems help students make connections to their own experiences and enhance their problem-solving skills. In other cases, students focus on details in the problem that distract them from mathematics. This issue is related to controversy over appropriate mathematics curricula for diverse student populations. Although several studies have shown that diverse students are well served by curricula that are open ended in nature and include an emphasis on problem solving, other studies suggest that diverse students may need more structure. Further investigation may add to the evidence provided by studies reported here that indicate that curricula that include explicit instruction in norms of mathematics discourse and how to learn mathematics and use thinking and reasoning skills increase diverse students' chances for success.

All of the above emphasizes that teaching is a complex endeavor. It always has been, but it seems more so now with the expectation that all students achieve high standards. Although research about effective curriculum and instruction may not decrease the complexity of the task, it does provide evidence that all students can achieve the levels of mathematics learning envisioned by standards, given appropriate curricula and instructional practices. In particular, we know that it is of critical importance that teachers care enough about students to know and explicitly value their culture and prior knowledge in the classroom. But, as Knapp, Adelman, et al. (1995) conclude, "caring about students is not enough. Although not caring is clearly destructive, the combination of understanding, caring, and adapting curriculum and instruction to diverse needs is necessary to create sound environments for learning" (p. 46).

The message of hope revealed by the research presented in this chapter is that the mathematics performance of U.S. students can be improved. Achievement gaps can be eliminated, and all students can learn challenging mathematics. There are specific strategies that can be applied to accomplish this task. And, the task will be accomplished if educators have opportunities to learn about these strategies and are given support to implement them.

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CHAPTER 3

TEACHER LEARNING FOR STANDARDS-BASED EDUCATION

by
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In 1996, the National Commission on Teaching and America's Future (NCTAF) published a document that emphasized the importance of good teachers for the future of education in America. The authors stated, "What teachers know and can do makes the crucial difference in what children learn" (p. 5). Citing research on teaching practices and policies, the authors elaborated on the close connection between teachers and student learning.

The NCTAF document has stimulated new studies on variables related to effective teaching as well as re-examinations of previous research on teacher quality. Underlying these new investigations and literature reviews is the current context of standards-based education reform. The NCTAF report stresses that for reforms to improve students' learning, teaching practices and policies must also be reformed. For example, the authors assert that there should be standards for teachers as well as students, using the National Board for Professional Teaching Standards as benchmarks for accomplished teaching. To attain a knowledge base that can help them achieve these standards, teachers need effective preservice programs and opportunities for high-quality, in-service learning.

The purpose of this chapter is to describe and analyze research and commentaries by education experts on the relationships among teachers' characteristics and practices, teacher learning, and high standards as goals for student learning. According to a recent report by the National Academy of Sciences (2001) on teacher licensure, teach*er* quality is the "knowledge, skills, abilities, and dispositions of teachers" (p. 2-1), whereas teach*ing* quality depends on many factors that are primarily contextual, such as school and district resources, school organization, professional development, administrator support, and interactions with parents and community. The following sections examine aspects of both teacher and teaching quality in the context of standards-based reform.

The first section describes what teachers need to know and believe in order for all students to achieve the standards described in this report. The second section looks at how teachers can learn what they need to know for effective standards-based education. The third section discusses accountability or how educators can know when professional development helps all students to achieve standards. The fourth section describes policies and practices that best support teacher professional development. The final section examines teacher learning in the specific context of schools that have significantly increased the achievement of traditionally low-performing students.

TEACHER KNOWLEDGE AND BELIEFS FOR AMBITIOUS STANDARDS-BASED EDUCATION

Research continues to accumulate regarding the critical influences of teaching on students' achievement. An example is the oft-cited work of Sanders (1998), which showed that effective teachers in Tennessee had students who made gains in achievement on state assessments, while students with ineffective teachers did not exhibit the academic growth that was expected based on previous performance. Other research shows that money spent by districts to improve the quality of teaching produces more positive impacts on students' achievement than do other uses of district funds (NCTAF, 1996). Thus, student learning depends on high-quality teaching.

Teachers as Key to Standards-Based Reform

Based on their research of teachers' practices in mathematics and science, Thompson and Zeuli (1999) conclude that teacher learning is key to the success of standards-based reform in classrooms. The authors suggest that K–12 curricular reforms require a new curriculum for teachers and new approaches to professional development. In support of this view, the Educational Testing Service (Wenglinsky, 2000) reported on a national quantitative study that linked teachers' classroom practices to eighth graders' achievement in mathematics and sciences, as indicated by performance on the National Assessment of Educational Progress. Wenglinsky cited the results as clear evidence that teacher quality is directly related to student learning. The author concludes that "unless a child is taught by competent teachers, the impact of other education reforms will be diminished" (p. 3). Similarly, in an in-depth qualitative study of three high schools, Ancess (2000) found a reciprocal relationship between restructuring and teachers' practices. Restructuring was necessary to provide opportunities for teacher learning, which in turn was necessary for improved teaching practices, higher student outcomes, and successful reform.

Teacher Knowledge for Ambitious Student Learning

Many education researchers contend that standards for K–12 student learning require a different way of teaching than in the past. According to Lord (1994), who was involved in early national discussions of K–12 standards (Lord, 1992), content standards envision new images of teaching and learning. Standards-based reform requires that teachers have an expanded knowledge base, new teaching strategies, new forms of pedagogical reasoning, and new types of relationships among themselves and with their students. In 1996, Wilson and Ball discussed the impact of K–12 content standards on teacher preparation by summarizing the kinds of knowledge and skills that standards require of new teachers. Teachers in standards-based school systems must be able to address curricular outcomes, prepare students for standards-based assessments, design lessons that cover complex content and result in deep student understanding, provide opportunities for discussion, practice effective classroom management, and ensure that all students achieve.

Darling-Hammond (1999) summarizes the following key types of knowledge that teachers need to help all students reach the challenging learning goals of standards-based reforms:

- An understanding of subject matter that includes knowledge of how inquiry is conducted in the field and how ideas are connected across subjects, in addition to an understanding of the core knowledge in the field
- Pedagogical content knowledge so that teachers can represent the content of a field to students in a way that considers how to build on their previous experiences
- Knowledge of human development including all aspects of growth — cognitive, social, physical, and emotional
- Understanding of the influences of individual student differences due to factors such as gender, ethnicity, culture, language, and prior learning experiences and difficulties
- An understanding of motivation that encompasses how to structure tasks and encourage students while considering their beliefs about themselves and their interests
- Knowledge of different types of learning tasks and the kinds of teaching strategies needed to support them
- Knowledge of how to devise ways and means to assess students to determine their different learning styles
- A repertoire of teaching strategies that can address the learning needs of individual students, including those with learning disabilities and low language proficiencies
- Knowledge of how to use technology and other resources in connecting students with information beyond their classrooms and textbooks
- An understanding of how to use processes of collaboration to promote learning, both among students and among teachers
- The ability to analyze and reflect on the impact of their teaching practices on students' understanding

Although teachers need many kinds of knowledge for standards-based education, the primary difference between current views of teacher knowledge and those of the past is that new reforms reflect an increased emphasis on students' thinking. For example, Thompson and Zeuli (1999) describe "thinking to learn" as the heart of reforms in mathematics and science:

> By "think," we mean that students must actively try to solve problems, resolve dissonances between the way they initially understand a phenomenon and new evidence that challenges that understanding, put collections of facts or observations together into patterns, make and test conjectures, and build lines of reasoning about why claims are or are not true. (p. 346)

What kind of teaching is needed for this kind of learning? Thompson and Zeuli state that for mathematics and science, teachers must be able to pose appropriate problems, arrange for student interactions through questioning, provide learning materials and tools, assess how students' thinking is proceeding, and introduce new content at the appropriate time. Taylor, Pressley, and Pearson (2000) comment that good literacy teaching balances higher order instruction that emphasizes comprehension with instruction on skills and strategies. The authors base their conclusions on a

study of effective schools with successful primary grade teachers that the Center for Improvement of Early Reading Achievement sponsored (Taylor, Pearson, Clark, & Walpole, 1999). Effective standards-based instruction in literacy and mathematics are discussed in more detail in Chapters 1 and 2 of this report.

Ball and Cohen (1999) also stress that views of learning advocated by standards-based reforms require teachers to have new types of knowledge. These prominent educators and researchers suggest that, first, teachers need a deep conceptual understanding of the subject matter they teach. This includes an understanding of the methods of reasoning within a field and the connections among ideas across fields. Second, teachers need to know about children's developmental stages and the ideas that children bring to subject matter. Third, teachers need to know how differences among students in areas such as culture, language, class, and gender relate to learners' frames of reference. Fourth, teachers need to increase their understanding about how children learn and to view children as capable of higher order learning. Finally, teachers need to know pedagogy and a variety of instructional strategies. As Ball and Cohen comment, "In order to connect students with content in effective ways, teachers need a repertoire of ways to engage learners effectively and the capacity to adapt and shift modes in response to students" (p. 9).

The Consortium on Chicago School Research recently examined the relationships between instructional practices and students' achievement in elementary mathematics and reading (Smith, Lee, & Newmann, 2001). The researchers distinguished between two types of teaching: didactic and interactive. In general, didactic instruction means that teachers lecture or demonstrate, ask students short-answer questions about objective knowledge, assess students only for the correctness of their answers, and determine what students will study. Interactive instruction means that teachers listen and guide students, ask students questions that have multiple correct answers, assess how students produce answers, and give students choices during learning. The researchers found that students whose teachers reported using more interactive than didactic instruction scored higher on the Iowa Test of Basic Skills in both mathematics and reading compared to students of teachers who used more didactic than interactive instruction. The authors emphasized that effective instruction balances the two approaches, depending on students and classroom contexts. However, the authors maintain that Chicago teachers need to use more interactive methods because these strengthen learning by helping students to think more deeply about subject matter.

Studies of teaching in subject areas such as mathematics and literacy conclude that regarding teacher quality, subject knowledge matters. An Educational Testing Service study (Wenglinsky, 2000) found that eighth graders whose teachers majored or minored in the subject being taught (mathematics or science) had higher achievement than students whose teachers did not have a major or minor in the subject being taught. Shulman (1986) proposes that in addition to knowing the subject matter, teachers need pedagogical content knowledge. This type of knowledge includes knowledge of how best to represent the core ideas of a subject to students and understanding the common mistakes that students make when learning a subject.

In one of several reports on the success of District 2 in New York City, Stein and D'Amico (1999) discuss the importance of teachers' subject knowledge and pedagogical content knowledge to the performance of the district's K–5 students in literacy and mathematics. The authors acknowledge

that the district's reformed approaches to literacy and mathematics have similar philosophies regarding student learning because in both subjects, students construct and interpret knowledge, and teachers are seen as engineers of learning who encourage students' higher order thinking. However, the authors state that the nature of knowledge and the learning activities in the two subjects differ. Accordingly, teachers need both substantive knowledge of a discipline — the central topics, concepts, and procedures — and an appropriate subject orientation — beliefs about the creation and verification of knowledge in the discipline. In interviews with District 2 teachers, Stein and D'Amico found differences in teachers' knowledge of and orientations toward mathematics compared to literacy, with teachers indicating more familiarity and comfort with the latter. The authors use these data as well as data from classroom observations to justify the district's use of subject-oriented approaches to professional development.

Teachers' Expectations of Students

Research has demonstrated that teachers' beliefs and expectations about their students' capabilities for learning influence their classroom practices and the performance of their students. A study by Solomon, Battistich, and Hom (1996) illustrates the relationship between teachers' beliefs about students' learning and teachers' instruction. Using teacher surveys and classroom observations, the researchers found that elementary teachers in schools with predominantly high-poverty students had lower expectations for students than did teachers in other schools. In addition, the instruction of teachers in high-poverty schools tended to be more didactic and gave students less autonomy and opportunities for interaction. Even when student achievement levels were statistically controlled, "teachers saw students in high-poverty schools as less capable. . . . This suggests that expectations were exerting a powerful influence on attitudes" (p. 345).

Weinstein (1998) reviewed research on the influence of teachers' expectations on students' motivation and learning. The author summarizes studies showing that teachers differentiate their practices toward students for whom they have high versus low expectations for performance. For example, compared to their low-expectancy students, teachers give their high-expectancy students more warmth, increasingly more difficult material to learn, and more opportunities to respond in class. The author also summarizes research showing that teachers are more likely to have low expectations for certain groups of children, including those who are poor, of some ethnic minorities, handicapped, and with prior low achievement. According to Weinstein, research demonstrates that children are aware of differential treatment by teachers and that teachers' low expectations and differential treatment are associated with lower student achievement. The author describes a two-year intervention designed to increase secondary teachers' positive expectancy behaviors toward low-performing ninth-grade students. Teachers, administrators, and researchers collaboratively studied the expectancy research literature and designed programs, practices, and policies to target expectancy communications in the school. Quantitative and qualitative data indicated that teachers increased their positive expectations and behaviors, and students increased their motivation (e.g., involvement in school) and learning outcomes (e.g., overall grade-point averages). Weinstein concludes that it is possible to change teachers' expectations, but the change must occur through collaboration at the school level.

In Scheurich's (1998) description of successful elementary schools with primarily high-poverty students of color, holding high expectations for students' learning is one of the schools' core beliefs. According to Scheurich, educators in these schools believe that all students, with no exceptions, can achieve at high levels, which they make possible by assuming responsibility for all children to succeed, without lowering standards. Based on interviews and observations of teachers and administrators, Scheurich concludes that the operationalization of such beliefs is responsible for the high academic performances of students in these schools.

Summary and Conclusions: Teachers' Knowledge and Beliefs

Research studies support the conclusion that teachers' classroom practices have strong influences on both the achievement of students and the success of school reforms. Standards-based reforms require that teachers have new types of knowledge to help their students achieve high levels of learning that are based on thinking and understanding. The empirical studies discussed in this section emphasize the following types of teacher knowledge needed for standards-based education:

- Knowledge of a subject area and its connections to other fields
- Knowledge of how to represent subject matter to students including an understanding of student errors (pedagogical content knowledge)
- A repertoire of instructional strategies that balances higher order interactive teaching with didactic skills instruction

Education commentaries discussed in this section (e.g., Darling-Hammond, 1999; Ball & Cohen, 1999) add the following types of teacher knowledge based on research and experience in the field:

- An understanding of how differences among students in development, culture, language, gender, and class influence students' learning
- Knowledge of how to adapt instruction in response to the learning needs and styles of different students
- Knowledge of how to assess students' learning and understanding
- Knowledge of how to use collaboration among students to support learning

However, knowledge by itself is not enough. Teachers' beliefs and expectancies are associated with student motivation and learning outcomes. Teachers must believe that their students are capable of higher order learning and also communicate these expectancies for high achievement to their students.

TEACHER LEARNING FOR EFFECTIVE STANDARDS-BASED EDUCATION

If teachers are key to the success of standards-based reform, then teacher learning is key to the acquisition of knowledge and beliefs that support ambitious student learning. As described by Wasley (1999), teacher learning occurs in a continuum, starting with the preservice years in teacher preparation programs, followed by induction experiences and in-service professional development, and culminating in professional status, such as advanced certification. Because teacher preparation institutions are only beginning to align their programs with K–12 content standards, the majority of

teachers in the United States have had to learn how to teach in a standards-based system while practicing. Most of this learning occurs through staff development activities that vary greatly in content, format, duration, and effectiveness.

Teachers as Learners

To understand the influence of professional development on teachers' knowledge and beliefs, it is necessary to understand that the teacher's primary role in professional development is that of a learner. Thus, principles of learning apply to in-service teachers as well as to their students. Hawley and Valli (1999) argue that research related to learner-centered principles (American Psychological Association, 1993; Alexander & Murphy, 1998) should be applied to teacher professional development. This means that professional development should consider teachers' prior knowledge, higher order thinking, motivation, developmental stages of learning, and social contexts. In a report for the Consortium for Policy Research in Education, Cohen and Ball (1999) explain that successful professional development needs the same elements that are found in successful classroom instruction.

> These elements include a teacher or teaching agent; actively engaged learners; a curriculum of intervention; framing the teaching and curriculum in light of learner-enactors and what they bring (because that will affect interpretation and enactment); opportunities to learn, practice, revise, and reflect; examples of successful performance; support from other agents in the immediate environment. (p. 17)

Researchers of the success experienced by District 2 in New York City suggest that the district's professional development for teachers incorporates many aspects from academic theories of how humans learn (Stein, D'Amico, & Johnstone, 1999). Teacher learning in District 2 has features aligned with the kind of learning that is wanted for students. Teachers learn by doing — by engaging in authentic teaching tasks and interacting with teachers rather than by reading or listening to a lecture. Teacher learning builds on the district's Balanced Literacy Program, which begins with a focus on the classroom learning environment, provides workshops on literacy for teachers who need them, and gives teachers opportunities to work with expert teachers. Teachers observe models so they can begin to form images of good teaching. Teachers receive different kinds of assistance depending on where they are in their development as teachers. According to Stein et al., learning theorists recommend this kind of learning environment to promote the kinds of higher order thinking needed for standards-based education.

The Need for New Paradigms of Professional Development

The failure to consider teachers as learners may be one reason that professional development activities often fail to positively affect teaching practices and student learning (Hawley & Valli, 1999). Many educators and researchers are calling for new paradigms of professional development. Hawley and Valli refer to a new "consensus model of professional development" resulting from four developments:

1. Research on school improvement that links change to professional development;
2. Growing agreement that students should be expected to achieve higher standards of performance, which include a capacity for complex and collaborative problem solving;
3. Research on learning and teaching that reaches substantially different conclusions about how people learn from those that have shaped contemporary strategies for instruction and assessment; and
4. Research that confirms the widespread belief that conventional strategies for professional development are ineffective and wasteful and that provides support for the adoption of different ways to facilitate professional learning. (p. 128)

Hawley and Valli suggest that there is increasing agreement about changes that are needed in teacher professional development for standards-based reforms. This agreement is based on what reforms require of students and on research about teacher learning.

A 1996 report by the National Commission on Teaching and America's Future notes, however, that too few professional development programs are designed based upon current research about teacher learning. It asserts that "there is a mismatch between the kind of teaching and learning teachers are now expected to pursue with their students and the teaching they experience in their own professional education" (p. 84). The report cites the following as missing in teachers' learning opportunities: engagement in understanding new ideas, practice followed by feedback, critical reflection and problem solving, collaboration, a connection between what they are learning and their own experiences, and ongoing assessment. Thus, teachers do not have sufficient opportunities to learn how to teach students toward ambitious standards. In data collected by the National Center for Education Statistics (U.S. Department of Education, 1998) the need for more intense professional development related to education standards was clear. According to this 1998 national survey, although teachers were most likely to participate in professional development activities that focused on reform topics such as standards and assessment, the majority of these activities lasted for only a day, and only 36 percent of teachers felt very well prepared to implement state or district curriculum and performance standards.

In their report on instructional capacity, Cohen and Ball (1999) state that most in-service activities are "intellectually superficial, disconnected from deep issues of curriculum and learning, fragmented, and non-cumulative" (p. 12). Thompson and Zeuli (1999) suggest that these traditional forms of professional development are unlikely to help teachers understand the concepts behind education reforms. The authors call for transformative teacher learning that can change teachers' knowledge, beliefs, and practices. Such professional development would have the following requirements:

- The creation of cognitive dissonance between teachers' current beliefs and practices and their experiences with student learning
- Sufficient time to work through the dissonance through discussion and critical thinking
- The connection of these cognitive activities to teachers' contexts of practice, for example through examining student work

- The development of a repertoire of practices consistent with teachers' new understanding about what reforms require .
- Help with transferring teachers' new knowledge to the classroom through practice and peer support

Thompson and Zeuli (1999) describe professional development efforts that incorporated these characteristics and were successful in changing teachers' understanding and teaching of mathematics. For example, in SummerMath for Teachers, participants engaged in collaborative reflection of non-routine mathematics problems encountered by elementary and secondary students. Teachers engaged in cognitive conflict as they shared their reasoning. Then throughout the school year, SummerMath staff observed and supported teachers as they attempted to change their practices based on their new understandings of mathematics teaching and learning.

Writing for the National Staff Development Council, Sparks and Hirsh (1997) also call for a paradigm shift in professional development. The authors cite three influences that are shaping schools and staff development: results-driven education; systems thinking, which emphasizes the interrelationships of events and structures; and constructivism, which casts learning as the creation of knowledge in the learner's mind. It is due to these influences that Sparks and Hirsch argue for shifts in staff development toward more emphasis on organizational as well as individual development, more coherence with school improvement, more school rather than district-focused approaches, more focus on students' learning needs, an emphasis on all who affect students' learning and not just teachers, and a view of staff development as essential instead of as an extra.

Summary and Conclusions: Teacher Learning

At the heart of professional development is the opportunity for teachers to learn. For professional development to result in positive impacts on teaching practices and students' learning, research-based principles of human learning must be applied to in-service teacher learning. Professional development should incorporate the following learning principles:

- Consider teachers' prior knowledge and stage of development as a teacher.
- Engage teachers in higher order thinking, problem solving, and resolving dissonances between current and more effective beliefs and practices.
- Give teachers sufficient time to practice and revise their new learnings.
- Provide models of successful teaching performance.
- Support new learning through collaboration with other teachers.

Teacher learning that is based on these principles is rare, and consequently, most professional development in the United States is insufficient preparation for teachers to instruct students to high standards. However, ambitious student learning requires ambitious teacher learning.

Effective Professional Development for Standards-Based Education

In recent years there have been many research studies to determine the nature of effective teacher professional development. These studies vary greatly in the type of professional development and in the number of teachers and schools being studied. In most studies, researchers make conclusions about desirable content and format, sometimes emphasizing one or the other, and often producing a list of effective features. The definition of effectiveness usually is based on teachers' perceptions and/or practices and much less often on improvements in student learning. The following sections describe findings from some of the major research studies on teacher professional development.

Research About Professional Development Content

There is increasing evidence that to improve teachers' standards-based instruction, the content of professional development needs to be directly linked to the curriculum. For example, Cohen and Hill (1998) studied the influence of professional development in mathematics on the classroom practices of a random sample of 1000 California teachers in grades two through five. The researchers compared two different kinds of professional development — curriculum-centered workshops and special topics/issues workshops. Teachers who spent more time in the curriculum workshops than in the special topics workshops reported using more instructional practices that are aligned with the California mathematics curriculum compared to teachers who spent more time in topical workshops. More important, schools with higher proportions of teachers participating in curriculum-centered professional development had higher student achievement scores on the state test. The authors make the following important conclusion:

> If our analysis is correct, teaching practice and student performance are likely to improve when educational improvement is focused on learning and teaching academic content, and when curriculum for improving teaching overlaps with curriculum and assessment for students. (p. 11)

In similar research, Kennedy (1999) compared results from 12 studies of teacher professional development that varied in program content in the following four ways: (1) generic teaching behaviors, (2) generic teaching behaviors applied to a specific subject, (3) subject-specific curriculum and pedagogy, and (4) knowledge about how students learn a specific subject. The author described this variation as reflecting "continua from more prescriptive to more discretionary, and from more focused on behaviors to more focused on ideas" (p. 3). From a pool of 93 studies, 12 studies were chosen because they included measures of student learning and compared different groups of teachers. The subject matter context was either mathematics or science. The sizes of the effects on students' achievement were larger for professional development more closely connected to subject matter (categories 3 and 4) than for the more generic approaches (categories 1 and 2). This finding was particularly true for student reasoning and problem solving. Kennedy's review and analysis demonstrate that successful professional development needs to address what and how to teach a particular subject.

Interaction of Professional Development Format with Content

National studies on the effects of the federal government's Eisenhower Professional Development Program on teachers' classroom practices indicate how content and format interact. The focus of the Eisenhower Program is to help teachers develop knowledge and skills primarily in the subject areas of mathematics and science. A cross-sectional study (Garet, Birman, Porter, Desimone, & Herman, 1999) identified six features of professional development that are associated with reported improved teaching practices, three structural or format features and three core or content features, respectively:

- Reform-type organization (e.g., networks, study groups, mentoring, action research, teacher resource center) instead of traditional organization (e.g., one-shot workshop, conference)
- Longer duration in total hours and time span
- Collective participation of teachers (e.g., by schools or departments)
- Active learning opportunities for teachers (e.g., examining student work, obtaining feedback on teaching)
- Content focus (e.g., in mathematics or science)
- Coherence with teachers' goals and with state standards and assessments

The researchers found that structural professional development features (e.g., duration) influenced the intensity of core features (e.g., content focus) and that core features influenced the impact of the learning experience on teachers' reported growth in knowledge, skills, and teaching practices. For example, longer activities gave teachers more opportunities to deepen their content knowledge, and collective participation provided teachers more active learning experiences. Professional development that was content focused and included active learning was associated with teachers' reported changes in practices.

A three-year longitudinal study of the Eisenhower professional development program extended the findings (Porter, Garet, Desimone, Suk Yoon, & Birman, 2000). In this study, professional development that was coherent, involved active learning, and had a reform-type format was associated with a reported increase in teachers' use of active, project-centered classroom instruction. Professional development that emphasized methods for teaching higher order learning (e.g., interdisciplinary methods) were associated with teachers' reported increased use of higher order instruction, and this occurred more so if the professional development had the effective features identified in the earlier study (Garet et al., 1999). An interesting minor result suggested that teachers who learn specific higher order instructional strategies in one subject in mathematics or science might use it when teaching similar subjects, a "spill-over hypothesis" (Porter et al., 2000, p. 45). In summary, national studies of the Eisenhower program demonstrate that both content and format influence the impact of teacher learning on teaching practices. Throughout the Eisenhower studies, there is a theme that standards-based reforms must be accompanied by teacher professional development that is aligned with standards.

Professional Development as Intellectual Activity

Thompson and Zeuli (1999) emphasize that for teachers to learn from professional development, they need to be intellectually engaged in ways that transform their thinking. Other researchers also have conceptualized professional development as fundamentally an intellectual activity. Sprinthall, Reiman, and Thies-Sprinthall's (1996) review gives support for this perspective. The authors cite research that showed positive connections between teachers' complexity of cognitions about student learning and their students' problem-solving skills (Kennedy, 1991). In another study (Hopkins, 1990), teacher implementation of innovations taught through an in-service course was higher for teachers who were more abstract and cognitively complex. Peterson, Fennema, Carpenter, and Loef (1989) found that students of teachers who were higher in cognitive-conceptual complexity performed better on problem-solving tests than students with teachers who were less cognitively based. Sprinthall et al. conclude on the basis of these and other studies that teacher cognition evolves from less to greater complexity, and that "teacher cognitions are very important as regulators of the ability to use innovations" (p. 687). Because standards-based instruction is an innovation that most teachers must learn, professional development must support teachers' related cognitive development. Chapters 1 and 2 on literacy and mathematics suggest parallel recommendations for student learning, that is, that classroom instruction needs to address student thinking and understanding.

Roskos and Bain (1998) also emphasize the need to view professional development as an intellectual activity and to identify features in the learning environment that support teachers' intellectual engagement. According to these researchers, staff development that focuses simply on improving teaching techniques through the identification of discrete effective behaviors fails to change teachers' practices because it does not engage them intellectually, and often the techniques are wrongly applied without flexible adaptation. The authors also state that teacher empowerment through approaches such as site-based management is inadequate to change instructional quality. Both of these approaches are behavioral rather than cognitive in emphasis. Based on a qualitative analysis of a two-year project in which teachers studied curriculum models, the authors identify several features of the learning environment that resulted in increased complexity of teachers' understanding and more functional uses of concepts. These include school involvement of teachers in decisions related to strategic planning and thus permission for teachers to think and study; models of thoughtfulness provided by individual participants who were eager for intellectual engagement; and, an emphasis on critical discussion (rather than delivery of content) mediated by analytic writing tasks and the posing of challenging questions.

Professional Development as Communities of Learners

Research indicates that teachers' critical thinking about teaching and learning are supported by interacting with other teachers as part of the learning process. Lord (1994) urges that new professional development efforts be based on "critical colleagueship" to support a critical stance toward teaching (p. 184). Critical colleagueship results in teachers voicing their questions and concerns, sharing their classroom practices with other educators, and learning from constructive criticism. At the heart of this approach is the creation of an intellectual disequilibrium that requires teachers to lay aside their comfortable but no longer applicable ways of teaching. Lord emphasizes that many different forms of professional development can promote critical colleagueship such as

peer observation, study groups, action research, and curriculum development. In Lord's view, what is important is not the form but, rather, that professional development supports review, reflection, and critique. In addition, teachers need access to "resource-rich professional communities" such as teacher networks, subject-matter associations, and university partnerships to provide national and cross-district perspectives to their work and to expand the sources of knowledge (p. 198).

Ball and Cohen (1999) agree that teacher learning should take place within a community and also within the context of practice: "Orienting professional learning toward the joint professional study of teaching and learning would knit professional development inextricably into the practice of teaching" (p. 19). In Cochran-Smith and Lytle's (1999) view, teacher learning opportunities need to result not only in reflection but also in teacher inquiry which includes studying, posing problems, constructing new ideas, and testing new practices. Fundamental to the authors' notion of inquiry is that it occurs collaboratively within teacher learning communities and networks in which all participants are both learners and researchers rather than novices and experts.

Putnam and Borko (2000) recently discussed how three new views of knowledge relate to the context of teacher learning. In the "cognition as situated" (p. 4) perspective, learning depends on interactions with the context and with other learners, and there is an emphasis on authentic activities. The "cognition as social" (p. 5) view emphasizes that other people in the learning environment have major influences on knowledge acquisition through the different discourse communities in which learners participate, such as classrooms and teacher networks. The third view, "cognition as distributed," (p. 5) suggests that knowledge is distributed across people and tools resulting in the accomplishment of tasks by the collective that cannot be accomplished individually. According to the authors, the implications of these theories for teacher learning are that (1) professional development needs to be grounded in teachers' classroom practices; (2) teachers need discourse communities to discuss and reflect on new teaching strategies; and (3) technological tools should be incorporated into professional development in ways that give teachers access to distributed expertise.

Teacher interaction through collaboration is a pervasive theme in the literature on contemporary professional development. In Wilson and Berne's (1999) discussion of research on teacher learning, there were three ideas common to the contemporary professional development projects they reviewed. First, the professional development involved communities of learners who were reconceptualizing teaching practices. Second, teacher knowledge was not disseminated or delivered to teachers but rather activated through approaches such as teacher inquiry. Third, the projects developed professional discourse through teacher collegiality built on trust and community.

Across research studies, consensus has developed about the importance of collaboration to achieve change in teacher practices and ultimately students' achievement. With regard to new strategies for teacher learning, Darling-Hammond (1998) asserts, "Teachers learn best by studying, doing, and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see" (p. 8). The Eisenhower studies described earlier indicated that collective participation of teachers from the same grade or department provides more active learning opportunities for the participants compared to traditional approaches (Garet et al., 1999). A central feature of successful staff development in New York City's District 2 is the emphasis on collaboration and sharing of expertise among principals, teachers, and district staff (Elmore, 1997).

Teachers' acquisition of professional knowledge through learning communities is critical to standards-based reform. Myers (1997) stresses that to be effective, teacher development in reform efforts must reflect the latest research and conceptualizations of learning including the following characteristics: (1) learning, by both students and adults, as intellectual construction based on past and new experiences; (2) teaching as a process of identifying problems followed by classroom-based problem solving; (3) schools as communities of learners with shared beliefs and values; and (4) teacher professional knowledge as developed from reflective practice and based on principles of adult learning.

Peer coaching is a specific type of teacher collaboration that has been effective in changing teachers' practices (Sprinthall et al., 1996). Peer coaching involves one teacher or a teacher team providing in-class assistance and feedback to teachers who are practicing and applying new instructional strategies. Based on research reviewed by Joyce and Showers (1995), peer coaching increases the likelihood that teachers will transfer their professional development training to the classroom.

Education reform networks comprise another type of learning community. Although the characteristics of such networks vary greatly, education networks typically involve educators coming together from different schools, districts, and sometimes states for the purpose of participating in professional development and sharing work experiences. Lieberman and McLaughlin (1992) discuss some examples including the Foxfire Teacher Outreach Network in which teachers share their experiences with authentic learning and the National Writing Project which organized K–16 writing teachers for collaboration. Lieberman and McLaughlin describe successful networks as having the following features: a clear focus, such as a particular subject matter or pedagogy; a variety of activities, including social events; a discourse community that encourages knowledge sharing in which members act as both teachers and learners; and, opportunities for leadership when teachers take their new knowledge back to their home schools to share with colleagues. Based on an in-depth analysis of 16 education reform networks, Lieberman and Grolnick (1996) note that networks also face tensions, such as balancing flexibility with formal rules of operation and balancing insider knowledge with knowledge from outside experts. Funding, which often comes from dues and/or foundations, is frequently a struggle for networks. As a professional development format, participants' learning is indirect, making it difficult to measure the impact of a network. As Lieberman and McLaughlin indicate, for a network to influence schools, it must first change the classroom practices of teachers. This requires that teacher participants convince their school colleagues who are not in the network to support ideas from the outside.

Pennell and Firestone (1996, 1998) studied state-supported teacher networks in California and Vermont. Their research indicates that these networks can help support state and district initiatives and are more successful in meeting teachers' needs when they combine packaged programs with those constructed by network participants and when they include university educators. Based on their interviews of teacher participants, Pennell and Firestone (1996) conclude:

> The California and Vermont network programs were most effective when teachers held beliefs that did not strongly conflict with program philosophies, some social support existed for participation and classroom change, and practical circumstances were not heavily prohibitive of participation and change. (p. 72)

Recommended Principles for Designing Professional Development

Based on the growing body of research on teacher learning to achieve the goals of standards-based education, organizations and education researchers have outlined principles for designing effective professional development. The purpose of this section is to demonstrate the congruence among national organizations and the conclusions of researchers about the characteristics of effective professional development. Specifically, there are descriptions of reports from two key groups, the National Foundation for the Improvement of Education (NFIE), a foundation created by the National Education Association to improve teaching and learning, and the National Staff Development Council (NSDC), which has created a set of standards for K–12 staff development at the elementary, middle, and high school levels (Available: http://www.nsdc.org/list.htm).

In 1998 report, the NFIE identifies several characteristics of high-quality professional development programs, most notably that such programs are explicitly focused on improving student learning, which includes meeting the needs of students who learn in different ways and who come from diverse backgrounds" (Renyi, 1998, p. 72). Such programs must also be sustained, designed and directed by teachers, and focused on deepening both teachers' subject-matter knowledge and their understanding of student learning (Renyi, 1998).

In its 1996 report, NFIE recommends that schools and districts find ways to build time for professional development into the daily lives of teachers, help teachers take responsibility for their own professional development, promote community involvement and partnerships that can help provide school-based professional development, and work to find new sources of funding for teacher learning.

The NSDC's staff development standards (available: http://www.nsdc.org/list.htm) echo the NFIE's characteristics of high-quality professional development in several ways. NSDC also recommends that staff development be "results driven and job embedded," focus on subject-matter knowledge, sustained, and be "directly linked to what teachers do in their classrooms." The NSDC standards, however, provide more description of the contexts, processes, and content of good professional development. For example, one of the context standards is "requires and fosters a norm of continuous improvement." An example of a process standard is "bases priorities on a careful analysis of disaggregated student data regarding goals for student learning." Finally, an example content standard is "prepares teachers to use various types of performance assessment in their classrooms."

Hawley and Valli (1999) provided a set of design principles that reflect the "new consensus model of professional development" (p. 137) described earlier, a model based on the congruence or consensus among research studies, syntheses, and national reports. Hawley and Valli's principles incorporate many of the NFIE and NSDC recommendations, but place particular emphasis on ensuring that professional development is data driven, that is, guided by "analyses of the differences between (1) goals and standards for student learning and (2) student performance" (p. 138). They also note that staff development should "provide learning opportunities that relate to individual needs, but for the most part are organized around collaborative problem solving" (p. 138). In keeping with this notion, they recommend that staff development be "primarily school based" and "integrated

with a comprehensive change process that deals with the full range of impediments to and facilitators of student learning" (p. 138).

Summary and Conclusions: Effective Professional Development

Research studies of professional development vary widely in methods and definitions of effectiveness. However, major studies that have examined the impact of professional development on teaching practices and student learning are beginning to converge on some important conclusions. Both researchers and national organizations including NFIE and NSDC have proposed principles for designing professional development that aligns with these conclusions. Professional development is more likely to have positive impacts on teacher and student learning if it has the following research-based features:

- Focuses on a content area with direct links to the curriculum
- Challenges teachers intellectually through reflection and critical problem solving
- Aligns with goals and standards for student learning
- Is of sufficient duration for practice and revision
- Occurs collaboratively within a teacher learning community
- Involves all the teachers within a school or department
- Provides active learning opportunities that have direct applications to the classroom
- Is based on teachers' input regarding their learning needs

National education organizations add that professional development should have the following characteristics:

- Driven by results in students' performance
- Ongoing and embedded in the daily lives of teachers
- Helps teachers meet the needs of students who are at different developmental levels and who have diverse backgrounds

ACCOUNTABILITY IN SUPPORT OF TEACHER LEARNING

As the previous discussion indicated, there is considerable overlap among current recommendations for effective teacher professional development. Foremost in this congruence is the emphasis on student learning. That is, the purpose of teacher professional development is to change teachers' practices in ways that improve student learning. Accordingly, states are being urged to fund and support staff development for teachers only if it provides teachers the knowledge and skills to teach to higher standards and contributes to improvements in student learning (Sparks & Hirsh, 2000). Sykes (1999) expresses this trend in stating, "First and most obvious, the teacher-student learning connection should serve as a *criterion for selection of professional and school development activity* [italics in original]" (p. 161). However, the means of establishing this link between professional development and students' achievement has proven to be elusive (Guskey, 1997), and very few research studies of teacher professional development even attempt to measure effects on students' achievement (Harwell, D'Amico, Stein, & Gatti, 2000). The U.S. Department of Education

emphasizes the importance of this link through an awards program for district- and/or school-based professional development that can demonstrate positive impacts on students' achievement (WestEd, 2000).

Connecting Teacher Learning to Student Learning

A national survey of 800 teachers conducted by NFIE found that 73 percent of teachers identified improving student achievement as their primary motivation for growing as a professional (NFIE, 1996). Thus, the motivation for teacher learning is its connection to student learning. Renyi, executive director of NFIE, urged schools to use students' test scores to indicate where students need help and then design teacher professional development programs to address those needs ("State Councils," 1999). According to Sykes (1999), the criterion for selecting professional development should be based on its connection to student learning. Sykes also suggests that teacher professional development address the content that teachers need to instruct their students, that a wide range of student assessment results be integrated when designing professional development, and that the implementation of new practices and programs be judged by their effects on student learning.

Causal models are one way to examine the connections of professional development to student outcomes (Sykes, 1999). A causal model maps the variables that influence the implementation of an intervention on an outcome. As Guskey (1997) discusses, one of the problems in judging the effectiveness of professional development is the failure to examine its interaction with all the factors that influence the quality of its implementation such as content, structure, and context. In Guskey and Spark's causal model (1996), factors such as school culture, administrator knowledge and practices, parental involvement, and district policies are related to the final outcome of improved student learning. All these factors should be measured to determine whether and why student achievement improves.

There are a few examples that use causal mapping to study professional development effects on student learning. The Educational Testing Service (Wenglinsky, 2000) study mentioned earlier linked classroom practices with teachers' professional development and students' achievement. Eighth-grade students whose teachers received professional development in higher order thinking skills and hands-on learning activities performed better on the National Assessment of Educational Progress in mathematics and science than did other students. In addition, mathematics performance was linked to teacher professional development on teaching special populations, and science performance was linked to professional development in laboratory skills.

Similarly, Yoon and Resnick (1998) studied professional development for middle school mathematics teachers in the California Mathematics Renaissance Program. The Renaissance program worked directly with middle school teachers to help them improve their instruction and engagement in "a thinking-centered mathematics curriculum" (p. 3). The researchers were able to connect teachers' opportunities to learn standards-based instruction through Renaissance professional development to the teachers' classroom practices and also to students' performance on a standards-referenced mathematics assessment. Yoon and Resnick found that "participation in staff development and the use of 'reform methods' of instruction were positively associated with achievement" (p. 19).

A final example that demonstrates the link between teacher learning and student learning is the recent analysis of instructional improvement in New York City's District 2. D'Amico, Harwell, Stein, and van den Heuvel (2001) used the statistical technique of Hierarchical Linear Modeling to estimate the associative links among the components of District 2's improvement strategy. The researchers demonstrated that instructional leadership supported high-quality professional development in mathematics and literacy. In addition, teachers in grades three through five who reported having high-quality professional development in the district's mathematics framework had students with higher achievement in mathematics compared to teachers who reported having lower quality professional development. In literacy, student achievement was most closely correlated with the alignment of teacher instruction with the district's literacy framework, and this alignment was correlated with the perceived quality of professional development. According to the researchers, the findings "support District #2's conviction that professional development which is anchored by a core instructional program or curriculum can increase student learning" (p. 27).

Evaluating Professional Development for Effects on Student Learning

Most evaluations of professional development do not measure the impact on teachers' knowledge or practices nor do they assess the influence on student learning outcomes. When there are evaluations, they usually consist of cursory surveys of participants' satisfaction (Bredeson & Johansson, 2000). Yet, states are being urged to fund and support staff development for teachers only if it provides teachers the knowledge and skills to teach to higher standards and contributes to improvements in student learning (Sparks & Hirsch, 2000). How then should schools and districts evaluate professional development?

Guskey describes (2000) five levels of professional development evaluation and suggests corresponding sets of questions:

- Participants' reactions (e.g., Did they like it?)
- Participants' learning (e.g., Did they acquire the intended knowledge and skills?)
- Organization support and change (e.g., Did it affect organizational climate and procedures?)
- Participants' use of new knowledge and skills (e.g., Did they effectively apply new knowledge and skills?)
- Student learning outcomes (e.g., Did it affect student performance or achievement?) (pp. 79–81)

Guskey reminds educators that professional development can have indirect effects on student learning by influencing other variables that support change in teachers' practices (e.g., organizational improvement). By examining evidence in relation to each of these levels, schools and districts can better understand the direct and indirect influences of teacher learning on student learning.

Little (1997) suggests a general framework that schools can use to assess their professional development practices. First, schools need to demonstrate how their professional development strategies are linked to goals for student learning. For example, are there opportunities for teacher

learning that align with the school's curriculum? Second, schools must show how the organization of teachers' work facilitates learning opportunities. For example, does the schedule support teacher collaboration? Third, schools should have evidence that all educators are engaged in high-level sustained professional development. For example, what follow-up activities and support are available for teachers who are trying out what they have learned? Fourth, the school should have a coherent plan for staff evaluation and school review. For example, how are student achievement data connected to staff evaluation? Fifth, the school should have a culture and climate that value learning. For example, in what ways do school administrators support teachers' learning? Little believes that through self-assessment with this framework, a school can better understand its current capacity for professional development and the areas in which it needs to improve.

The guidance provided by Guskey (2000) and Little (1997) suggests that evaluations of professional development should serve both formative and summative functions. As a formative function, evaluation data can provide feedback about the content, context, and format and indicate whether changes are needed. As a summative function, the evaluation provides evidence for administrators and policy makers about final outcomes, for example changes in instruction and student achievement. As discussed in the next section, the latter information is particularly important to those making decisions about funding for professional development.

Summary and Conclusions: Accountability for Teacher Learning

Accountability for teacher learning should reflect the purpose of professional development — to change teachers' practices in ways that improve student learning. Both the design and the evaluation of teacher professional development need to reflect the connection between teacher learning and student learning. Schools and districts should design in-services based on causal models that map the connection of teacher learning activities and implementation of new knowledge and practices to student outcomes. Evaluation and research studies need to examine the link of professional development to changes in teaching and student learning. Districts and states should base their judgments of professional development programs on student performance data.

Organizational Supports for Effective Teacher Learning

The evaluation and assessment guides proposed by Guskey (2000) and Little (1997) both indicate that many factors can influence teacher learning outcomes. Central to Little's analysis is that school support is essential for effective professional development. Others argue that district organization (e.g., Sykes, 1999) and state policies (e.g., Darling-Hammond & McLaughlin, 1995) are also strong influences. Chapter 4 in the current report discusses organizational policies and practices that support ambitious student learning. The following sections discuss how policies and practices associated with professional development contexts can best support teacher learning.

School Practices and Policies

According to Hawley and Valli (1999), a school that fosters teacher learning (1) minimizes rules and constraints; (2) has clear goals with established priorities; (3) uses valid measures of student performance; and (4) provides opportunities for teachers to learn together, practice what they have

learned, and evaluate the results. The Consortium on Chicago School Research found that the key to the influence of school practices such as these is their coherence with the school's instructional program (Newmann, Smith, Allensworth, & Bryk, 2001). Newmann et al. define instructional program coherence as having three major components:

- A common instructional framework that guides curriculum, instruction, and assessment, including strategies and materials
- Staff working conditions that support implementation of the framework, including accountability policies and professional development
- Allocation of resources that advance the instructional framework and avoid scattered improvement efforts.

The Chicago researchers developed a rubric for instructional program coherence based on these components. They then used teacher surveys and field data to measure the presence of coherence in Chicago's elementary schools. Survey results indicated a positive correlation between teachers' perceived coherence and students' achievement on the Iowa Test of Basic Skills. The field study examined data from 11 diverse high-poverty elementary schools using classroom observations, teacher and administrator interviews, and school documents. The 11 schools varied substantially in coherence, and the researchers found that schools higher in coherence had principals who were stronger leaders. These principals invested technical resources in common instructional frameworks, promoted staff collaboration, and concentrated school resources on a few core improvement goals. The results of this research suggest that to support standards-based reforms, professional development should be aligned with school improvement and a coherent instructional framework.

Other research provides information about the role of the school principal in supporting professional development. In District 2 in New York City, Stein and D'Amico (1999) found that administrators' knowledge of literacy and mathematics influenced the design and implementation of teachers' professional development in those two areas because instructional leadership is a core component in the district's improvement process. Based on their analysis, the researchers argue that leadership content knowledge is needed for standards-based reforms to be successful due to the new modes of thinking and interacting with subject knowledge that the standards require of students:

> Leadership content knowledge would be seen as the special province of principals, superintendents, and other administrators who see their role as primarily one of instructional leadership. It would involve the transformation of subject matter knowledge for the purposes of providing intellectual leadership for instructional reform. In mathematics and literacy, it would include practice-based standards for instruction in each content area, the forms of teacher observation and instructional artifacts that would be needed to fairly evaluate teachers of literacy and mathematics, understanding of the kinds of difficulties that teachers are apt to experience as they attempt to change their instruction in ways called for by the new reforms in mathematics and literacy, and knowledge of the kinds of professional development that are needed to transform teachers from lecturers to reform teachers of mathematics and literacy. (pp. 42–43)

Thus, one view of the role of the principal in professional development is that of an instructional leader who has knowledge of both content and pedagogy. Bredeson and Johansson (2000) conducted 48 structured interviews of principals, school administrators, and teachers to examine the range of school principal roles related to teacher professional development. The researchers found that principals influence professional development in four areas.

First, principals are both leaders and learners. The authors cite the following roles related to this area: stewards who value learning for all those in the school; models who participate with teachers in professional development efforts; experts with professional knowledge related to teaching and learning, and instructional leaders who guide the school in accomplishing its learning objectives and goals. Second, principals must create a supportive learning environment for teacher learning, which they do in the following ways: as a communicator who interacts verbally and interpersonally with teachers; as a supporter of teachers by providing resources for their learning and by creating a learning environment where teachers can practice new ideas; and, as a manager of the myriad tasks essential to school functioning such as hiring, scheduling and evaluating.

A third area in which principals are influential is working with teachers on the design, delivery, and content of professional development. This includes keeping the focus on student learning and aligning professional development with both teacher needs and student goals. The fourth area of principal influence on professional development is the assessment of outcomes. The principal develops processes to collect data about the impact of professional development in the school and uses this data in planning additional teacher learning. Finally, Bredeson and Johansson view principals as facilitators of professional development, not guardians of learning. In other words, it is the principal's responsibility to move teachers toward taking responsibility for their own professional development and to build leadership capacity among the teaching staff.

District Practices and Policies

Just as schools need coherence between professional development and instruction, so do districts need a coherent plan for organizing how resources are used to provide effective professional development. As the 1996 report by the National Commission on Teaching and America's Future indicates, many districts fail to coordinate the use of professional development funds that are controlled by their central offices.

District 2 in New York City is an example of the powerful influence that district policies and practices can have on professional development. Elmore (1997) describes several themes in the district's improvement and professional developmental strategies. First, the district introduced changes in instruction in phases organized around content areas, starting with literacy. A second theme was blurring boundaries between staff development and management. This meant that managerial tasks such as staff meetings and annual improvement plans revolved around the improvement of instruction through staff development. A third theme was establishing a balance of authority between the central office and individual schools. The district exerted discipline and focus on instructional improvements, and school principals devised their own strategies to meet improvement goals. However, as the fourth theme indicates, the district exerted control when success depended on schools being aligned with districtwide instructional improvement. The district replaced

20 principals and gave considerable attention to principal recruitment. The fifth theme was sustained focus on the priority of instructional improvement through professional development, rather than changing priorities from year to year. A hallmark of the district's stance toward professional development was the concept of shared expertise. District staff visited teachers and principals, teachers observed teachers in their own and other schools, and principals worked together across schools.

Spillane (2000) found that district leaders' support of teachers' professional development depends on leaders' beliefs and understanding about teacher learning and change. Spillane interviewed district leaders in nine school districts (administrators, curriculum specialists, and lead teachers) who were responsible for designing and selecting learning opportunities for teachers. The predominant view of teacher learning among the leaders was quasi-behaviorist, that is, dependent on external motivation through rewards and sanctions, with inertia and resistance as the main challenges to teacher change. A quasi-behaviorist perspective does not require district leaders to understand teachers' beliefs and knowledge related to reforms. District fragmentation in responsibilities for teacher learning, high ratios of district leaders to teachers, and pressures from state accountability mechanisms all contributed to leaders' adoption of a quasi-behaviorist approach. Transforming district practices in professional development to support teacher learning will require challenging district leaders' theories about teacher learning.

State Policy Influences

Because professional development generally is viewed as a local issue, states have been slow to adopt policies that improve staff development for educators, and there are wide variations in professional development activities across the states. In addition, most states have no or minimal standards or criteria for teacher professional learning, and in many cases, any kind of formal learning experience counts toward the hours required to maintain certification (Hirsch, Koppich, & Knapp, 1998). Although some states have provided funds for professional development, most have not developed any means to ensure that the quality and quantity of staff development activities give teachers the support they need to implement K–12 standards (National Association of State Boards of Education, 1998). Meanwhile, the notion of linking professional development to student outcomes has become an issue due to increased state emphasis on accountability. Ward, St. John, and Laine (1999) suggest some criteria that states can use to promote connections to student performance, including state policy recognition of the complexity in improving student outcomes, coherent links of professional development programs to student outcomes, evidence of past success for funded programs in improving student performance, a method to account for state subsidies for professional development, and a method to link the subsidies to student outcomes.

The research does suggest that local implementation of professional development is related to state support and involvement. In a study of 16 school districts by the Education Commission of the States (ECS, 1997), districts with more dependence on state rather than local funds for education spent more of their budgets on teacher professional development. According to the ECS, this implies that local implementation of teacher professional development programs is related to state priorities and funding for implementation of these priorities.

States are starting to recognize the need for infrastructures to support quality professional development, although the form of these varies. Laws requiring districts to offer professional development on certain topics and regional centers within states to organize the delivery of staff development are two state strategies (Hirsch, Koppich, & Knapp, 1998). The National Association of State Boards of Education (1998) suggests several options for states, including the use of measures to evaluate improvement of teacher learning and student achievement by professional development programs, a review of a state's policy effects on local decisions concerning professional development, the establishment of new state teacher organizations and partnerships for professional development, and changes in (or the addition of) state funding structures for professional development.

Darling-Hammond and McLaughlin (1995) discuss the need for state policies to support "*a learner-centered view of teaching and a career-long conception of teachers' learning* [italics in original]" (p. 601). The authors are referring to professional development that helps teachers teach for understanding so that students can reach challenging outcomes or the ambitious student learning discussed through the current document. They urge policymakers to examine policies in relation to what is known about effective professional development for standards-based education. For example, do policies support professional development with meaningful content? Do policies give districts the flexibility to restructure time to create extended opportunities for teacher learning? Darling-Hammond and McLaughlin stress that to support the kinds of professional development needed for state reforms in curriculum and assessment, state and district policies must encourage teachers' in-depth conceptual learning about the reforms.

Based on a research review of professional development activities in several different states, Youngs (2001) concludes that for professional development to reform schools and improve students' achievement, it must improve school capacity. In Youngs's view, three areas of capacity are particularly amenable to professional development: teachers' skills, knowledge, and attitudes; professional community; and the coherence of the school's programs for staff and students with learning goals. State policies can hinder or support effects of professional development on school capacity. For example, as Youngs discusses, a state policy environment that includes high-stakes assessment can narrow a school or district's approach to professional development by emphasizing test preparation and leaving little time for teachers to reflect on and understand state standards. Although state-level professional development activities such as networks can provide learning opportunities for teachers, they can also stifle within-school collaboration if only a few teachers from each school are involved. State-required school improvement plans are an opportunity for teachers and principals to learn by studying ways to make changes based on school data. Youngs cites research showing that for this process to increase school capacity, state regulations should require that a collaborative planning process be used that includes teachers and parents (Jennings & Spillane, 1996). Without such a requirement, principals might not share decision making with teachers, making teacher motivation and learning less likely.

In Ancess's (2000) study of restructuring in three high schools, restructuring and the resulting teacher learning were made possible by a state policy context that gave considerable decision-making authority to schools and districts. The three high schools each used this flexibility to institute changes — for example, in courses, assessments, and grading procedures — that influenced teachers'

practices and improved student learning. According to Ancess, "tyranny in standards policy" (p. 618) can hinder successful restructuring processes.

Summary and Conclusions: Supports for Teacher Learning

Supports from the school, district, and state are necessary for professional development to result in effective teacher learning. Schools need a coherent instructional framework based on the alignment of curriculum, instruction, assessment, professional development, and resources for improvement. Principals of schools are best able to support teacher learning by being instructional leaders who are knowledgeable about standards-based reforms in the content areas. Principals also should provide supportive learning environments in their schools and keep the focus of professional development on student learning outcomes. At the district level, leaders need to understand the influence of teacher knowledge and beliefs on the effectiveness of standards-based reforms. As demonstrated by District 2 in New York City (Elmore, 1997; Elmore & Burney, 1999), a coherent district plan focused on improved instruction can result in improved student learning. Finally, states should examine whether their professional development policies support or inhibit effective teacher learning about standards-based reforms and whether policies are based on the connection between teacher and student learning.

TEACHER LEARNING IN HIGH-PERFORMING, HIGH-NEEDS SCHOOLS

The previous sections discuss the importance of teacher professional development for improving student learning. This section provides supporting evidence in the context of high-needs schools. The research on effective schools (e.g., Purkey & Smith, 1983) and on high-performing, high-needs (HPHN) schools (e.g., Education Trust, 1999) share the goal of discovering the characteristics of effective school improvement efforts, especially in settings with large proportions of students who are traditionally low-achieving, e.g., students in poverty, minority groups, and second language learners. In both types of research, cross-case comparisons result in a summary of important features to which schools should attend to obtain improvements in student performance. For example, Purkey and Smith's research review produced a set of nine organization-structure variables related to school effectiveness: school-site management, instructional leadership, staff stability, curriculum articulation and organization, schoolwide staff development, parental involvement, schoolwide recognition of academic success, maximized learning time, and district support. Education Trust's study found that high-poverty schools that exceeded expectations tended to have six characteristics. The schools used state standards to drive curriculum, instruction, and assessment. They extended instructional time in math and reading. Compared to other schools, they spent proportionately more money on professional development. They used systematic assessments to monitor student progress. The schools encouraged parents to be involved with student schools work. Finally, many of these HPHN schools had accountability systems in place that held adults responsible for student outcomes.

The primary difference between the two studies is Education Trust's (1999) greater emphasis on standards and accountability, which reflects current contexts of reform. Both studies suggest that there is no magic bullet, but rather that many if not all factors affecting the school system, including professional development, need to be aligned toward the goal of improving student learning

SUMMARY AND CONCLUSIONS

This chapter examines research on how to design and support opportunities for teacher learning that can result in ambitious student learning. Teachers are key to students' achievement and to the success of standards-based reforms in education. The research demonstrates that for these reforms to improve student outcomes, teachers need complex knowledge about how to teach students for higher levels of thinking and understanding than they needed to teach students in the past (Thompson & Zeuli, 1999). Teachers need deep conceptual understanding of a subject and its connections to other fields. They also need a repertoire of strategies to engage and assess learners from diverse backgrounds and different developmental levels (Ball & Cohen, 1999). Teachers also must believe that students are capable of ambitious learning and communicate these positive expectations to their students (Weinstein, 1998).

The empirical studies and commentaries discussed in this chapter indicate that teachers need the following *knowledge and beliefs* to teach students to high standards:

- Knowledge of a subject area and its connections to other fields
- Knowledge of how to represent subject matter to students including an understanding of student errors (pedagogical content knowledge)
- A repertoire of instructional strategies that balances higher order interactive teaching with didactic skills instruction
- An understanding of how differences among students in development, culture, language, gender, and class influence student learning
- The capacity to adapt instruction in response to the learning needs and styles of different students
- Knowledge of how to assess students' learning and understanding
- Knowledge of how to use collaboration among students to support learning
- Beliefs that all students are capable of higher order learning

For teachers to acquire the necessary knowledge and beliefs for standards-based education, they need effective learning opportunities. As Cohen and Ball (1999) indicate, successful professional development requires the same elements that are found in successful classroom instruction. Thus, for teachers to learn through professional development, the following *principles of teacher learning* should guide the design and implementation of in-service programs:

- Consider teachers' prior knowledge and stage of career development.
- Engage teachers in higher order thinking, problem solving, and resolving dissonances between current and more effective practices.
- Give teachers sufficient time to practice and revise their new learnings.
- Provide models of successful teaching performance.
- Support new learning through collaboration with other teachers.

Several research studies discussed in this chapter illustrate the kinds of professional development that can change teachers' instructional practices and improve student learning. National education organizations that emphasize the importance of teacher learning have endorsed the findings from this

research and have recommended principles for designing and implementing professional development. Based on this congruence between research and policies of education organizations that support teacher learning, the following are *characteristics of effective professional development for standards-based education*:

- Focuses on a content area with direct links to the curriculum
- Challenges teachers intellectually through reflection and critical problem solving
- Aligns with goals and standards for student learning
- Is of sufficient duration for practice and revision
- Occurs collaboratively within a teacher learning community
- Involves all the teachers with a school or within a department
- Provides active learning opportunities that have direct applications to the classroom
- Is based on teachers' input regarding their learning needs
- Is driven by results in student performance
- Is ongoing and embedded in the daily lives of teachers
- Helps teachers meet the needs of students who are at different developmental levels and who have diverse backgrounds

Accountability for professional development should be based on its purpose — to change teachers' practices in ways that improve students' learning. Therefore, evaluation of teacher professional development should emphasize the connection between teacher learning and student learning. Schools and districts can use causal mapping to demonstrate how teacher learning activities and implementation of new knowledge and practices link to student outcomes. When making judgments about their professional development programs, districts and states should examine program effects on student performance.

Support from the school, district, and state influence the effectiveness of professional development efforts. Professional development will have more impact on teaching and learning at a school if it is aligned with the school's instructional framework (Newmann et al., 2001). The school's principal should provide instructional leadership and help create a culture in which learning is valued for all those in the school and that encourages the development of teacher leadership. At the district level, policies and leaders that focus on staff development as a priority can result in instructional improvements (Elmore, 1997; Elmore & Burney, 1999). Finally, flexible state policies set the stage for teacher professional development to result in successful school restructuring for standards-based education. Also needed from the state are policies that support teacher learning connected to state standards and policies that emphasize accountability for professional development. Indeed, at all levels of the education system, the connection of teacher learning to student learning should drive the design of teacher learning opportunities.

Teachers are key to the success of standards-based reforms in education. Teacher learning is key to the acquisition of knowledge and beliefs that support ambitious student learning. Effective school improvement efforts in settings with large proportions of students who are traditionally low achieving have emphasized professional development. A specific example cited throughout this chapter is New York City's District 2. Staff development in this district is subject-oriented,

collaborative, linked to student outcomes, ongoing, and builds on teachers' expertise. The district's professional development programs are based on a coherent instructional framework and supported by strong instructional leadership and policies that make staff development central to the district's work. Several research studies have demonstrated that the district's approach has resulted in changes in teachers' instructional practices and improved student achievement (e.g., Stein & D'Amico, 1999; Harwell, D'Amico, Stein, & Gatti, 2000)

In conclusion, standards-based education requires that teachers acquire the knowledge and beliefs that are needed to teach students to high levels of learning. To achieve this outcome, teachers need professional development programs that incorporate principles of learning in design and implementation and that have research-based characteristics of effectiveness. Accountability and organizational supports increase the probability that such professional development programs will result in improved teaching practices and improved student learning.

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CHAPTER 4

ORGANIZATIONAL POLICIES AND PRACTICES SUPPORTING AMBITIOUS LEARNING FOR ALL STUDENTS

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THE SYSTEM CONTEXT

Current education policy is characterized by standards and assessments. State governments, and more recently, the federal government, have largely taken the lead in developing these policies. Such policies form an important aspect of the context in which teachers, students, and schools must function, and they provide sometimes conflicting messages about instructional guidance. For example, a vision of ambitious changes in instruction for all students spurred the development of initial standards policy work. This type of vision was based in content-specific descriptions of ambitious teaching and learning like those envisioned by reformers in mathematics (e.g., National Council of Teachers of Mathematics [NCTM], 1989, 2000) and science (Rutherford & Ahlgren, 1990).

This synthesis of the current literature on standards-based education in literacy and mathematics classrooms provides similar visions of student learning. In Chapter 1, Apthorp synthesizes the research and defines literacy in ways that clarify our goals for students: that students learn to read, read to learn, read and write to get something done or for enjoyment, and read and write a wide variety of materials for various purposes and across different situations. Based on current understanding of how people learn, literacy includes awareness (metacognition) about significant content and processes of reading and writing, with reflection on how one uses language to affect others and how others use language to affect us.

In mathematics, as addressed in Chapter 2, Florian describes mathematics standards in terms of specific goals for students: that students understand and appropriately use basic and advanced mathematics concepts and topics such as numbers and operations (e.g., addition, multiplication), algebra, geometry, measurement, and how to represent and analyze data. They correctly and fluently apply basic and advanced mathematics skills including computation, estimation, and mathematical reasoning. They use a variety of strategies to solve routine and nonroutine problems, can explain their reasoning and methods, and understand mathematics as an emerging field of inquiry with connections to other content areas.

Such visions of standards as an approach to instruction sometimes conflict with the current interpretations of standards policy as accountability (Simon, Passantino, & Foley, 1998), in which little or no attention is paid to the nature of classroom instruction. Within a context of standards as accountability, primary attention is paid to students' achievement results on large-scale tests, generally administered on a set schedule, as operationalized through grade-level accountability

testing. The policy implementation literature indicates that such policies have mixed effects on changing classroom instruction (see, e.g., Cohen, 1990; Shields, Knapp, & Wechsler, 1995). Such variability in implementation has been the norm, and may be due to the mixed messages inherent in current standards policies as well as the relatively decoupled and multilayered nature of education policy. However, it is most certainly due to variations in how local individuals and organizations interpret standards policies and thus put them into place.

Although the policy context of standards and assessments provides some guidance for teachers about what to teach, how often to teach it, and how to teach it, this guidance sends mixed messages. This can be due to different underlying interpretations of standards — standards as instructional guidance and standards as accountability assessments. Or it may be due to other systemic factors, such as a misalignment between standards documents and assessments, as is the case in some states, or because assessments do not adequately represent the full range of learning assumed by a broadly phrased standard (Hirsch, Koppich, & Knapp, 2001).

A factor that further complicates these mixed messages inherent in standards policy is the complexity of the education policy system, which is relatively loosely coupled and operates at a variety of levels — federal, state, district, school, and classroom. At different levels of the system, different policy actors engage and select, interpret, and sometimes re-form policy initiatives from those levels of the system that are more removed from the classroom (see e.g., Firestone, 1989). At the classroom level, teachers act as "street-level bureaucrats" to shape the nature of classroom instruction in ways that are consistent or at least apparently compliant with external policy requirements and their own beliefs and knowledge about reform (Weatherley & Lipsky, 1977). At each level, different interpretations of policy are possible, and actors at each level may either interpret policy consistent with constraints imposed at higher levels, or they subvert those constraints, either intentionally or through misunderstandings of policies. Whether standards are interpreted as accountability or as instructional guidance may be due to a variety of intervening factors between the state standards and tests and the classroom.

Variety is the primary characteristic of standards implementation — and this variety occurs at different organizational levels. For instance, recent research indicates that, in general, district-level responses to testing pressures take several distinct paths (e.g., Firestone & Fairman, 1998; Skrla, Scheurich, Johnson, & Koschoreck, 2000). Spillane (1996, 1998) considered the interpretive nature of policy implementation in his exploration of district reactions to state reading policy in Michigan. He found that not only did key actors in a district interpret policy directives differently from one another, but that these interpretations also varied across districts, in part due to individual differences of interpretation. In these studies, the ways in which such policies were interpreted were found to be highly dependent not only on the knowledge and beliefs of district administrators, but also on those individuals' opportunities for further learning about the reforms. Skrla et al. (2000), in their description of Texas school districts' recent responses to accountability reform, also list a variety of possible responses that range from *test factories* to *learning communities*.

Further studies of school- and teacher-level responses to policy levers also indicate a variety of responses to the policy context of standards as accountability, particularly in terms of classroom instruction. Although tests seem to matter somewhat in shaping instruction, how and to what extent

they do so is not clear. Although teachers appear to be relatively sensitive to changing and, in some cases, narrowing *their content coverage* based on pressures from testing programs (e.g., Stecher & Barron, 1999; Stecher, Barron, Chun, & Ross, 2000; Firestone, Mayrowetz, & Fairman, 1998), a recent study out of Rutgers indicates that this is not the case in terms of affecting *how* teachers teach (Firestone et al., 1998). In other words, although teachers modify what they teach and possibly the sequence in which they teach it, their instructional strategies do not always appear to change dramatically. In general, research indicates that teachers exhibit mixed and complex responses to the pressures of external tests. They express both trepidation and hope about the measures (Grant, 2000) and demonstrate varied responses to test preparation consistent with their own professional identities (Rex & Nelson, 2001). However, the organizational contexts in which teachers work — most particularly their school contexts — play an important role in how they interpret and shape standards policies in the classroom.

The remainder of this chapter presents a discussion of the findings in the research concerning organizational capacity — particularly focusing on school-level capacity. It also introduces an important distinction in considering studies of capacity — a distinction that is consistent with the dual notions of standards as accountability and standards as having implications for instructional practice. It does so by highlighting a split in the research between studies of organizational capacity for improving students' achievement and organizational capacity for changing classroom practice in ways that are consistent with standards as high expectations for all students. These two types of capacity — *capacity for raising achievement* and *capacity for changing instruction* are not mutually exclusive. They likely overlap considerably. However, the precise nature of their relationship is still under study.

The literature that focuses on organizational capacity for raising achievement is characterized by studies of schools and districts that generally serve poor students and are higher performing on an external measure than are other schools serving a similar student population. Thus they are in some ways "beating the odds" for these students, although it is not clear how instruction is changing in these sites. On the other hand, the research about capacity for changing instruction, while encompassing promise for high student achievement, focuses rather on those organizational qualities that provide support for the learning needed by all stakeholders to make meaningful changes in classroom processes consistent with the idea of standards as having implications for instruction. This chapter highlights recent key research reports about high-capacity education organizations (in terms of both types of capacity) and provides a comprehensive synthesis of this research about specific elements of organizational capacity along both dimensions. Readers should note that this focus excludes other related study focuses, for example studies on the efficacy of comprehensive school reform models.

THE IMPORTANCE OF LOCAL ORGANIZATIONAL CAPACITY

In understanding the translation of state-level policy within a school or district context, a useful early concept from the policy implementation research is that of mutual adaptation between the external reform and the change setting (McLaughlin, 1990). Building on this, more recent policy implementation research indicates that when externally situated reforms are introduced into district and school sites, the quality and fidelity of local efforts to the original intent vary greatly (Elmore,

1997; Knapp, 1997). This is particularly the case when reforms entail complex changes in core technological functions of the organization, such as those changes in teaching and learning that are embodied in the idea of standards as instruction.

Variations in the implementation of complex reforms can be attributed largely to local factors, where local policymakers (e.g., teachers, administrators, and others) construct their understandings of external policies to be consistent with their own beliefs about education and their own individual and institutional agendas (Firestone, 1989; Spillane, 1998; Weatherley & Lipsky, 1977). This has been particularly well explored in the case of teachers as policymakers relative to classroom instruction — particularly the ways in which teachers combine new ideas about instruction with more traditional and comfortable ways of teaching (Cohen & Ball, 1990; Cohen, 1990). However, school and district administrators' understandings and actions relative to policy shape the contexts in which teachers operate (Peterson, Prawat, & Grant, 1994; Price, Ball, & Luks, 1994; Spillane, 1994); leaders' actions and their interpretations of policies help to define the acceptable interpretations of what standards might mean for other practitioners in the school and district. All of these beliefs are situated within the specific organizational context of the local school and district.

Local capacity to implement education reforms has emerged as a significant variable in explaining variations in implementation (Massell, 1998). In its most general sense, capacity refers to the ability of an entity to achieve the goals of reform. However, there are definite subcategories that refine the concept of capacity. A variety of writers (Elmore, 1996; Spillane & Thompson, 1997; Century, 1999) have developed specific categorizations of capacity, which tend to address elements of both human capacity (e.g., individual capacities for learning about and implementing reform within the organization) and organizational capacity (e.g., formal and informal aspects of the school and/or district as an organization that relate to reform implementation).

Organizational capacity helps explain school processes because it provides an explanation for why education reforms have traditionally failed to reach the technical core of classroom instruction. Schools have been described as loosely coupled systems (Elmore, 2000; Weick, 1976), with weak control structures over what teachers do in their classrooms and lack of agreement about what constitutes "best practice" in the classroom. Traditionally, it has been easier to change elements of schooling outside of the classroom (e.g., school mission, textbooks) than to change the enacted curriculum (Cuban, 1993) as taught in the classroom.

Standards reforms represent policy attempts to change classroom practices in curriculum and instruction. Standards-based assessment policies, or standards as accountability, are attempts to affect core technology by focusing teachers on specific student outcomes or by holding various actors accountable for the outcomes. A wide variety of organizational responses result with both positive and negative consequences for student learning. In some districts, pressured administrators are encouraging nonstandard test administration procedures — and, in the worst cases, falsifying student test results (e.g., Cart, 2000). Teachers in some schools are neglecting content areas that are not tested, such as social studies and science. In other places, teachers may artificially raise test scores by "teaching to the test." These types of responses do not necessarily reflect the initial ideas of standards as guiding instruction designed to teach all students the "thinking curriculum" (Resnick & Resnick, 1992).

CAPACITY FOR WHAT?

In considering any questions about organizational capacity, one must ask, "Capacity for what?" In the most recent research, many schools have been termed "high capacity" because they have demonstrated that they are doing a better job of raising students' achievement on external measures than schools with comparable student background characteristics. Although these research studies provide us with little information about the specific nature of curriculum, learning, and instruction that goes on within these schools, they do provide an operational definition of organizational capacity as capacity for raising students' achievement on a specific measure.

On the other hand, there is a considerable body of research that focuses on organizational capacity to support instructional changes that provide all students with opportunities to learn to high levels, consistent with the idea of standards as having implications for instruction (e.g., capacity for changing instruction). This research assumes that the goal is high achievement for all students, although such achievement is not defined on a single measure like it is in the "high-capacity" sites described in the previous paragraph. However, the focus of this research is on the considerable learning needs for teachers and others to be able to learn about and then put these reforms into place in ways that are consistent with the idea of standards as instruction. This research describes other organizational and personal supports needed to provide support for these instructional changes. Such supports may require the reorganization, restructuring, and re-culturing of schools and districts around explicit goals of high student achievement and teaching and learning so that such changes can take root and grow (Clune, Elmore, & Fuhrman, 1988).

Capacity for Raising Achievement on a Specific Measure

To examine the most recent research about the elements of capacity for raising students' achievement, this chapter focuses on several recent, high-profile studies of high-performing, high-poverty schools. Among the most important of these is a study by the Education Trust (1999) in cooperation with the Council of Chief State School Officers (CCSSO). This study involved surveying the principals of elementary and high schools with poverty levels of above 50 percent and that were either among the 10 highest performing, high-poverty schools on state assessments or among the most improved (e.g., the 10 biggest gaining schools on state assessments). Another, similar set of studies comes from the Charles A. Dana Center. These studies focus on high-performing urban elementary schools that serve poor children, and also on the characteristics of high-performing school districts (Charles A. Dana Center, 1999; Ragland, Asera, & Johnson, 1999).

The Education Trust/CCSSO study (1999) consists of survey data from principals in 21 states. Principals were sampled from schools that serve poor populations and that are high performing. According to this study, these schools

1. use state standards extensively to design curriculum and instruction, assess student work, and evaluate teachers;
2. increase instructional time in reading and math in order to help students meet standards;

3. devote a larger proportion of funds to support professional development focused on changing instructional practice than schools that were not performing;
4. implement comprehensive systems to monitor individual student progress and provide extra support to students as soon as it's needed;
5. focus their efforts to involve parents in helping students meet standards; and
6. have state or district accountability systems in place that have real consequences for adults in the schools.

In 1999, the Charles A. Dana Center released the results of its case study of nine high-performing, high-poverty urban elementary schools. These schools predominantly served poor students, did not have selective admission policies, and student achievement in mathematics and reading was higher than the average of all schools in the state (based on three years of assessment data). Data collection entailed interviews of district and school administrators, teachers, parents, and other school personnel, observations, and document review. Although there were some key differences across schools (e.g., size of enrollments, grade-level configurations, demographics, use and non-use of comprehensive school reform models), the study found some important similarities in the strategies used by these schools to improve achievement:

1. School leaders identified and pursued a symbolically important and visible, yet attainable first goal, focused organizational energies on that to succeed, and then used the momentum of success to work toward other goals.
2. Leaders redirected the organization's focus toward service to children.
3. Educators cultivated students' sense of responsibility for appropriate behavior and built an environment in which students were likely to behave well.
4. Leaders created a collective, shared sense of responsibility for school improvement.
5. Quality and quantity of time spent on instructional leadership activities increased.
6. Educators aligned instruction to standards and assessments required by their state or district.
7. School leaders made sure that all educators got the training and resources they felt they needed to get students to achieve to high levels.
8. Leaders created opportunities for teachers to work, plan, and learn together around instructional issues.
9. Educators worked to win the confidence and partnership of parents.
10. Additional time was created for instruction.
11. Educators maintained the school focus over time, and through setbacks.

A related study was developed by Ragland et al. (1999) to examine school districts that are similarly characterized by high student achievement — with at least one-third of their high-poverty schools receiving a Recognized or Exemplary rating on Texas's accountability system, based on scores on the Texas Assessment of Academic Skills (TAAS). The study took a case study approach, using source data consisting of interviews of central office and school site administrators, observations of board and staff meetings, and district documents and data sources. In these districts, actions were characterized by

1. creating a sense of urgency in the community, frequently using student achievement data that tracked progress toward organizational goals;
2. sharing responsibility for academic achievement, involving clear performance expectations for schools and principals, along with regular use of achievement data; and
3. aligning resources and structuring support, which meant frequently changing the role of the central office from monitoring to assistance, creating structures to support teacher learning, and allocating resources for data use and support of school plans.

In general, the research about capacity for raising students' achievement tends to provide relatively general information, similar to the early effective schools literature (e.g., Purkey & Smith, 1983; Levine & Lezotte, 1995). The unit of analysis is frequently at the school or district level. Recommendations for action tend to lack detail, but generally report that high-performing schools enjoy strong leadership, a shared sense of purpose or vision, supportive organizational structures that facilitate cooperative work, and systematic use of student achievement data (frequently on the accountability measure, although this is not specified in most studies) to diagnose progress and inform planning.

While this information provides a useful outline of the elements included in organizational capacity, it lacks detail about how these elements interact. A particularly significant gap in the research on capacity for raising achievement is the lack of attention to the specific classroom practices related to students' achievement. It is important to address classroom practices in high-performing sites for two reasons: (1) the nature of schools as loosely coupled organizations, in which outward, surface-level change may not translate into ambitious classroom practices; and (2) the potential for corruptibility of the external (and frequently high-stakes) tests being used to define school effectiveness.

Because the studies of high-performing schools and districts tend to be based on sites selected on a single performance criterion (frequently performance on an accountability test), it is necessary to examine just what high test scores are telling us about these sites, particularly when they are being held up by policy makers as examples of what schools should be doing. It is quite possible that these student test scores may indicate ambitious learning. But it is also likely that, given the research about testing influences on instruction, they indicate increased test preparation and narrowed curricular experiences. There is a need for further study of organizational and classroom processes that build on the general information provided by these studies. With more collection and analysis of contextual data, with related studies of sites that have been selected as exemplary based on performance on a variety of measures, and with better information about how performance on the criterion measures translates into broader student learning, one can extend the information gleaned from such studies to better inform educators about the predictors of improved student learning to high levels.

Capacity for Changing Instruction

In terms of describing organizational capacity for changing instruction, this chapter draws on information from a series of recent studies. These studies, similar to those described above, examine student achievement. However, rather than sampling exclusively from sites that are high achieving on a specific measure, they focus more and in more depth on the organizational and classroom contexts surrounding achievement. They tend to examine classroom practices as well as organizational qualities of sampled sites, and describe them in more detail than the above studies.

The first study addressed here is based on a comprehensive study of standards-based systemic reform implementation by the Center for Policy Research in Education (CPRE) (Goertz, Floden, & O'Day, 1995), which involved case studies of exemplary schools and districts in several different states. The researchers describe organizational capacity as "the ability of the education system to help all students meet more challenging standards" (p. 105). They argue that, even in the exemplary sites they studied, teachers' instructional practices were not sufficient to help all students meet more challenging standards. This is because they are hindered both by their own and the system's limited capacity to make the desired changes. Teachers' individual capacities for ambitious instruction interact and are interdependent with organizational capacity. Further, according to this study, the most salient influences on teacher capacity and practice are at the organizational level of the school or sub-school unit. Therefore, it is important to study school capacity for changing instruction, particularly in connection to how well it supports the growth of teachers' individual capacity.

In the CPRE study of reforming schools, five dimensions of capacity emerged from the data:

1. Vision and leadership, which involves a collective sense of purpose, focused on curriculum and instruction, improved achievement for all students, and teacher responsibility for student learning.
2. Collective commitment and cultural norms to realize the vision. The most actively reforming schools studied were characterized by a sense of collective (rather than only individual) commitment and responsibility for student learning. Additionally, the schools demonstrated a set of cultural norms that stressed ongoing reflection and improvement — norms that were exemplified through the development, use, and gradual institutionalization of specific tools and processes that helped to evaluate organizational progress toward learning goals.
3. Knowledge or access to knowledge that is related to the vision.
4. Organizational structures that support ambitious instruction, such as schedules to allow teachers common planning time for collaboration or extended blocks of instructional time. Other structures included student grouping schemes based on developmental rather than age-related levels.
5. Resources, the most essential of which in this study was time — primarily for teachers to meet together to plan, reflect, and learn from their practice. Other resources included personnel and other material resources.

These elements are not discrete, but, rather, are interdependent. For example, one indicator of environments with high capacity for changing instruction is that staff members are united in

collaborative learning communities that support a culture of ongoing reflection, use of data to monitor progress toward student learning goals, and a culture of shared accountability for student learning. Such a culture requires a common and broadly communicated central vision around which to organize and school or district leadership that is knowledgeable about and supports collaboration in this venture, rather than a top-down approach. It also demands an organizational context that provides adequate support in the way of structures (e.g., common planning time for teachers focused around ambitious visions of student learning, as well as alternative grouping structures for students who need additional help to meet the standards), and access to knowledge (e.g., adequate funding for ongoing professional development, availability of student performance data and technical assistance for teachers and principals to use such data). All of these aspects of organizational capacity for changing instruction entail the appropriation of adequate use of resources.

Another important group of studies reviewed encompasses the ongoing studies of New York's Community School District #2, conducted under the auspices of the Learning Research and Development Center (LRDC) (e.g., Stein & D'Amico, 1998; Resnick & Harwell, 1998, 2000; Stein, Harwell, & D'Amico, 1999; LRDC, 1998, 1999; Elmore, 1997; Elmore & Burney, 2000). This nested case study of schools within a district comprises the High Performance Learning Communities Project. It provides an extensive examination of the policies, leadership, achievement, and organizational practices in New York's Community School District #2. The group of studies in the Project focuses both on students' achievement as the "bottom line" and also the capacity for changing instruction. It reports that, in terms of students' achievement, "there is no doubt that District #2's professional learning organization is working successfully" (Learning Research and Development Center, 1998, p. 2). This quote is telling in terms of its emphasis. Student achievement is, indeed, important. However, unlike the research on schools that have "beat the odds," it is considered largely in terms of how well the organization is doing in terms of professional learning — in this instance, learning how to provide high-quality instruction related to ambitious standards.

Other chapters of this synthesis have treated the findings from School District #2 in considerable depth, depending on their respective emphases. The elements of the District #2 studies that have the most relevance to a definition of organizational capacity for changing instruction through building a learning community are the following:

1. New initiatives in the district are evaluated for their consistency with stated core values and vision. Therefore, successive improvement efforts are aligned with one another and are consistent over time — primarily through their common focus on instructional improvement.
2. Student performance is the criterion against which all new initiatives are judged. This work, which entails monitoring of student performance on a variety of measures, builds on earlier district work to make explicit standards of teaching practice and to create a common culture of what good classroom practice looks like.
3. The bar of expectations for performance is to be continuously raised — for all students and all schools — which may entail using progressively more demanding achievement measures and allocating more resources to address areas of low performance.

4. The district has shortened the improvement cycle so that it is more responsive to the problems to be solved.
5. Resources need to follow problems — in short, time, professional development, and staffing are allocated to the improvement plan rather than following existing budgetary formulas and staffing patterns.
6. Open and public debate about new initiatives is not only necessary, but is encouraged and supported within the context of a common approach to solving problems of student learning (Learning Research and Development Center, 1999).

These principles help to describe an organization that is relatively unified around a broadly shared vision of student learning, in which progress toward meeting related goals is measured through a variety of mechanisms, and in which resource allocation and action planning are determined in consideration of this goal and progress toward it.

These studies of District 2 are conceptually related to work by researchers who tend to describe policy implementation from a teaching and learning perspective (e.g., Cohen & Ball, 1990; Knapp, 1997; Jennings & Spillane, 1996; Spillane, 2000; Elmore, 2000). Such researchers examine capacity in terms of organizational supports for individuals and groups to build a common understanding of what constitutes good teaching and learning and to extend their capacities to deliver this type of educational experience to all students, a process which should ultimately result in high achievement on a variety of measures.

Knapp (1997), in a summary of systemic reform research, describes this perspective on the implementation of the complex policies implied in standards as instructional change as "professional and organizational learning" (p. 252). He provides a succinct description of its theoretical underpinnings as based in three streams of research; policy research about compliance behavior, organizations research that examines organizational learning, and a third branch of thinking that focuses on professional learning (by teachers, policy makers, and others) and the pedagogy of policy — or how policy serves as a tool to enable that learning. Such a perspective has a twofold focus — on the individual learning that needs to take place in order to realize the intent of standards in relation to changing instruction, and on the organizational/institutional learning that needs to take place (in terms of shared norms of practice, routines, and structures) to support this learning and the associated changes. The latter focus is prefigured by Goertz et al.'s (1995) description of individual capacity as interactive and interdependent with organizational capacity for changing instruction. Spillane, Peterson, Prawat, Jennings, and Borman (1996) describe such a perspective on policy and practice in terms of a "pedagogical frame."

> We see policy-makers' attempts to enact policy as a form of teaching and their reforms (e.g., curriculum frameworks, student assessment, professional development) as a kind of curriculum for reform. And we view local educators, both administrators and teachers, as learners. That is, learners about teaching and learning. (Spillane et al., 1996, p. 432)

In many instances, this is described as a learning community or a community of learners. Hord's (1997) review of the literature described five general dimensions of a learning community, which are roughly analogous to Goertz et al.'s (1995) elements of organizational capacity for changing instruction:

1. Supportive and shared leadership
2. Shared values and vision
3. Collective learning and application of learning
4. Supportive conditions, including structures (e.g., school size, building layout, schedules, communication structures, and collegial relationships)
5. Shared personal practice

The High Performing Learning Communities Project, in an analysis of the research literature on high-performing schools, has developed a similar list of characteristics, which include a shared vision, challenging curriculum and engaged student learning, supportive organizational structures, a collaborative learning community, and proactive community relations (Berman, Chambliss, & Wood, 2001).

Elmore (2000) provides a partial summary of the research on capacity for changing instruction in his argument for a new structure of distributed school leadership. Based on his own work in New York Community School District #2 and findings from other capacity studies, he provides five general design principles for large-scale improvement in school systems — with implications for changing classroom instruction:

1. Maintain a tight instructional focus sustained over time. This focus is to be applied to all in the organization, it is to relate both to instructional practice and to performance, and should be gradually phased in by instructional area and practice over time.
2. Routinize accountability for practice and performance in face-to-face relationships. This would entail a shared sense of adult accountability for the learning of all children, rather than select groups of children. It would also build on face-to-face relationships rather than bureaucratic routines. Work roles and responsibilities in the organization would be organized mainly to improve others' capacity and performance.
3. Reduce isolation and open teaching practice up to observation, analysis, and criticism. Under this principle, direct observation and feedback would be considered routine, the boundaries of the school or district organization would be opened up to outsiders, and desired classroom practice would be a topic of discussion and would be modeled in a variety of contexts.
4. Exercise differential treatment based on performance and capacity rather than volunteerism. This principle suggests that differences among units (classrooms, schools, communities) be acknowledged within a common improvement infrastructure, and that supervisory time and professional development be targeted based on explicit judgments about where schools are on this framework.

5. Devolve increased discretion based on practice and performance. This principle allows for variation in treatment and administrative control based on data about the quality of practice and student performance.

These principles imply an infrastructure organized around a common goal for which all stakeholders are broadly accountable and which uses regular and broadly supported feedback measures about progress toward that goal. These principles also allow for variation in management structures and routines depending on the progress of different units toward this goal.

In summary, the research about organizational capacity for changing instruction, while providing lists of attributes similar to those from the research about capacity for raising achievement, tends to have a different emphasis. This literature about capacity for changing instruction, although addressing achievement, emphasizes the necessity for educators to have access to learning opportunities and to work together collaboratively so that they develop a rich, technologically specific vision of what ambitious teaching and learning entails in the classroom. The literature focusing on capacity for changing instruction provides more detail about the "strong" leadership that is described in the literature about capacity for raising achievement. It describes the role of leadership in supporting collaborative norms of discourse and details about the shared assumption of leadership tasks and responsibilities. In the literature about capacity for changing instruction, the organizational context is important not only in terms of its relationship to students' achievement, but also because of how well it articulates a vision of ambitious learning for all students, how well it supports the learning of all involved to understand the related changes in teaching and learning that implies, and in how well it adjusts structures to support progress on such a venture.

The remainder of this chapter provides a synthesis of the findings about the key elements of organizational capacity that emerge from the research. These include organizational vision, leadership and distributed leadership, data-driven decision making, organizational structures, collective commitment and organizational norms, and resources. Each of these elements are discussed in relation capacity for raising students' achievement and capacity for changing instruction.

ORGANIZATIONAL VISION

Across the literature, one element of organizational capacity that emerges from studies of schools that have demonstrated capacity for raising students' achievement is their *organizational* focus around a group of common goals related to student performance (Lake, Hill, O'Toole, & Celio, 1999; Aldersebaes, Potter, & Hamilton, 2000; Education Trust, 1999; Haycock, 2001). The importance of shared goals is well established in the effective schools literature; a variety of studies have demonstrated that faculty in such schools express a strong commitment to helping all students master important learning objectives (e.g., Clancy, 1982; Lezotte, 1991; Rossmiller, Holcomb, & McIsaac, 1993). The framework of High Reliability Organizations (Datnow & Stringfield, 2000) as applied to schools also recognizes the importance of a shared vision, described in this case as a finite set of clear goals, shared at all organizational levels and a shared commitment toward meeting those goals. The vision, developed through a broad-based process and reiterated through constant

examination and discussion, needs to be sustained over time, supported by most or all personnel, and it needs to drive resource allocation and school or district action.

Another aspect of organizations with high capacity for raising achievement is the extent to which personnel in such sites apply a problem-solving approach to the system. This seems to be related to an authentic and broadly held belief that all students are, in fact, *capable* of learning to high levels. Such a belief system leads to the attribution of student failures to flaws in the system rather than the students themselves, and is supported both by a long tradition of earlier research (e.g., Levine & Stark, 1981; Sizemore, Brossard, & Harrigan, 1983) and more recent research on high-performing sites (e.g., Wolf, Borko, McIver, & Elliott, 1999; Skrla et al., 2000). These studies also frequently describe a shared responsibility for student learning analogous to Newmann and Wehlage's idea of internal accountability (1995), in which all staff have a strongly felt sense of responsibility and personal accountability for student learning.

However, in general, these recent studies of high-achieving sites do not specifically address the implications of such a vision for classroom instruction. Although there is attention in this body of research to a vision of "ambitious teaching and learning," it is unclear whether this means a general trend of improvement on students' test scores or whether it actually addresses the processes related to higher order learning. The descriptions of guiding visions in such studies, although in some instances concrete and linked to teaching and learning, are not specific enough to make inferences about specific classroom practices. It is likely that, within these sites, considerable variation occurs in terms of actual classroom practices. Although test scores are indeed rising, this may be due to a variety of instructional strategies, some of which may emphasize lower level skills. This is an important area for further study.

A second concern about these studies of high-achieving sites is that they do not address the relative breadth of these organizational visions. One concern in the research about the organizational visions adopted in these high-performing schools and districts is their possibility for reductionism. Such a concern is valid if the vision is linked only to one achievement measure, such as an external accountability measure (Sergiovanni, 2000). Multiple measures of student learning that exemplify the vision of student learning are important, and extensive explorations of whether the visions of student learning that guide the efforts of high-performing schools are reductionist or rich are not described in the current literature.

The research that focuses on organizational capacity for changing instruction includes these characteristics of a broadly shared vision focused on all students' performance, a problem-solving approach, and shared accountability for learning as well. However, it provides more clarity about the specific nature of the vision in terms of its utility as a learning tool. This research focuses on the extensive need for learning on the part of all involved that is related to the idea of instructional changes associated with standards. For instance, in study sites that have demonstrated changes in instruction, the vision tends to be expressed through a variety of ways and artifacts that have direct implications for teaching and learning interactions and in ways that are consistent with the idea of standards as ambitious instruction. These might include specific criteria for teacher evaluation protocols, guidelines for practice, as well as through instructional materials and programs that provide consistent instructional guidance. These artifacts and concrete expressions of the vision

provide more opportunities for educators to learn what it is that they might need to know to change their instruction consistent with these goals.

Within this framework of teaching and learning, this literature provides clarity about the nature of the vision in providing specific guidance for educators. It clarifies that, in order to help educators learn about changing their practice, the organizational vision needs to have specific implications about the directions in which teaching and learning should progress. An indicator of this type of vision is that it is expressed through a shared technological language that indicates a common, widely understood agreement about the nature of the vision within that particular school and what it means specifically for classroom practices (Jennings & Spillane, 1996). The extent to which such a language develops and supports instructional change is dependent on how much different individual understandings of policy are revealed and discussed at different levels, and it is dependent on the nature of the organization's discourse community. Spillane et al. (1996) in a study of district discussions about reforms, note the following:

> Discourse is a necessary but insufficient condition for learning to occur. Discourse within a group can serve to enhance "learning" from policy, but certain conditions need to be present. These include focusing on the same concrete referents and developing a common language to describe these referents . . . individuals from different discourse communities often assume that they are talking about the same phenomena when they use the same language and words, but in fact, they may end up talking past one another. They do not mean the same thing in terms of an actual teaching and learning event. (pp. 437–438)

Further, a key aspect of this is clarity, knowledge about, and skills related to new instructional strategies and challenging curricula (Newmann & Wehlage, 1995; U.S. Department of Education, 1995).

Another example comes from research conducted in New York City's Community School District #2. According to the researchers, a key element in the success of its approach is its organization as a set of nested learning communities, all organized around student achievement, where all educators are considered to be working professionals who are continually learning. Within this context, both students and educators are expected to participate in learning communities, which are characterized by, among other things, clearly defined standards for what constitutes good teaching practice. These standards are explicit, widely discussed, and modeled wherever possible (Learning Research and Development Center, 1998).

LEADERSHIP AND DISTRIBUTED LEADERSHIP

In the research about organizational capacity for raising students' achievement, "strong" leadership, generally described in terms of a strong principal, is perceived as a prerequisite for effective schools by teachers, parents, and administrators (Scieszka, 1996; Van der Burg, 1987; Wiebe, 1991). However, the relationship between principal leadership and student achievement is a complex and indirect one.

In their meta-analysis of the research on effects of principals on students' achievement, Hallinger and Heck (1996) conclude that principal leadership behavior is linked to student learning indirectly through its influences on internal school processes. The one mediating variable that consistently interacts with principal leadership through a variety of leadership studies is that of school goals. The relationship between principal behavior and students' achievement is systematic only in terms of the principal's function of sustaining a school wide purpose focusing on student learning.

A review of the research on high-performing, high-needs schools indicates that strong leadership is a common, albeit relatively generally described, theme in these sites. Another common theme is the distribution of leadership tasks and responsibilities through the school as an organization. In these studies, successful leaders tend to engage in tasks that include setting attainable goals (which tend to be structured and prioritized to ensure early successes that then provide momentum and support for reaching loftier goals), supporting the ongoing use of data to monitor the organization's progress toward those goals, establishing a culture of ongoing growth, and reorganizing school structures and resources specifically in support of organizational goals (e.g., Ragland et al., 1999; Just for the Kids, 2000). Further, leaders play an important part in helping to construe external policy mandates as opportunities for growth, rather than as problems to be overcome (Wolf et al., 1999). Another trend in successful high-performing sites is that reform efforts have enjoyed sustained support from school and district leaders, either through a consistent tenure of one leader or through a succession of like-minded individuals. Such individuals have been able to maintain the organization's focus on high goals for all students' learning and to sustain the momentum of reform.

The literature on capacity for changing instruction provides additional clarification of "strong" leaders as people who help to enable the learning of all in the organization. Therefore, a measure of strength in leadership may involve how well school personnel are supported and encouraged to learn how to change classroom practice consistent with a well-communicated vision for teaching and learning. Leaders can have the most positive effects on instruction when they promote a shared vision within their schools and provide opportunities and incentives for teachers to change their practices (Lieberman, Falk, & Alexander, 1994; Rosenholtz, 1989; Haynes, 1998; Puma et al., 1997; Shields, Knapp, & Wechsler, 1995; Stringfield, Datnow, & Ross, 2000). Other studies indicate that the principal's skill in developing the learning capacity for all within the school and how well the principal understands and supports the reform are key elements related to positive effects on instruction (Davidson & Taylor, 1998). According to Elmore, Peterson, and McCarthey (1996), transforming teaching practice is "fundamentally a problem of enhancing individual knowledge and skill" (p. 240) and the role of the principal in this process therefore becomes one of supporting ongoing learning about complex reforms. Lauer's chapter on teacher learning in this synthesis also discusses the role of the principal in supporting professional development.

The extent of knowledge that principals and other leaders may need to have to be successful at this can become mind-boggling. For instance, research about administrators' content knowledge indicates that it is an important aspect of the ability to lead effectively. When administrators lack deep understanding of content and reform goals, they are unlikely to provide adequate support for the reform (Price et al., 1994; Nelson & Sassi, 2000; LRDC, 2000). Stein and D'Amico (1998) consider administrators' content knowledge to be a "deeply embedded, contributing factor to the effectiveness

of the district's systemic instructional improvement effort" in New York's Community School District #2. They note:

> The effect of the interrelationship between support and accountability may depend upon who is at the helm. In the hands of competent, knowledgeable supervisors, it leads to better teaching and learning inside classrooms. In the hands of less competent and less knowledgeable supervisors, it may not have the same effect. (pp. 30–31)

Leadership for supporting learning needs may be considered as an attribute of personnel who are not necessarily building administrators. According to Senge (2000), fundamental change efforts (which have effects on core technology) take three different types of leaders: network leaders, who may not have formal authority to make changes, but who provide important support for others to learn about the changes; line leaders, who may have some authority to make substantive changes (e.g., building principals); and executive leaders (e.g., district superintendents) who provide large-scale support and the overarching vision for change. This type of framework for considering the impact of leadership on reform implementation indicates the need for a broader definition of leadership beyond the role of school administrator.

One model, similar to Senge's (2000), that helps to broaden the definition of education leadership is distributed leadership, an approach proposed by Spillane, Halverson, and Diamond (1999, 2001), which takes into account leadership tasks related to instruction that are assumed by other education personnel within the school or district (e.g., teacher leaders and program coordinators). Shared tasks may include constructing and selling an instructional vision, developing school culture and norms of trust and collaboration, supporting teachers' growth and development, monitoring instruction, and organizing resource allocation. Deal and Peterson (1999) describe leadership similarly as distributed throughout the organization. They report that "successful schools have leadership emanating from many people — leadership that maintains and supports learning for all students, as well as learning for staff" (p. xiii).

Given the complexity of current education reform goals, some suggest that distribution of leadership is necessary. Elmore (2000) describes distributed leadership as

> multiple sources of guidance and direction, following the contours of expertise in an organization, made coherent through a common culture. It is the "glue" of a common task or goal — "improvement of instruction" — and a common frame of values for how to approach that task — culture — that keeps distributed leadership from becoming another version of [organizational] loose coupling. (p. 15)

Distributed leadership is one way to address the issue of ensuring leadership expertise across a broad variety of domains and subjects. It is also an important element of organizational capacity for changing instruction, particularly as it relates to supporting the learning of how to make such changes. As such, it may be critical for sustaining such changes. Although school and district administrators are important, their importance in relation to raising students' achievement is relatively indirect, and based on their authority to allocate resources and help to build a supportive

organizational culture. In terms of the importance of administrators and other leaders in supporting ambitious changes in instruction, their role as supporting ongoing learning and a culture of inquiry is also key.

DATA-DRIVEN DECISION MAKING

A significant element of organizational capacity for raising students' achievement is the systematic, strategic use of data to monitor progress. This action, although broadly distributed throughout the literature, historically (Levine & Lezotte, 1995) has not been defined specifically in practice, although it has been hinted at. (See, for instance, Datnow and Stringfield's (2000) description of highly reliable schools as those in which practitioners are alert to program lapses. Such lapses are identified through the building and maintenance of powerful databases to inform decision making.)

In recent studies of reforming schools and districts, use of data to systematically monitor student progress has been a consistent finding (Education Trust, 1999; Aldersebaes et al., 2000; Lake et al., 1999; U.S. Department of Education, 1995). For instance, in a study of high-performing, high-needs schools, the Charles A. Dana Center study (1999) found that data were used not only to spur action, but also to keep abreast of student learning on specified achievement measures related to learning goals. In instances where student learning was not up to expectations, systematic action was taken to remedy the problem. Similarly, programs that were successful demonstrated their success and were continued, based on the evidence shown in student achievement trends. In some instances, central district office personnel provided assistance for school-level practitioners to use data; in other cases, outside technical assistance providers were hired. In Washington State, improving schools took action by analyzing the weak points in their test scores and focused time on areas they felt they needed to improve (Lake et al., 1999).

Recent work has begun to focus on how states and, to a lesser extent, districts can support the use of data in school-level decision making. Clearly states and districts have a role in providing timely data to schools. For example, if schools are to use student achievement data to create instructional responses to students' needs, then schools must receive the data several months before the end of the school year. Districts and states can also create policy structures to support schools' use of data such as accreditation requirements that require annual school improvement plans that respond to issues raised in data. Finally, states and districts have a role in building or supplying the technical expertise schools need to interpret and manipulate data (Massell, 2001; Reichardt, 2000).

The research about capacity for changing classroom instruction is less specific about the use of data, but tends to focus on the ways in which practitioners create discourse communities specific to practice and the nature of external policies in terms of their utility as educative tools (e.g., Cohen & Barnes, 1993; Spillane et al., 1996; Jennings & Spillane, 1996; Spillane, 1998; Peterson et al.,1994). Knapp, in an analysis of the implementation of systemic reforms (1997), reports that some of the failures of these reforms to reach the classroom can be attributed to

> poor policy pedagogy (i.e., policies communicate reform intentions in a didactic and monolithic way), limited opportunities for learning (i.e., policies do not stimulate or support a variety of occasions and means for deeper learning about subject matter,

> instructional technique, and change strategies), and impoverished resources to support professional and organizational learning over time. The evidence of greater learning in high-capacity settings can thus be a manifestation of greater attention by actors within these settings to the nature of the learning opportunities they construct (e.g., through professional development and the development of communities of practice). (p. 254)

Although strategic use of student performance data fits into such an educative framework and can help to inform meaning making at the district, school, and classroom levels, it is not specifically addressed by the research. Further, although systematic, strategic use of student performance data is described as important both for schools that have raised students' achievement on external measures and for schools described as learning communities, the research lacks clarity about who uses what sorts of data, and how these data are used. Additional questions unaddressed by current research involve the support structures that schools and districts need to enhance data use — as well as the ways in which different stakeholders use the data.

ORGANIZATIONAL STRUCTURES

School and district organizational structures, such as policies addressing incentives for change, teacher evaluation, and scheduling and/or grouping practices, have been consistent factors in reform implementation. Elements of structure can include physical arrangements of space, time, people, and other resources as well as allocation of teacher responsibilities for students, and procedures (e.g., standard operating procedures, processes for assessing and communicating student learning, and formally defined approaches to tasks) (Elmore, 1996). Since organizational structures include organization of resources, there is some overlap in recommendations between this section and the resource section.

In the research about high-achieving schools, some attention is paid to structures that support teachers to work together around a shared focus on student learning. However, another aspect of structural capacity for raising achievement entails the development of alternate learning structures for students, particularly those students with the greatest need for assistance, as indicated by Scheurich (1998). The effective schools literature indicates that one structural aspect of schools that support high achievement is that instructional time is protected through scheduling. Other time-maximizing structures include the coordination of how teachers use time, allocating relatively large amounts of time for instruction, increasing instructional time specifically for core areas (e.g., reading, language arts, and mathematics) and reducing classroom interruptions (Levine & Lezotte, 1995).

In those schools with high capacity for raising students' achievement, a variety of learning opportunities have been put into place to maximize student learning time, including parallel classes and scheduling, individualized and small-group instruction, team teaching assignments, tutoring, transitional classes, developmental and remedial learning opportunities, and after-school and summer school programs. In general, the effective schools research indicates that:

1. Reduction or elimination of pullout approaches have resulted in improved achievement in Chapter I schools.
2. Class size and number of low-achievers per class are important considerations in scheduling.
3. In high-needs schools, some degree of leveling will probably be required — and leveling, which entails broad grouping for differentiated treatment, implies an attempt to avoid overuse of homogeneous grouping.
4. To the extent that leveling is used, attempts must be made to avoid homogeneous grouping (Levine & Lezotte, 1995).

The research about capacity for changing instruction provides another possibility, in terms of the presence of organizational (e.g., extrinsic, rather than intrinsic) incentive structures for teachers to learn (Elmore, 1996). However, the research about capacity for changing instruction has covered most extensively the development and use of scheduling practices within the school to provide common time for teachers to plan and work together around the task of improving student learning (Haynes, 1998; Darling-Hammond & Ball, 1998). Newmann and Wehlage (1995) note that organizational capacity for changing instruction tends to be supported by interdependent work structures for teachers, that is, structures that organize teachers' work in groups, such as team teaching assignments, or support teachers to assume collective responsibility for students. In Chapter 4 of this synthesis, Lauer discusses the importance of collaboration for teacher learning.

How instructional time is used, particularly in terms of extending learning opportunities for low-performing students, is also an aspect of organizational structure related to capacity for raising achievement and capacity for changing instruction. One early interpretation of standards expressed the view that all students could learn to high standards, but that they might require different amounts of time to do so. Therefore, flexible grouping and scheduling policies related to student learning needs are essential in ensuring different students' success in learning to high standards. The National Education Commission on Time and Learning (1994) recommended that schools should be reinvented around *learning, not* around time. Resnick and Harwell (2000) further echo this emphasis on the variability in time for learning as part of what they call an "effort-based educational system" — one that has clear expectations (e.g., standards), fair and credible evaluations of achievement (e.g., performance assessments), celebration and payoff for success, expert instruction, and as much time as necessary to meet learning expectations. Structures that might support extra learning time include programs like extended day, week, and year programs, and tutoring and summer school programs. They may also include practices like multi-age grouping or flexible grouping strategies for instruction (Adelman, Haslam, & Pringle, 1996).

Overall, the research indicates that supportive organizational structures are necessary, but not sufficient for building organizational capacity for reforms — either in terms of capacity for raising achievement or capacity for changing instruction. In general, changes in organizational structure are mediated by relatively powerful cultural factors like the shared norms, knowledge, and skill of teachers (Elmore, 1995; Elmore et al., 1996). It is important to further examine the interactions between organizational structure and other elements of organizational capacity to clarify the optimal conditions for improved teaching and learning.

Much research has addressed the use of alternate organizational structures to improve teacher morale and cohesion within the school culture. Further, there is some mixed research about the effectiveness of alternative organizational structures that are used to provide low-performing students with extra time and opportunities to meet the standards. However, the research remains relatively silent about the specific nature of student learning opportunities within those structures — particularly in terms of considering standards as having implications for ambitious instruction.

Collective Commitment and Cultural Norms

Elements of cultural capacity in the form of collective commitment and common cultural norms are common in the research addressing capacity for raising achievement and capacity for changing instruction. According to Newmann and Wehlage (1995), cultural capacity requires a professional community of educators who pursue a clear, shared purpose for all students' learning, engage in collaborative activity to achieve the purpose, and take collective responsibility for student learning. The theme of a common purpose that unites the organization around learning goals is echoed further by Elmore (1997), who reports that "the common work creates settings in which principals, teachers, and staff developers have to create a common language, a common set of norms and expectations, and a common view of practice in order to get the work done" (p. 17). In Chicago, recent research indicates that more effective instruction, in terms of using interactive instructional strategies, occurs in schools where teachers are oriented toward innovation and where they can engage in reflective discussions together about their practice (Smith, Lee, & Newmann, 2001), sometimes characterized as an inquiry stance toward teaching and learning. Organizational learning depends on the richness of the discourse, who participates, and the nature of their opportunities to participate. Peterson et al. (1994) highlight the importance of three elements of culture in their studies of capacity for changing instruction:

1. Problem-solving approaches (e.g., challenges were construed as opportunities to learn).
2. A basis for understanding policy that is rooted in an understanding of ambitious learning in specific content.
3. A consistent valuing of collaborative learning and discourse within and outside their own organizations.

One aspect of these collaborative norms involves broadly shared ownership and responsibility for student learning. D'Agostino (2000), in a recent study of effects on student mathematics and reading achievement, describes the culture of effective schools as "successful at accumulating human resources, and they reach this state by fostering intra-group cohesion and morale. Good schools increase personnel commitment, and thus, motivate employees to achieve the organization's goals" (p. 232). Newmann, King, and Rigdon (1997) describe organizational capacity for changing instruction in terms of a culture of strong, shared internal accountability for student learning. They report that schools strongly oriented toward external accountability tend to have low organizational capacity, whereas schools oriented toward strong internal accountability, in terms of broad-based responsibility for student learning, have high levels of organizational capacity.

When organized around common problems and support of ongoing opportunities for all to learn about strategies for meeting these problems, school cultures have been described as communities of learning or communities of learners (Barth, 1990; Elmore et al., 1996; King & Newmann, 2000). Knapp (1997) identified common approaches to supporting learning opportunities across high-capacity settings. In these schools and districts, teachers and others were offered numerous opportunities for professional development that was engaging, intellectually challenging, ongoing, and respectful of their professional knowledge. In addition, these sites offered numerous other avenues for learning about reforms — such as teachers' participating in scoring student assessments, deliberating about textbook adoptions, or using replacement units. Other studies indicate similar findings. Although high-quality learning experiences are necessary for teachers to learn about the implications of reform for changes in their classroom practice, the presence of professional community and sustained supports for ongoing learning are also necessary (King & Newmann, 2000; Education Commission of the States, 1999). These aspects of the culture all relate to Goertz et al.'s aspect of capacity described as *knowledge* or *access to knowledge* (1995). They have been addressed in more detail in the previous chapter by Lauer in the section on *communities of learners*.

RESOURCES

Financial resources are key elements of school and district capacity to implement standards successfully, and tend to take three forms: actual dollars that are available to spend (such as grants), additional services (e.g., professional development from the district or from other sources), and additional staff — or more experienced staff. Schools and districts can reallocate these resources, and since the predominant resource expenditure is for teacher time (e.g., Picus, 2001), resource reallocation frequently involves changes in schedules and staffing assignments. However, a key issue for policymakers at all different levels of the system is the most effective way to use resources, and this area needs further study, both in terms of refining measures of resource use, and in linking resource use with achievement and measures of classroom practice.

The research on sites with high capacity for raising achievement provides some general guidance about resource allocation, but it has done so unsystematically. Although much of this research touches on resource use, it neglects the *amount* of resources used to get results. Some studies describe how the schools under examination actually have *more* resources than other schools in terms of more senior staff (Klitgaard & Hall, 1975; Puma et al., 1997) or additional professional development resources (Levine & Lezotte, 1995), while many of these studies clearly do not control for additional resources (Charles A. Dana Center, 1999; Fisher & Adler, 1999; Lake, McCarthy, Taggart, & Celio, 2000; Carter, 2000; Taylor, Pearson, Clark, & Walpole, 1999). In order to provide guidance to other schools and districts, studies of high-achieving sites need to address the use and sources of additional resources. Without controlling for resource usage, it is unclear how or whether such studies help to inform schools that do not have access to additional resources.

This literature does touch upon how decisions are made about resource allocation and describes systems where decisions about resource allocation are made at the school level through a group process (Purkey & Smith, 1983; Levine & Lezotte, 1995). This is consistent with the literature on capacity for changing instruction that highlights the importance of collaborative cultural norms of discourse. It is also consistent with the theoretical basis for school-based decision-making about

resource allocation (Odden, 1992; Miles & Darling-Hammond, 1998; Wohlstetter & Buffett, 1992), However, the evidence linking school-based resource allocation decisions with students' achievement is mixed (Leithwood & Menzies, 1998), which may be due to differing degrees of alignment between different school-level goals and students' achievement (Hanushek, 1994a).

Within the broader school finance literature, attempts have been made to link resource use with achievement, but the results are mixed. One way of examining resources and students' achievement is the statistical analysis of large-scale administrative and accounting data, which provides broad outlines of resource use. However, this body of research lacks sufficient detail about resource usage, school level variables, and classroom instruction to provide useful information about connections among these elements.

There is also mixed evidence about the connections between resource allocation and achievement. One reason may be that such studies, drawing on a production-function economic model, suffer both from poor measures of the factors thought to be important and incorrect specifications of the models used (Hanushek, 1979). Another reason may be that different researchers disagree about how to select and interpret the findings of different production-function studies linking resource expenditure with students' achievement. One example of the research conflict over the value of additional expenditures for student achievement is found in the contrasting findings of Hedges, Laine, and Greenwald (Hedges, Laine, & Greenwald, 1994; Greenwald, Hedges, & Laine, 1996) and Hanushek (Hanushek, 1989, 1994b, 1996; Hanushek & Rivkin, 1997). Both groups use a meta-analytic approach to determine a relationship between expenditures and achievement, but they come to different conclusions. While Hedges, Laine, and Greenwald argue that increases in educational expenditures would improve students' achievement; Hanushek and his colleagues refute such arguments.

The key finding from these resource-achievement studies, despite the rather important differences in interpreting the necessary *amount* of money spent, is that *how* money is spent is very important. In the words of Greenwald, Hedges, and Laine (1996), "We do not argue that money is everything. How we spend the money and the incentives we create for both children and teachers are equally important" (p. 385). Hanushek made the same point (1996) when he noted that "how resources are used will be more important than how many resources are used" (p. 407). These findings indicate the need for additional analysis at the school level of how resources are used.

Another methodological approach to school finance research offers some promise in linking resource allocation more strongly with school reform, broadly defined. This method consists of case studies of district and school behaviors and thus provides the needed contextual information about school and classroom-level variables that are so lacking in the large-scale resource-achievement studies. However, their findings are difficult to generalize. There are very few case studies that systematically address how resources are used in schools, and such studies often examine exemplary schools in terms of innovative strategies for resource use. These case studies usually address resource use in terms of (1) how personnel dollars are spent — that is, on aides compared to teachers; (2) how students are assigned to instruction — that is, use of pull-out programs; and (3) how school days are scheduled — that is, time used for collaborative planning and longer instructional blocks (Miles,

1995; Miles & Darling-Hammond, 1998; Odden & Archibald, 2000). Such studies may provide guidance in considering resource allocation to build capacity for changing instruction.

The work done by Miles and Darling-Hammond (1998) in particular, has underlined the link between resource allocation and instructional strategies. They developed five principles of resource allocation to align resources in support of school goals:

1. Reduction of specialized programs
2. Flexible student grouping
3. Structures to create more personal environments
4. Longer, more varied blocks of instructional time
5. More common planning time

Miles and Darling-Hammond (1998) argue that, in exemplary schools, "resource reallocation and the design of an instructional vision and strategy are intertwined" (p. 27). That is, an instructional vision provides the reasoning behind resource allocation in these schools. Resources are allocated to meet learning goals as opposed to the traditional bureaucratic reasoning behind resource allocation.

This theme of the link between resource allocation and instructional vision is expanded upon by Odden and Archibald's case studies of reforming schools' resource allocation and reform strategies (2001). The focus of the book is *how to* reform instead of research *on* reform, a fact that underscores the lack of research on resource use in schools but does provide a good framework for thinking about resources within a school. It has a specific focus on class size, staffing, and finding resources to support struggling students, new additions to the literature. A key lesson in this work is the need for schools to change individual instruction plans to align with the school's instructional vision and resource allocation strategy.

Odden and Archibald's case studies are in line with the general research on capacity for raising achievement and for changing instruction. Although both areas of research lack systematic exploration of those resources necessary and how specifically they are used in different sites, each tends to emphasize the importance of focused resource allocation that supports progress toward the instructional vision (Goertz et al., 1995; Knapp, 1997; Lake et al., 1999; 2000; Learning Research and Development Center, 1999). In some cases, this entails an effort to focus resources on one topic or subject (Carter, 2000; Education Trust, 1999).

Resource allocation for professional development is a common theme across the capacity research. Studies of sites with capacity for raising students' achievement focus on areas where these sites have changed or expanded resource use around professional development and staffing or scheduling changes. Many studies have described intensive use of professional development strategies (Purkey & Smith, 1983; Levine & Lezotte, 1995; Briggs & Thomas, 1997; The Charles A. Dana Center, 1999; The Education Trust, 1999: Lake et al., 1999). Resources for this professional development can either come from outside sources or from refocusing the site's existing professional development resources. They also include providing time to support teacher planning and collaboration (Purkey & Smith, 1983; Briggs & Thomas, 1997), which also may entail the revision of class and planning

schedules and student grouping structures (Levine & Lezotte, 1995; Purkey & Smith, 1983; Education Trust, 1999). These findings are echoed in the research about organizational capacity for changing instruction described previously (e.g., Learning Research and Development Center, 1999; Elmore, 1997; Knapp, 1997; Goertz et al., 1995).

In general, the broad study of resource allocation for professional development is plagued by problems. One problem is that the measures are inadequate. For example, the accounting data used in many macro-studies of school finance seldom have an item called professional development, although Picus (2001) in a review of education expenditure research, found that districts spend about 5 percent of their revenue on "instructional support," a category that may entail professional development among other things (e.g., instructional coordination, program development, and supervision). Related to this problem, many resources that are devoted to professional development are hidden, particularly that of teacher time. For instance, many districts schedule a number of days per year for teachers without student contact time, but whether professional development occurs during this time is not recorded and neither is the cost of this time accounted for as professional development.

There are a few studies that have begun to systematically address the resources needed to change classroom instruction. District 2 was able to direct three percent of its resources towards professional development. This is assumed to be a low-end estimate because it does not capture the cost of teacher and principal time during the school day and year which is part of the existing salary budget. The majority of District 2 professional development resources paid for teachers' time in the first year of the reform. As the reform progressed, the reported professional development resource use moved more towards contracted services (Elmore, 1997). It is possible that during the later years of the reform, training occurred during the regular school day and year, essentially hiding the cost of participants' time within the existing salary budget.

In a study of New American Schools (NAS) comprehensive school reform designs, Keltner (1998) was able to measure the cost of personnel time. He found that the cost of NAS model implementation usually was about $162,000. Of this cost, 40 percent was for teachers' time for professional development and planning, 36 percent was for additional personnel, 16 percent was for design services and 8 percent for materials. An important insight from this research is that the cost of teachers' time for reform was over two and one-half times the cost of the professional development services.

The study of resource allocation in relation to school and district capacity for raising students' achievement and for changing instruction is in need of a systematic approach. In general, the research on resources indicates that high-capacity sites have worked to realign their resource allocation so that it supports new structures and schedules and focuses on an organizational vision of instructional improvement. Frequently, this entails an investment in professional development for a variety of learners in the system, as well as creative reallocations of time and other available resources to support instructional change. However, the resource literature, as a whole, is not tightly linked to classroom practices and the link between resources and students' achievement is still a matter for debate.

The work of Miles and Darling-Hammond (1998) and Odden and Archibald (2001) offers promise for measuring and examining resource use and providing theoretical links between resource use and other factors within the school including instruction and students' achievement. But the methods used so far and the minimal number of studies conducted makes definitive links between resource use and practice unclear. Further research is needed to strengthen this link. Additionally, the existing research on resources for professional development underscores the difficulty in completely capturing the resources that are devoted to reform. An efficient systematic resource study of professional development needs to take into account those resources directed to schools from districts as well as school-controlled resources (such as teacher time) and external resources (e.g., grants).

SUMMARY AND CONCLUSIONS

Education policies, such as standards policies, are implemented within a complex and loosely coupled organizational context. Teachers are key to the success of standards-based reforms in education; however, their interpretation and implementation of standards as ambitious learning opportunities for all students is particularly dependent on how well their schools and districts support and sustain them as they enact these interpretations in their classrooms. Therefore, the organizational capacity of schools and districts to support high student achievement and changes in instructional practice is crucial.

In order to effect positive instructional change and improved student achievement, many, if not all, elements of the organizational context need to be aligned toward the goal of improving student learning. However, the specific nature and sequence of this alignment process is dependent on the particular elements or variables that need to change. The current chapter has provided a broad layout of the different elements involved, and other chapters in this work have provided insight about the types of changes that may be required in professional development and in classroom instruction. Specific recommendations for action are highly dependent on local organizational needs.

The following lists provide general research recommendations. In organizations with high capacity for raising achievement and for changing instruction in ways that are consistent with increased student achievement and ambitious standards, the research indicates several things.

The organizational vision

- is ambitious and clear and addresses the learning of all students;
- is exemplified by multiple measures of student learning;
- has clear implications for classroom practices;
- unifies the entire organizational culture;
- shapes resource allocation and action in order to support progress toward the vision; and
- helps to guide shorter-term goals that are structured so that early successes are more easily attainable, in order to help build organizational momentum for further progress.

Organizational leadership

- communicates, builds, and sustains the organization's focus on students' learning;
- supports a collaborative organizational culture;
- supports teacher learning; and
- is distributed across roles in the organization and draws on different individuals' expertise.

Data-driven decision making

- is characterized by the use of data in organizations to support strategic decision making;
- focuses on student learning issues;
- is structured in relation to measuring progress toward organizational goals;
- informs systematic responses (programmatic and individual/instructional) to areas where student performance needs to improve;
- highlights and helps target areas where support and resources are needed; and
- is supported by both formal and informal support structures.

Capacity-building structures

- include formal and informal grouping, networking, and scheduling of teachers and students;
- are organized to maximize understanding of the common vision;
- are organized to support individuals in learning what they need to know to reach the vision; and
- are focused on collaborative support of student learning that enables classroom-level reform.

Collective commitment and cultural norms

- are characterized by an inquiry stance to teaching and learning; and
- are unified by a belief that all students can learn to high levels.

Resources

- consist of time, money, and personnel expertise;
- are collected, allocated, and reallocated creatively in high-capacity sites;
- are organized primarily in support of progress toward the organizational vision; and
- are reallocated through changes in staffing, scheduling, and grouping procedures in order to free up time for teachers and others to learn what they need to improve students' achievement and to change classroom instruction.

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CHAPTER 5:
SUMMARY OF THE STATUS OF RESEARCH

To accomplish the goal of organizing and describing recent research and reports about standards-based education, the authors of this synthesis select, review, and present information in categories of proximity to student learning. Beginning closest to the student, these categories are standards-based classroom practices, teacher knowledge and beliefs, and organizational capacity. The discussion of standards-based classroom practices focuses on literacy and mathematics since these are the areas most often assessed at the state level and, therefore, are most relevant to a wide audience.

The chapters on standards-based classroom practices in literacy and mathematics, Chapters 2 and 3, describe what students should know and be able to do according to national-level standards documents. Based on the literacy and mathematics standards, the literature is synthesized around components of effective classroom practices to answer these questions: What classroom practices enable all students to achieve high literacy standards? What classroom practices enable all students to achieve high mathematics standards?

EFFECTIVE STANDARDS-BASED CLASSROOM PRACTICES: COMMON THREADS IN LITERACY AND MATHEMATICS

There are several practices that are effective in promoting students' learning of standards in both literacy and mathematics. One of these practices is using a curriculum that covers the breadth and depth of knowledge reflected in the standards and balances understanding of concepts with the development of skills. Another practice is focusing on the development of students' understanding, not just of basic concepts but of higher order knowledge and skills as well. To accomplish this, teachers need to ensure that students have opportunities to apply their developing knowledge in meaningful ways. In literacy, this includes engaging students in the study of language, providing plenty of opportunities for them to read personally meaningful texts, and presenting writing tasks with clear criteria for quality that require them to write for a variety of audiences and purposes. In mathematics, this means presenting students with tasks that encourage them to make connections between mathematics and other content areas and that enhance their ability to solve problems and communicate mathematical reasoning. Discussion plays a key role in developing students' understanding. Effective discourse helps students examine and re-examine their knowledge, test their understanding, revise ideas, and elaborate and clarify their thinking. To use discussion effectively in the classroom, teachers must ask questions that engage and challenge students' thinking, know when to provide information and when to let students figure things out on their own, and know when and how to encourage students to participate.

Another effective practice is tailoring instruction to students' needs; assessment is an important part of this practice. Gathering information about students' progress in a variety of ways and at frequent intervals during instruction helps teachers assess students' understanding and their misconceptions. Effective teachers use this information to adjust instruction and provide early interventions to help students who are falling behind or in danger of doing so. Tailoring instruction also means finding ways to connect to students' background, interests, and prior knowledge and knowing how students'

learning may be influenced by these factors. Effective teachers know their content area and how students learn it. They also have effective behavior and management skills and understandings, including knowledge of their students — their level of knowledge, how far they have progressed, what they can learn on their own, and what they need to be taught.

PROFESSIONAL DEVELOPMENT AND ORGANIZATIONAL CAPACITY

Most teachers currently do not know how to implement the range of classroom practices that enable all students to achieve high standards. There is much knowledge and many new skills that they must acquire. Chapter 3 addresses the question, How do teachers learn what they need to know and do to ensure that all students achieve standards? Literature on teacher learning and professional development indicates that implementing effective standards-based classroom practices requires significant investment of resources in professional development and extensive changes in what teachers learn as well as how they learn it.

To acquire new knowledge and skills, teachers need to be treated as learners. This means that basic principles of adult learning must be applied to the design and implementation of teacher professional development. When these principles are applied, professional development provides teachers with opportunities to engage in higher order thinking, problem solving, and resolving conflicts between current and more effective beliefs and practices. Further, teachers are given sufficient time to practice and revise their new learning and have opportunities to learn through collaboration with other teachers.

Changes in classroom structures and processes and increased teacher knowledge and skills have to be supported by significantly increased organizational capacity that is not present in most schools. This synthesis addresses the question, What organizational capacities are needed to use standards effectively in support of high-performing learning communities? Chapter 4 includes a discussion of the role that local capacity plays in the interpretation and implementation of policies related to standards and assessments. It also synthesizes research on the key elements of organizational capacity and discusses them in relationship to two types of organizational capacity — the capacity to raise students' achievement and the capacity to change instruction.

The literature on organizational capacity indicates that contextual elements are very important in shaping school- and classroom-level responses to standards. Whether standards are interpreted primarily as accountability tools, with little attention to classroom practice, or whether they are interpreted as guidelines for practice that help all students learn to high levels depends largely on the extent to which the local school and district provide support for such interpretations.

Several important elements of organizational capacity have been identified in the research. These elements include a vision that sets high expectations for all students, strong leaders who convey the vision to others, and resources to support learning the content and pedagogical knowledge needed to implement reform. Leaders also keep the focus on student learning, use data to develop a sense of urgency and commitment, and guide decisions about school improvement and classroom practice.

FOR FURTHER STUDY

The research presented in this synthesis provides guidance about effective instructional practices, professional development, and organizational capacity. But many questions remain in each of these areas.

A primary goal of instruction in standards-based education is to develop students' understanding and ability to apply knowledge. Yet, we still need to know which strategies promote students' engagement in instruction that develops their understanding. Further, do high-needs students need to be prepared to engage in this type of instruction? If so, what specific strategies can help engage them, and how are these strategies the same or different for different populations of high-needs students?

Each student presents a somewhat unique challenge to the teacher. This means that teachers must examine their practice and continually learn from the outcomes it yields. But questions remain. For example, What incentives, supports, and resources allow teachers to examine their practice and continually improve it? How should these incentives, supports, and resources differ for novice and veteran teachers?

We know that a number of variables influence the effectiveness of professional development, but we need to know more about the relative contributions of each. What characteristics of professional development are necessary and sufficient to result in teacher learning? An important influence on the outcomes of professional development is a school culture that values teacher learning and that encourages teachers to be leaders. But how can schools develop such cultures, particularly in contexts of poverty and low student achievement?

Research is fairly clear about key elements of organizational capacity, but it is not clear how to develop and sustain these elements in a variety of settings. The relationships among the elements also are not yet obvious. For example, what are the trade-offs between a tightly focused vision and the breadth of student content learning? If the vision focuses on literacy development, for example, is students' learning in science, social studies, or the arts compromised?

Research does not provide clear guidance about how components of capacity should be combined into a systemic model of reform that ensures that students achieve high standards. Each component of capacity represents a necessary but not sufficient condition for reform to be implemented. However, because the research has not been systematic in exploring the interrelationships of different capacity components, this remains an area that merits further exploration.

Whether organizational capacity is defined as the ability to raise students' achievement or to change instructional practice, data about students' progress are typically used to determine the level of capacity. The content and technical qualities of assessments affect the clarity with which research can define and specify organizational capacity and determine effects on students' achievement. New research is needed using assessments that represent the depth and breadth of knowledge in standards and have the technical quality needed to determine true growth in students' achievement.

Through its descriptions of the goals for students' learning and teachers' instructional practices that help students reach those goals, this synthesis helps clarify what standards-based classrooms look like. In these classrooms, teachers actively engage students in meaningful tasks and productive discussions that develop students' understanding and ability to apply knowledge. The research synthesized in this document validates the instructional practices of good teachers. It also highlights the changes in instruction that must occur if all students are to reach high standards and provides guidance about instructional strategies and skills that teachers should acquire to increase their effectiveness.

Research does not yet provide guidance on how to address all of the issues raised when implementing standards-based education. It does, however, describe some ways that various components of the system (instructional practice, professional development, and organizational capacity) can support the learning of both students and teachers. The challenge is to put into practice what we know about the elements of the system and their interactions and continue to refine and extend our knowledge about how to make the system work effectively. In this way, the vision of improved teaching and learning that is at the core of standards-based education can be realized.

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Bredeson and Johansson describe results from 48 structured interviews of principals, school administrators, and teachers to examine the range of school principal roles related to teacher professional development. The researchers found that principals influence professional development in four areas. First, principals are both instructional leaders and co-learners with teachers. Second, principals create a supportive learning environment for teachers by providing appropriate resources and opportunities for practice. Third, principals work with teachers in the design, delivery, and content of professional development. Fourth, principals assess the impact of professional development in their schools. The authors give an in-depth analysis of principals as facilitators of teacher learning.

Charles A. Dana Center. (1999). *Hope for urban education: A study of nine high-performing, high-poverty urban elementary schools.* University of Texas, Austin: Author.

In 1999, the Charles A. Dana Center released the results of its case study of nine high-performing, high-poverty urban elementary schools that served predominantly poor students, did not have selective admission policies, and had scores higher than the state average on student achievement tests in mathematics and reading over three years. Although there were some key differences across schools, the study found some important similarities in the strategies used. The strategies included identifying symbolic, visible early goals so that early successes could provide momentum for later more difficult work, an organizational focus on collective responsibility for serving children and improving the schools, alignment of instruction to standards and assessments and increased instructional time, and ensuring access for educators to the training and resources they felt they needed to get students to achieve to high levels.

Cohen, D. K., & Hill, H. C. (1998, January). *State policy and classroom performance, Mathematics reform in California* (CPRE Policy Briefs, RB-23-January). Philadelphia: Consortium for Policy Research in Education.

To better understand the influence of professional content, the researchers studied the influence of professional development in mathematics on the classroom practices of a random sample of 1000 California teachers in grades two through five. They compared curriculum-centered workshops with special topics/issues workshops. Teachers who spent more time in the curriculum workshops than in the special topics workshops reported using more instructional practices that are aligned with the California mathematics curriculum compared to teachers who spent more time in topical workshops. In addition, schools with higher proportions of teachers participating in curriculum-centered professional development had higher student achievement scores on the state test. The study indicates the importance of aligning professional development with the curriculum in use.

D'Amico, L., Harwell, M., Stein, M. K., & van den Heuvel, J. (2001, April). ***Examining the implementation and effectiveness of a district-wide instructional improvement effort.*** **Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.**

The subject of this paper is the link between teacher learning and student learning in New York City's District 2 using the statistical technique of Hierarchical Linear Modeling. The researchers found that instructional leadership supported high-quality professional development in mathematics and literacy. In addition, teachers in grades three through five who reported having high-quality professional development in the district's mathematics framework had students with higher achievement in mathematics compared to teachers who reported lower quality professional development. In literacy, students' achievement was most closely correlated with the alignment of teacher instruction with the district's literacy framework. The study is an example of how research can help establish the elusive link between professional development, school practices, and student outcomes.

Education Trust. (1999). ***Dispelling the myth: high poverty schools exceeding expectations.*** **Washington, DC: Author.**

The Education Trust/CCSSO study (1999) consisted of survey data from principals in 21 states. Principals were sampled from schools that serve poor populations but which are high performing. According to this study, these schools used state standards extensively to design curriculum and instruction, assess student work, and evaluate teachers and increased instructional time in reading and math in order to help students meet standards. They devoted a larger proportion of funds to support professional development than lower achieving schools; and implemented (1) comprehensive systems to monitor individual student progress and provide extra support to students as soon as it was needed, and (2) state or district accountability systems with real consequences for adults in the schools. They also focused efforts on involving parents to help students meet standards.

Elmore, R. F. (2000). ***Building a new structure for school leadership.*** **The Albert Shanker Institute.**

Based on a synthesis of different studies, this analytical essay puts forth an argument for structures of distributed leadership throughout the educational system within a teaching and learning perspective on standards implementation. After identifying five principles for this model in education, Elmore goes on to recommend design principles for large-scale improvement, including maintaining a tight instructional focus over time, making accountability for learning routine, reducing teacher isolation, basing differential treatment on performance and capacity, and devolving increased discretion based on practice and performance. These design principles imply an infrastructure organized around a common goal for which all stakeholders are broadly accountable and which uses regular and broadly supported feedback measures about progress toward that goal. They also allow for variation in management structures and routines depending on the progress of different units toward this goal.

Elmore, R. F. (with Burney, D.). (1997). *Investing in teacher learning: Staff development and instructional improvement in Community School District #2, New York City.* New York: National Commission on Teaching and America's Future.

The author describes how district improvement and professional developmental strategies were instrumental in the success of District 2 in New York City. The district introduced changes in instruction in phases organized around content areas, starting with literacy. Managerial tasks such as staff meetings and annual improvement plans revolved around the improvement of instruction through staff development. There was a balance of authority between the central office and individual schools. However, the district exerted control when success depended on schools being aligned with district-wide instructional improvement. The article illustrates the powerful influence that district policies and practices can have on professional development and improvement in teaching.

Fennema, E., & Romberg, T. (Eds.). (1999). *Mathematics classroom that promote understanding.* Mahwah, NJ: Erlbaum.

Carpenter, T., & Lehrer, R. (1999). Teaching and learning mathematics with understanding. In E. Fennema & T. Romberg (Eds.), *Mathematics classrooms that promote understanding* (pp. 19–32). Mahwah, NJ: Erlbaum.

Fennema, E., Sowder, J., & Carpenter, T. P. (1999). Creating classrooms that promote understanding. In E. Fennema & T. A. Romberg (Eds.), *Mathematics classrooms that promote understanding* (pp. 185–199). Mahwah, NJ: Erlbaum.

This book is a compilation of papers that address teaching mathematics with understanding written by prominent researchers of mathematics education. The first section consists of chapters that define teaching mathematics with understanding. For example, in Chapter Two, Carpenter and Lehrer present critical dimensions of classrooms that promote understanding: tasks engaged in for fostering understanding, tools used to represent mathematical ideas and problem situations, classroom norms of seeking understanding, structuring and applying knowledge, reflection and articulation, and making knowledge one's own. Subsequent chapters address the specific topics of numbers, space, middle school mathematics, statistics, and algebra. Finally, assessment and classroom practices are presented in concluding chapters. A common theme to these chapters is the importance of teacher content knowledge and effective professional development experiences for teachers.

Goertz, M. E., Floden, R. E., & O'Day, J. (1995). *Studies of education reform: Systemic reform. Volume I: Findings and conclusions.* Rutgers, NJ: Consortium for Policy Research in Education [CPRE].

In a comprehensive CPRE study of systemic reform implementation, Goertz, Floden, and O'Day define organizational capacity as an enabling factor for building teachers' individual capacities for delivering ambitious instruction and report that the most salient influences on teacher capacity and practice are at the school or sub-school unit. Five dimensions of this definition of capacity for changing instruction are provided, including vision and leadership, collective commitment and cultural norms, knowledge or access to knowledge about what to change about instruction, supportive organizational structures, and adequate resources. Further, the extent to which different aspects of

instructional reform actually help to build local capacity is dependent on the degree to which they "are explicitly designed and used to foster learning among individuals and organizations within and around the system" (p. 123).

Hedges, L. V., Laine, R. D., & Greenwald, R. (1994). Does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes. ***Educational Researcher*****, 23(3), 5–14.**

Hanushek, E. A, (1994b). Money might matter somewhere: A response to Hedges, Laine and Greenwald. ***Educational Researcher, 23*****(4), 5–8.**

Although it may seem obvious on its face that additional expenditures will increase students' achievement, these articles highlight the fact that research in this area has mixed findings. This exchange centers on contrasting findings from meta-analyses of education production function studies. These studies use accounting data to analyze the relationship between school expenditures and students' achievement, which can result in serious technical constraints on the validity of the studies. Recognizing these constraints, these researchers use meta-analysis of multiple studies, assuming that by looking at many studies a clear relationship will emerge. But the researchers disagree on how to select and interpret the multitude of production function studies, and because of these disagreements come to different conclusions. Hedges, Laine and Greenwald argue that their meta-analysis shows that increases in expenditure improve students' achievement. Hanushek argues that there is no relationship between increased expenditures and increased student achievement. Despite these rather core differences in findings, these two groups of researchers move towards agreement on a key point: how money is spent is very important.

Indrisano, R., & Squire, J. R. (Eds.). (2000). ***Perspectives on writing: Research, theory, and practice.*** **Newark, DE: International Reading Association.**

This book presents theory and research for designing more effective classroom practice in writing. Twelve chapters written by distinguished researchers and teacher-scholars offer excellent reviews of research on writing and vocabulary development, the reading-writing connection, mental processes and writing mechanics, classroom practice, writing to learn, and use of portfolios. This book also includes an annotated bibliography of key research.

Kilpatrick, J., Swafford, J., & Findell, B. (2001). ***Adding it up: Helping children learn mathematics.*** **Washington DC: National Academy Press.**

This report, written by the National Research Council's Mathematics Learning Study Committee, provides a thorough presentation of goals for school mathematics in pre-kindergarten to eighth grade. The document focuses primarily on the topic of numbers and operations in those grades, though additional topics are addressed to a lesser degree. The document defines mathematical proficiency as a combination of the following five strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. The report also presents summaries of research about important instructional issues in mathematics education such as task selection and use, teacher planning, classroom discourse, grouping students, and using manipulatives.

Learning Research and Development Center. (1999, March). *High performance learning communities project final report.* Pittsburgh, PA: University of Pittsburgh.

This report is the final report of a group of studies on New York's Community School District 2. It explores the district's policies, leadership, achievement, and organizational practices and provides a summary description of the elements of capacity for changing instruction that include focus and coherence of vision, an emphasis on student performance as the criterion against which all new initiatives are judged, the idea of a continually rising level of expectations for students, support of open discussion about new initiatives, and the idea that resources are to be allocated to follow problems.

Lieberman, A., & Grolnick, M. (1996). Networks and reform in American education. *Teachers College Record, 98*(1), 7–45.

Based on an in-depth analysis of 16 education reform networks, this study examines the characteristics that are common to the teacher professional development approach of networks. The authors describe organizational themes that the networks demonstrate such as developing purposes, building commitment, using activities and relationships to support collaboration, defining leadership responsibilities, and finding funding sources. Networks also face tensions, such as balancing flexibility with formal rules of operation and balancing insider knowledge with knowledge from outside experts. As a professional development format, participants' learning is indirect, making it difficult to measure the impact of a network. The article provides extensive examples of different kinds of teacher networks, how they operate as sources of teacher learning, and how they negotiate the various tensions that occur.

Means, B., Chelemer, C., & Knapp, M. (1991). *Teaching advanced skills to at-risk students: Views from research and practice.* San Francisco: Jossey-Bass.

Means, B. & Knapp, M. S. (1991). Rethinking teaching for disadvantaged students. In B. Means, C. Chelemers, & M. S. Knapp (Eds.), *Teaching advanced skills to at-risk students: Views of research and practice* (pp. 1–26). San Francisco: Jossey-Bass.

This book is made up of chapters by leading researchers and educators who have developed and studied approaches to teaching advanced skills to educationally disadvantaged students. As a whole, the authors provide convincing evidence that at-risk students can learn complex, meaningful material when innovative methods of instruction are used. The authors espouse the integration of basic and advanced skills, providing opportunities for students to apply skills to novel and complex tasks at all stages of their education. The chapters focus specifically on effective mathematics and literacy instruction. The concept of teachers as "cognitive apprentices" of students is presented and elaborated. The last chapter addresses systemic supports that are required to implement the instructional models, including professional development and school schedules.

Miles, K. H., & Darling-Hammond, L. (1998). Rethinking the allocation of teaching resources: Some lessons from high-performing schools. ***Educational Evaluation and Policy Analysis, 20*****(1), 9–29.**

This work provides five useful resource allocation principles to school administrators:

- Reduction of specialized programs
- Flexible student grouping
- Structures to create more personal environments
- Longer, more varied blocks of instructional time
- More common planning time

The research uses case studies to draw lessons from how resources are allocated in exemplary schools. The researchers found in a sample of exemplary schools "resource reallocation and the design of an instructional vision and strategy are intertwined" (p. 27). For example, the elementary schools used resources from special programs (i.e. Title 1 or Special Education) to reduce class size either for the whole day or in a single subject depending on the school's goals. For each of the five principles the authors also created are easy to understand and calculate measures to describe principle implementation.

This work is one of the earliest looks into how resources can be allocated to support achievement and laid the groundwork for additional work into resource re-allocation to support students' achievement.

National Commission on Teaching and America's Future. (1996). ***What matters most: Teaching for America's future.*** **New York: Author.**

In this initial policy report, the National Commission on Teaching and America's Future gives recommendations for improving the quality of teaching in the United States. These are based on the premises that teachers are the most important influence on students' learning; that school improvement depends on recruiting, preparing and retaining good teachers; and that for reforms to succeed, schools need to create conditions for effective teaching. The report describes results from both quantitative research and qualitative case studies to support their five recommendations: (1) enforce standards for students, teachers, and schools of education; (2) reorganize professional development and teacher preparation to align with standards and teacher learning needs; (3) develop new methods of recruiting qualified teachers; (4) reward teachers' knowledge and skills through career incentives; and (5) create schools that are organized for success through appropriate funding and leadership.

National Reading Panel (NRP). (2000). ***Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.*** **Washington, DC: Author. Retrieved April 20, 2001, from http://www.nichd.nih.gov/publications/nrp/smallbook.htm. Also available in hard copy from the National Institute for Literacy (www.nifl.gov).**

This is a report of five reviews of research on the efficacy of materials and practices used in teaching reading, specifically for teaching alphabetic knowledge and skills, fluency, and comprehension. The final two reports are on teacher education and computer technology. Each

report analyzes evidence and provides conclusions about the readiness of materials and practices for adoption in classrooms.

Porter, A. C., Garet, M. S., Desimone, L., Suk Yoon, K., & Birman, B. F. (2000). *Does Professional development change teaching practice? Results from a three-year study.* Washington, DC: U.S. Department of Education.

The focus of this report is a three-year national longitudinal study of the effects of the Eisenhower professional development program in mathematics and science on teachers' classroom practices. The study extends earlier findings that structural professional development features (e.g., duration) influence the intensity of core features (e.g., content focus), and core features influence the impact of the learning experience on teachers' reported growth in knowledge, skills, and teaching practices. In the longitudinal study, professional development that was coherent, involved active learning, and had a reform-type format (e.g., study groups vs. workshops) was associated with teachers' reported increased use of active project-centered classroom instruction. Professional development that emphasized methods for teaching higher-order learning (e.g., interdisciplinary methods) were associated with teachers' reported increased use of higher order instruction, and this occurred more so if the professional development had the effective features identified in the earlier study. On the average, teachers did not report changes in their practices over the three years of the study (although individual teachers did), and teachers from the same school reported different professional development experiences. The authors recommend that schools provide more coherent high-quality professional development. The report includes extensive presentations of data relating professional development activities to teachers' reported classroom practices.

Pressley, M., Wharton-McDonald, R., Allington, R., Block, C. C., Morrow, L., Tracey, D., et al. (2001). A study of effective first-grade literacy instruction. *Scientific Studies of Reading, 5*(1), 35–58.

This article reports results of a multi-site study of effective first-grade literacy teachers. An appendix of key classroom practices is provided. This list of key practices can help operationalize sophisticated pedagogical content knowledge in beginning literacy.

Ragland, M. A., Asera, R., & Johnson, J. F., Jr. (1999). *Urgency, responsibility, efficacy: Preliminary findings of a study of high-performing Texas school districts.* University of Texas, Austin: The Charles A. Dana Center.

This case study examines school districts characterized by high student achievement with at least one-third of their high-poverty schools receiving a Recognized or Exemplary rating on the Texas accountability system. The study used source data consisting of interviews of central office and school site administrators, observations of board and staff meetings, and district documents and data sources. District actions are described in terms of creating a sense of urgency about student learning, frequently using student achievement data, sharing responsibility for students' achievement, and aligning resources and structuring support.

Silver, E. A., & Kenney, P. A. (2000). *Results from the seventh mathematics assessment of the National Assessment of Educational Progress.* Reston, VA: National Council of Teachers of Mathematics.

Dossey, J. A. (2000). The state of NAEP mathematics findings: 1996. In E. A. Silver & P. A. Kenney (Eds.), *Results from the seventh mathematics assessment of the National Assessment of Educational Progress* (pp. 23–44). Reston, VA: The National Council of Teachers of Mathematics.

Grouws, D. A., & Smith, M. S. (2000). NAEP findings on the preparation and practices of mathematics teachers. In E. A. Silver & P. A. Kenney (Eds.), *Results from the seventh mathematics assessment of the National Assessment of Educational Progress* (pp. 107–140). Reston, VA: The National Council of Teachers of Mathematics.

Strutchens, M. E., & Silver, E. A. (2000). NAEP findings regarding race/ethnicity: Students' performance, school experiences and attitudes and beliefs. In E. A. Silver & P. A. Kenney (Eds.), *Results from the seventh mathematics assessment of the National Assessment of Educational Progress* (pp. 45–72). Reston, VA: The National Council of Teachers of Mathematics.

This book contains chapters by researchers of various aspects of 1996 and previous NAEP assessment databases. Interpretive reports are based on NAEP findings in the following areas: the cognitive performance of students at grades 4, 8, and 12 on multiple-choice, short constructed-response, and extended constructed-response items; students' responses to a variety of background questions dealing with their attitudes and beliefs concerning mathematics and their participation in various forms of classroom activity; and teachers' responses to various background questions dealing with the nature of their mathematics instruction. Results are summarized for the different content areas (whole number properties and operations, rational numbers, geometry and measurement, data and chance, algebra and functions) and for subgroups of students by gender and race/ethnicity.

Silver, E. & Stein, M.K. (1996). The QUASAR Project: The revolution of the possible in mathematics instructional reform in urban middle schools. *Urban Education, 30*(4), 476–521.

This paper reports findings from a five-year project examining the implementation of an innovative mathematics program in six urban, diverse, high-poverty schools. The program, titled QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning), provides students with instruction to develop understanding of mathematics concepts through engagement with challenging mathematics tasks. QUASAR is intended to blend focus on basic skills and conceptual understanding, reasoning, and problem solving. The program also includes a broad range of math content topics, and provides opportunities for students to communicate and collaborate. Performance on NAEP assessment items showed a better performance by QUASAR students than demographically similar students throughout the nation, particularly on items assessing conceptual understanding and problem solving and constructed-response items. Impediments to implementing the QUASAR program were lack of teacher content knowledge and teacher and administrator turnover.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

This National Research Council report provides an integrated picture of how reading develops and how reading instruction should proceed. There are chapters on preventing reading difficulties before kindergarten, instruction for kindergarten and primary grades, classroom organization for kindergarten and primary grades, and helping children with reading difficulties in grades 1–3. Also included, is a list of grade level accomplishments (K–3) for reading development.

Sprinthall, N. A., Reiman, A. J., & Thies-Sprinthall, L. (1996). Teacher professional development. In J. Sikula, T. J. Buttery, & E. Guyton (Eds.), *Handbook of research on teacher education* (2nd ed., pp. 666–703). New York: Macmillan Library Reference USA.

This book chapter provides a review of the theory and research on teacher professional development and examines the evidence for teacher growth as a result of various types of programs. There is first a discussion of theories related to the teacher as an adult learner. Next, different models for teacher development are described, such as the craft model (e.g., case studies), the expert model (training on the use of expert strategies), expanding the repertoire (e.g., training on comprehensive instructional approaches) and interactive models (e.g., teacher induction). The authors found positive evidence to support the view of the teacher as a learner who can benefit from professional learning that requires conceptual complexity. The chapter is a good intellectual overview of how research on teachers' professional learning relates to the broader fields of adult development and learning.

Strickland, D. S., Bodino, A., Buchan, K., Jones, K. M., Nelson, A., & Rosen, M. (2001). Teaching writing in a time of reform. *The Elementary School Journal, 101*(4), 385–397.

These authors report teacher-scholar reflections on the impact of standards and accountability on writing instruction. Teachers reported that as a result of standards and accountability pressures, they increased their use of rubrics and shared problem solving with peers but also that there was insufficient time to teach writing.

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